Appendix G

Project-Specific Water Quality Management Plan

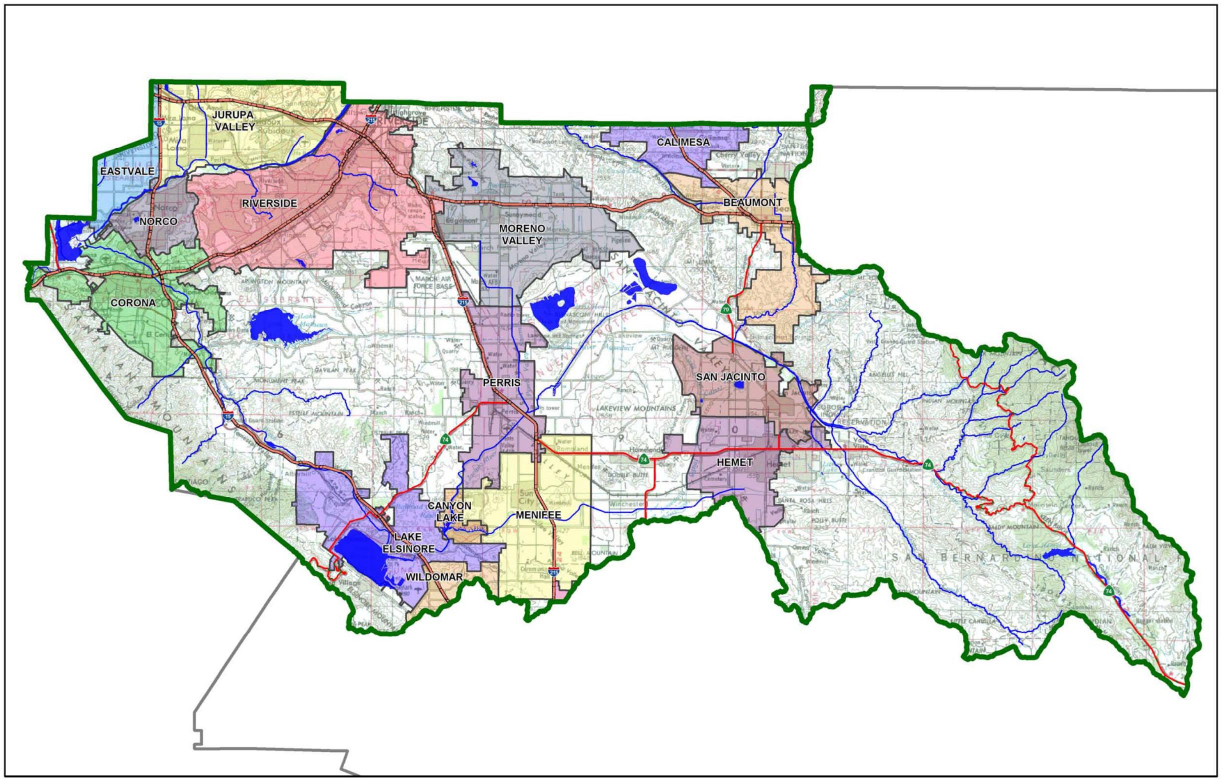
Project Specific Water Quality Management Plan

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

Project Title: Bamiyan Marketplace

Development No: TTM 37578

Design Review/Case No: PWQMP-2021-0005



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☒ **Preliminary**
☐ **Final**

Original Date Prepared: May 5, 2021

Revision Date(s): N/A

Prepared for Compliance with
Regional Board Order No. **R8-2010-0033**

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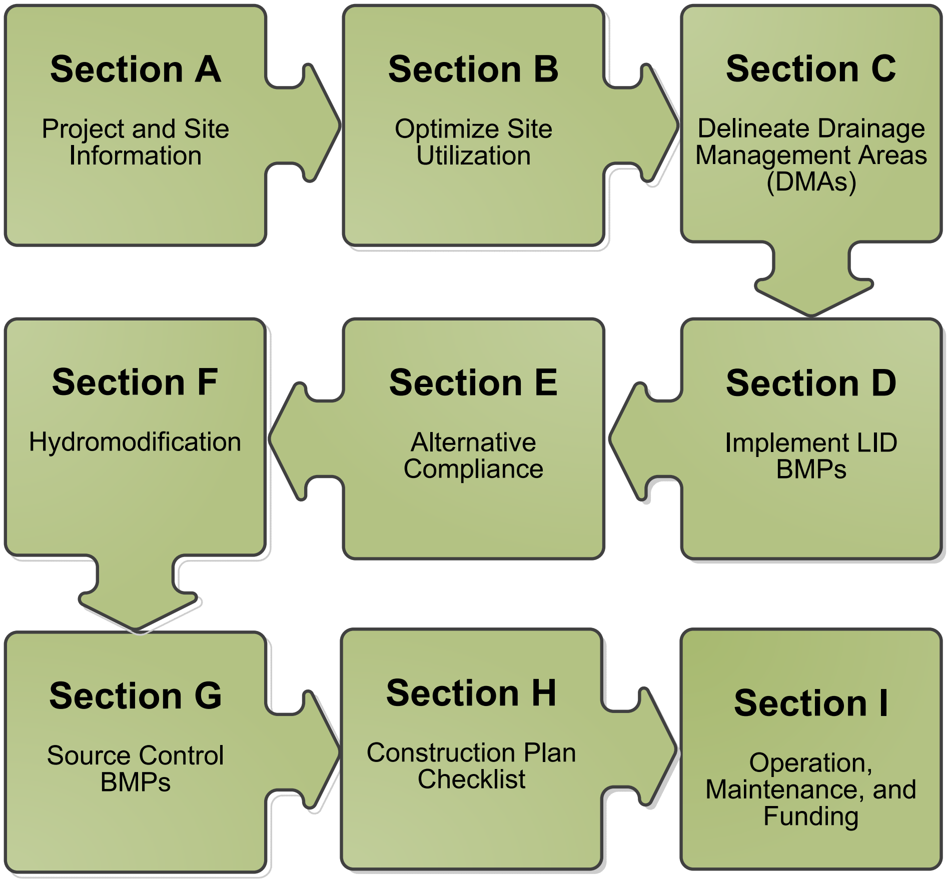
A Brief Introduction

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



OWNER'S CERTIFICATION

This Project-Specific Water Quality Management Plan (WQMP) has been prepared for **ZAIREY, Inc** by **SB&O, Inc**. for the **Bamiyan Marketplace** project.

This WQMP is intended to comply with the requirements of **City of Lake Elsinore for TTM TTM 37578** which includes the requirement for the preparation and implementation of a Project-Specific WQMP.

The undersigned, while owning the property/project described in the preceding paragraph, shall be responsible for the implementation and funding of this WQMP and will ensure that this WQMP is amended as appropriate to reflect up-to-date conditions on the site. In addition, the property owner accepts responsibility for interim operation and maintenance of Stormwater BMPs until such time as this responsibility is formally transferred to a subsequent owner. This WQMP will be reviewed with the facility operator, facility supervisors, employees, tenants, maintenance and service contractors, or any other party (or parties) having responsibility for implementing portions of this WQMP. At least one copy of this WQMP will be maintained at the project site or project office in perpetuity. The undersigned is authorized to certify and to approve implementation of this WQMP. The undersigned is aware that implementation of this WQMP is enforceable under **City of Lake Elsinore** Water Quality Ordinance (Municipal Code Section14.08).

"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

5/3/21
Date

Ahmad Zaki
Owner's Printed Name

President
Owner's Title/Position

PREPARER'S CERTIFICATION

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

Preparer's Signature

5/5/2021
Date

Allen L. Butcher, PE
Preparer's Printed Name

Project Engineer
Preparer's Title/Position

Preparer's Licensure: C47107

REGISTERED PROFESSIONAL ENGINEER
ALLEN L. BUTCHER
No. 47107
CIVIL
STATE OF CALIFORNIA

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Section A: Project and Site Information

PROJECT INFORMATION	
Type of Project:	Commercial, Gas Station, Mixed Use, Multi-family Residential
Planning Area:	TTM 37578
Community Name:	Lake Elsinore
Development Name:	Bamiyan Marketplace
PROJECT LOCATION	
Latitude & Longitude (DMS): 33.659054N / 117.378454W	
Project Watershed and Sub-Watershed: Santa Ana Watershed	
Gross Acres: 12.5 Gross / 11.8 acres (post dedication)	
APN(s): 381-320-020, 023	
Map Book and Page No.: Book 8, Page 377	
PROJECT CHARACTERISTICS	
Proposed or Potential Land Use(s)	Commercial / Residential
Proposed or Potential SIC Code(s)	5541, 5812, 5999
Area of Impervious Project Footprint (SF)	437,931
Total Area of <u>proposed</u> Impervious Surfaces within the Project Footprint (SF)/or Replacement	338,700
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)	Paved frontage
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)	A
What is the Water Quality Design Storm Depth for the project?	0.93 in

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
Lake Elsinore	Nutrients, Organic Enrichment/Low Dissolved Oxygen, PCBs, Sediment Toxicity, Unknown Toxicity	MUN, REC1, REC2, WARM, WILD	N/A

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

Table A.2 Other Applicable Permits

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

Documentation of the above items are not applicable for a Preliminary SWQMP or the Discretionary phase of the project.

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? Yes - *Existing site drains overland, northerly toward Lake Elsinore via existing storm drain system at the midpoint of the site. Box culvert per Ortega Channel Retrofit Stage 91*

Did you identify and protect existing vegetation? If so, how? If not, why? *No. Site was previously disturbed. Existing vegetation is non-native.*

Did you identify and preserve natural infiltration capacity? If so, how? If not, why? *No. Site is subject to "Treat & Release" since it is tributary to Lake Elsinore.*

Did you identify and minimize impervious area? If so, how? If not, why? Yes - *Multi-story residential and mixed-use buildings reducing the overall impervious footprint.*

Did you identify and disperse runoff to adjacent pervious areas? If so, how? If not, why? *Not feasible based upon limited landscape dimensions.*

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
A	Street Improvements	5,833	D
B	Street Improvements	24,101	D
C	Street / Grand Entry	47,487	D
D	Street Improvements	6,837	D
1	Gas Station	42,863	D
2	Parking Lot	10,854	D
3	Car Wash Area	35,948	D
4	Car Wash Exit	854	A
5	Ortega Entry	20,705	D
6	Car Wash Area	9,547	D
7	Truck Access	27,871	D
8	Covered Parking	13,340	D
9	Restaurant - West	7,842	D
10	Parking - Central	47,985	D
11	Paving near Residential Entry	14,406	D
12	Truck Access	15,916	D
13	Truck Access	8,224	D
14	Driveway – Macy Entry	5,468	D
15	Residential Area	176,108	D
16	Rear Slope	Remainder	A

[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)
4	854	Reused for Car Wash	

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]

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

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]

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

DMA Name or ID	BMP Name or ID
A	Modular Wetland
B	Modular Wetland
C	Modular Wetland
D	Modular Wetland
1	Bioretention Basin
2	Bioretention Basin
3	Bioretention Basin
5	Modular Wetland
6	Bioretention Basin
7	Modular Wetland
8	Bioretention Basin
9	Bioretention Basin
10	Modular Wetland
11	Bioretention Basin
12	Bioretention Basin
13	Bioretention Basin
14	Bioretention Basin
15	Bioretention Basin

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

Section D: Implement LID BMPs

D.1 Infiltration Applicability

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

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

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

Geotechnical Report

A Geotechnical Report or Phase I Environmental Site Assessment may be required by the Co-permittee 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:		
…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). **Tributary to Lake Elsinore**

☐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.

<u>If any of the above boxes have been checked, Harvest and Use BMPs need not be assessed for the site</u>. 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: ***Total Area of Irrigated Landscape*****: Highest & Best Use policy area for Lake Elsinore, therefore Irrigation Use BMPs not evaluated**.

Toilet Use Feasibility

Complete the following steps to determine the feasibility of harvesting stormwater runoff for toilet flushing uses on your site: ***Total Area of Irrigated Landscape*****: Highest & Best Use policy area for Lake Elsinore, therefore Toilet use BMPs not evaluated.**

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.

Total Area of Irrigated Landscape**: Highest & Best Use policy area for Lake Elsinore, therefore Other Non-Potable Use BMPs not evaluated**.

D.3 Bioretention and Biotreatment Assessment

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

Select one of the following:

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

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

D.4 Feasibility Assessment Summaries

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

Table D.2 LID Prioritization Summary Matrix

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

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

Highest & Best Use policy area for Lake Elsinore, therefore feasibility assessment not warranted.

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 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**		***BMP-A (Modular Wetland)***		
	[A]		[B]	[C]	[A] x [C]				
A	5,833	Street	*0.892, 0.110*	*0.741*	*4,321*	*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 = Σ[A]	***5,833***			4,321	[E] 0.2 in/hr.	0.020 cfs	100%	0.052

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Area x Runoff Factor		***BMP-B (Modular Wetland)***		
	[A]		[B]	[C]	[A] x [C]				
B	24,101	Street	*0.892, 0.110*	*0.688*	*16,587*	*Design Storm Depth (in)*	*Minimum Design Capture Volume or Design Flow Rate (cf or cfs)*	*Total Storm Water Credit % Reduction*	*Proposed Volume or Flow on Plans (cubic feet or cfs)*
	A_T = Σ[A]	***24,101***			Σ= [D16,587	[E] 0.2 in/hr.	0.076 cfs	100%	0.115

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Area x Runoff Factor		***BMP-C (Modular Wetland)***		
	[A]		[B]	[C]	[A] x [C]				
C	47,487	Street	*0.892, 0.110*	*0.791*	*37,559*	*Design Storm Depth (in)*	*Minimum Design Capture Volume or Design Flow Rate (cf or cfs)*	*Total Storm Water Credit % Reduction*	*Proposed Volume or Flow on Plans (cubic feet or cfs)*
	A_T = Σ[A]	***47,847***			Σ= [D] 37,559	[E] 0.2 in/hr.	0.172cfs	100%	.206

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Area x Runoff Factor		***BMP-D (Modular Wetland)***		
	[A]		[B]	[C]	[A] x [C]				
D	6,837	Street	*0.892, 0.110*	*0.712*	*4,865*	*Design Storm Depth (in)*	*Minimum Design Capture Volume or Design Flow Rate (cf or cfs)*	*Total Storm Water Credit % Reduction*	*Proposed Volume or Flow on Plans (cubic feet or cfs)*
	A_T = Σ[A]	***6,837***			Σ= [D] 4,865	[E] 0.2 in/hr.	0.022 cfs	100%	.052

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Area x Runoff Factor		***BMP-5 (Modular Wetland)***		
	[A]		[B]	[C]	[A] x [C]				
5	20,750	Street	*0.892, 0.110*	*0.796*	*16,472*	*Design Storm Depth (in)*	*Minimum Design Capture Volume or Design Flow Rate (cf or cfs)*	*Total Storm Water Credit % Reduction*	*Proposed Volume or Flow on Plans (cubic feet or cfs)*
	A_T = Σ[A]	***6,837***			Σ= [D] 16,472	[E] 0.2 in/hr.	0.025 cfs	100%	.052

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Area x Runoff Factor		***BMP-7 (Modular Wetland)***		
	[A]		[B]	[C]	[A] x [C]				
7	27,871	Street	*0.892, 0.110*	*0.845*	*23,561*	*Design Storm Depth (in)*	*Minimum Design Capture Volume or Design Flow Rate (cf or cfs)*	*Total Storm Water Credit % Reduction*	*Proposed Volume or Flow on Plans (cubic feet or cfs)*
	A_T = Σ[A]	***6,837***			Σ= [D] 23,561	[E] 0.2 in/hr.	0.025 cfs	100%	.052

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Area x Runoff Factor		***BMP-10 (Modular Wetland)***		
	[A]		[B]	[C]	[A] x [C]				
10	47,985	Street	*0.892, 0.110*	*0.864*	*41,448*	*Design Storm Depth (in)*	*Minimum Design Capture Volume or Design Flow Rate (cf or cfs)*	*Total Storm Water Credit % Reduction*	*Proposed Volume or Flow on Plans (cubic feet or cfs)*
	A_T = Σ[A]	***6,837***			Σ= [D] 41,446	[E] 0.2 in/hr.	0.025 cfs	100%	.052

Table D.4 **DCV Calculations for LID BMPs**

BMP ID	DMA Area (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factors	DMA Area x Runoff Factor	Design Storm Depth (in)	Minimum Design Capture Volume (cf)	Total Storm Water Credit % Reduction	Proposed Volume or Flow on Plans (cubic feet or cfs)
1	42,863	Parking Lot	79%	*0.892, 0.110*	*31,176*	0.93	*2,416*	100%	2,805
2	10,854	Car Wash Area	57%	*0.892, 0.110*	*6,005*	0.93	*465*	100%	515
3	35,948	Car Wash Exit	86%	*0.892, 0.110*	*28,108*	0.93	*2,178*	100%	2,640
6	9,547	Truck Access	66%	*0.892, 0.110*	*5,954*	0.93	*315*	100%	520
8	13,340	Restaurant	81%	*0.892, 0.110*	*9,922*	0.93	*769*	100%	899
9	7,842	Parking	76%	*0.892, 0.110*	*5,548*	0.93	*430*	100%	503
11	14,406	Truck Access	68%	*0.892, 0.110*	*9,213*	0.93	*714*	100%	850
12	15,916	Truck Access	69%	*0.892, 0.110*	*10,332*	0.93	*801*	100%	932
13	8,224	Macy Entry	55%	*0.892, 0.110*	*4,470*	0.93	*346*	100%	383
14	5,468	Residential	75%	*0.892, 0.110*	*3,806*	0.93	*295*	100%	380
15	176,108	Parking Lot	70%	*0.892, 0.110*	*116,30*	0.93	*9,014*	100%	10,255

[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.
>
> **None.**

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]
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**		***BMP-A (Modular Wetland)***		
	[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 = Σ[A]					[E]	0.0		

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

[E] is for Flow-Based Treatment Control BMPs [E] = .2, for Volume-Based Control Treatment BMPs, [E] obtained from Exhibit A in the WQMP Guidance Document

[G] is for Flow-Based Treatment Control BMPs [G] = 43,560, for Volume-Based Control Treatment BMPs, [G] = 12

[H] is from the Total Credit Percentage as Calculated from Table E.2 above

[I] as obtained from a design procedure sheet from the BMP manufacturer and should be included in Appendix 6.

E.4 Treatment Control BMP Selection

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

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

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

Table E.4 Treatment Control BMP Selection

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

[1] Treatment Control BMPs must not be constructed within Receiving Waters. In addition, a proposed Treatment Control BMP may be listed more than once if they possess more than one qualifying pollutant removal efficiency.

[2] Cross Reference Table E.1 above to populate this column.

[3] As documented in a Co-Permittee Approved Study and provided in Appendix 6.

Section F: Hydromodification

F.1 Hydrologic Conditions of Concern (HCOC) Analysis

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

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

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

If Yes, HCOC criteria do not apply.

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

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

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

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

Table F.1 Hydrologic Conditions of Concern Summary

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

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

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

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

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

F.2 HCOC Mitigation

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

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

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

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

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

Section G: Source Control BMPs

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

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

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

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

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

Table G.1 Permanent and Operational Source Control Measures

Potential Sources of Runoff pollutants	Permanent Structural Source Control BMPs	Operational Source Control BMPs
Fueling Gas Station	Covered Gas Pumps	Sweep / Spill Cleanup
Parking Lot	Maintenance & Repair	Sweeping
Trash Enclosure	Covered Enclosure / Drainage	Regular Cleaning / Trash Removal
On-site Storm Drain Inlet	Inlet Marking	Maintain / Replace Marking
Parking Lot	Partial Covered Spaces	
Landscaping	Pesticide / Herbicide / Leaf Litter	Professional Maintenance
Irrigation	Minimize Runoff / Overspray	Professional Maintenance
Food Service	Floor Drain / Gease Interceptor	Food Service BMP Guide
Vehicle and Equipment Cleaning	Vehicle Wash Station	Reclaim Wash water

Section H: Construction Plan Checklist

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

Table H.1 Construction Plan Cross-reference

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

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

Section I: Operation, Maintenance and Funding

The Co-permittee will periodically verify that Stormwater BMPs on your site are maintained and continue to operate as designed. To make this possible, your Co-permittee 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: Insert text here.

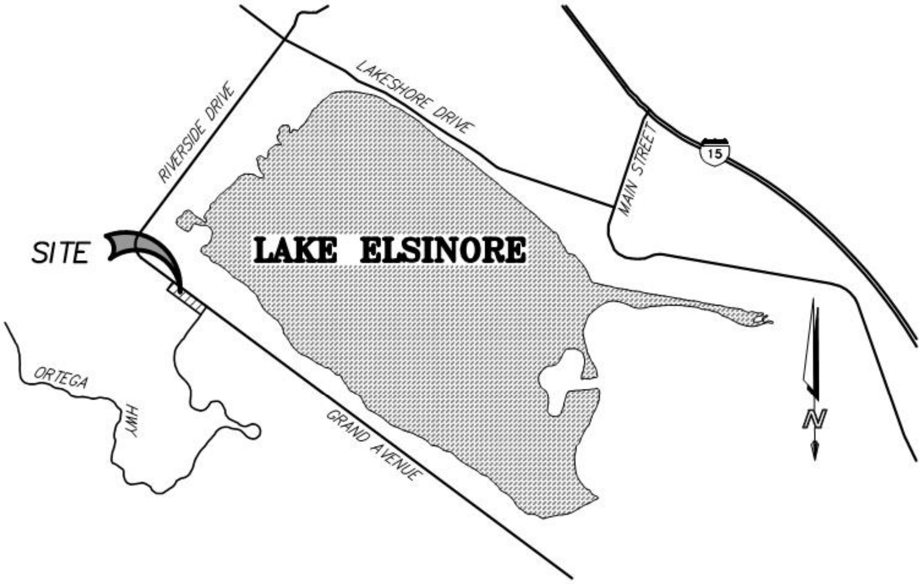
Will the proposed BMPs be maintained by a Homeowners' Association (HOA) or Property Owners Association (POA)?

☒ Y ☐ N

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

Appendix 1: Maps and Site Plans

Location Map, WQMP Site Plan and Receiving Waters Map

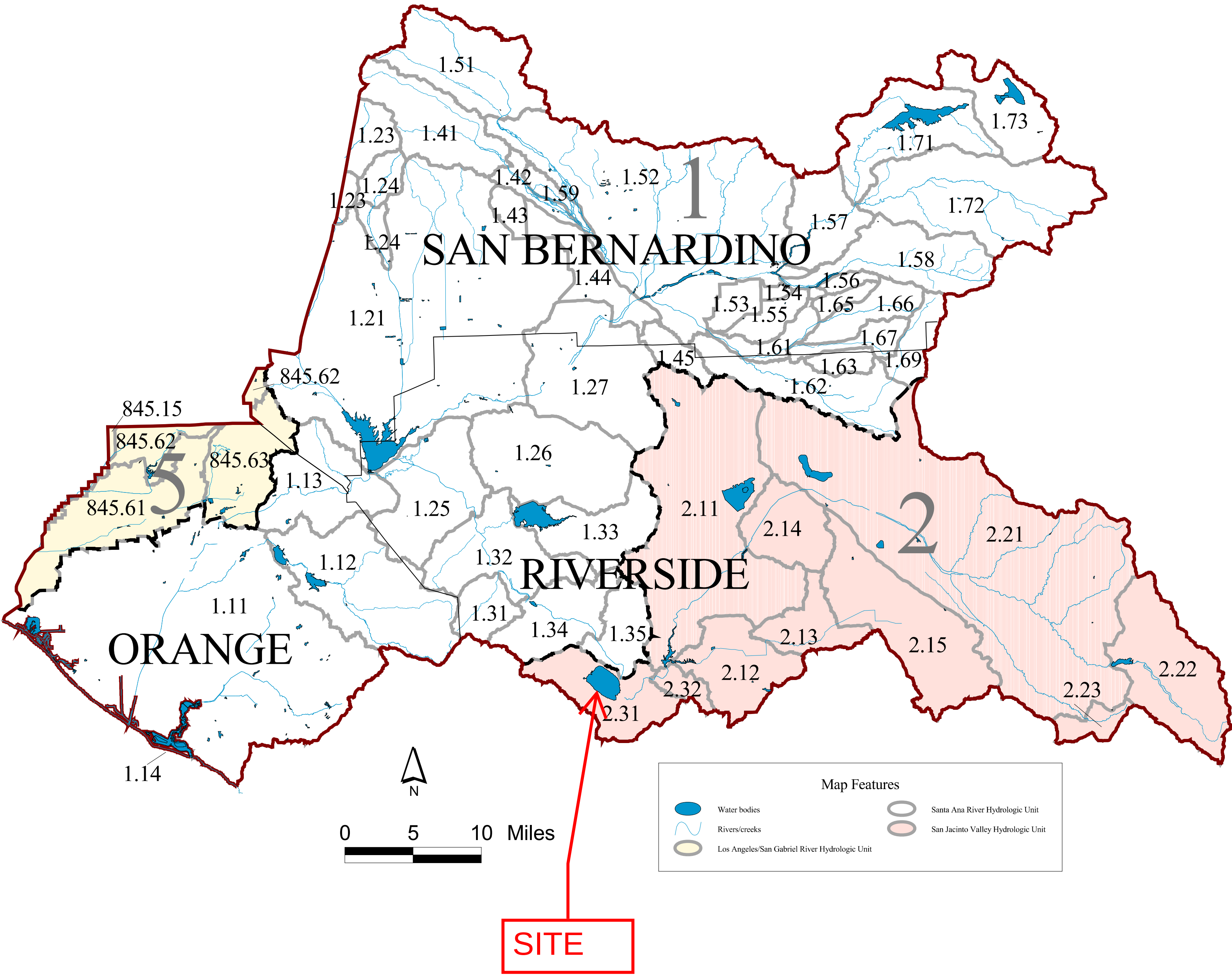


VICINITY MAP

THOMAS GUIDE REF.:

PAGE 865, GRID J6, J7, H6, H7

NOT TO SCALE


SAN BERNARDINO
RIVERSIDE
ORANGE
1
2
5
1.51
1.23
1.41
1.42
1.59
1.52
1.24
1.23
1.43
1.24
1.57
1.72
1.73
1.71
1.58
1.44
1.56
1.54
1.53
1.55
1.65
1.66
1.21
1.61
1.67
1.45
1.69
1.63
1.62
1.27
845.62
845.15
845.62
845.63
845.61
1.13
1.26
1.25
2.11
2.14
2.21
1.33
1.32
1.12
1.11
1.31
1.34
1.35
2.13
2.15
2.12
2.32
2.31
2.23
2.22
1.14
N
0
5
10
Miles
Map Features
Water bodies
Rivers/creeks
Los Angeles/San Gabriel River Hydrologic Unit
Santa Ana River Hydrologic Unit
San Jacinto Valley Hydrologic Unit
SITE


Temescal Creek
Reach 5
HIGHWAY 74
COLLIER
San Jacinto
Canyon Lake
(Railroad Canyon
CAMINO DEL NORTE
LAKESHORE
MACHADO
PALM
RIVERSIDE
Temescal Creek
Reach 6
San Jacinto River Reach 1
RAILROAD CANYON
LAKESHORE
Lake Elsinore
Elsinore
CORONA
ORTEGA
est
GRAND
CORYDON
MISSION
Site Location

		GWR	X
17	Serrano Creek	GWR	I
		MUN	+
		REC1	I
		REC2	I
		WARM	I
		WILD	I

Cell	Waterbody or GW Mgmt Zone Name	Beneficial Use	Beneficial Use Value
18	Canyon Lake	GWR	X
		REC1	X
		MUN	X
		AGR	X
		WARM	X
		REC2	X
		WILD	X
18	Elsinore (GW Mgmt Zone)	MUN	X
		AGR	X
		PROC	X
18	Hemet - South (GW Mgmt Zone)	MUN	X
		AGR	X
		IND	X
		PROC	X
18	Lake Elsinore	MUN	+
		REC1	X
		REC2	X
		WARM	X
		WILD	X
18	Menifee (GW Mgmt Zone)	MUN	X
		AGR	X
		PROC	X
18	Perris South (GW Mgmt Zone)	MUN	X
		AGR	X
18	Salt Creek	MUN	+
		REC1	I
		REC2	I
		WARM	I
		WILD	I
18	San Jacinto River Reach 1	AGR	I
		GWR	I

Return to map cell 18

Beneficial Use definitions can be found in the Basin Plan.

Beneficial Use Values key:

X = Existing Beneficial Use

I = Intermittent Beneficial Use

U = Rec1/REC2 not attainable uses as determined by UAA

+ = Excepted from MUN

Location Map

Bamiyan Marketplace
Lake Elsinore CA

RCFC&WCD Concrete Channel to Lake Elsinore

RCFC&WCD Existing Box Culvert under Grand Ave to Concrete Channel

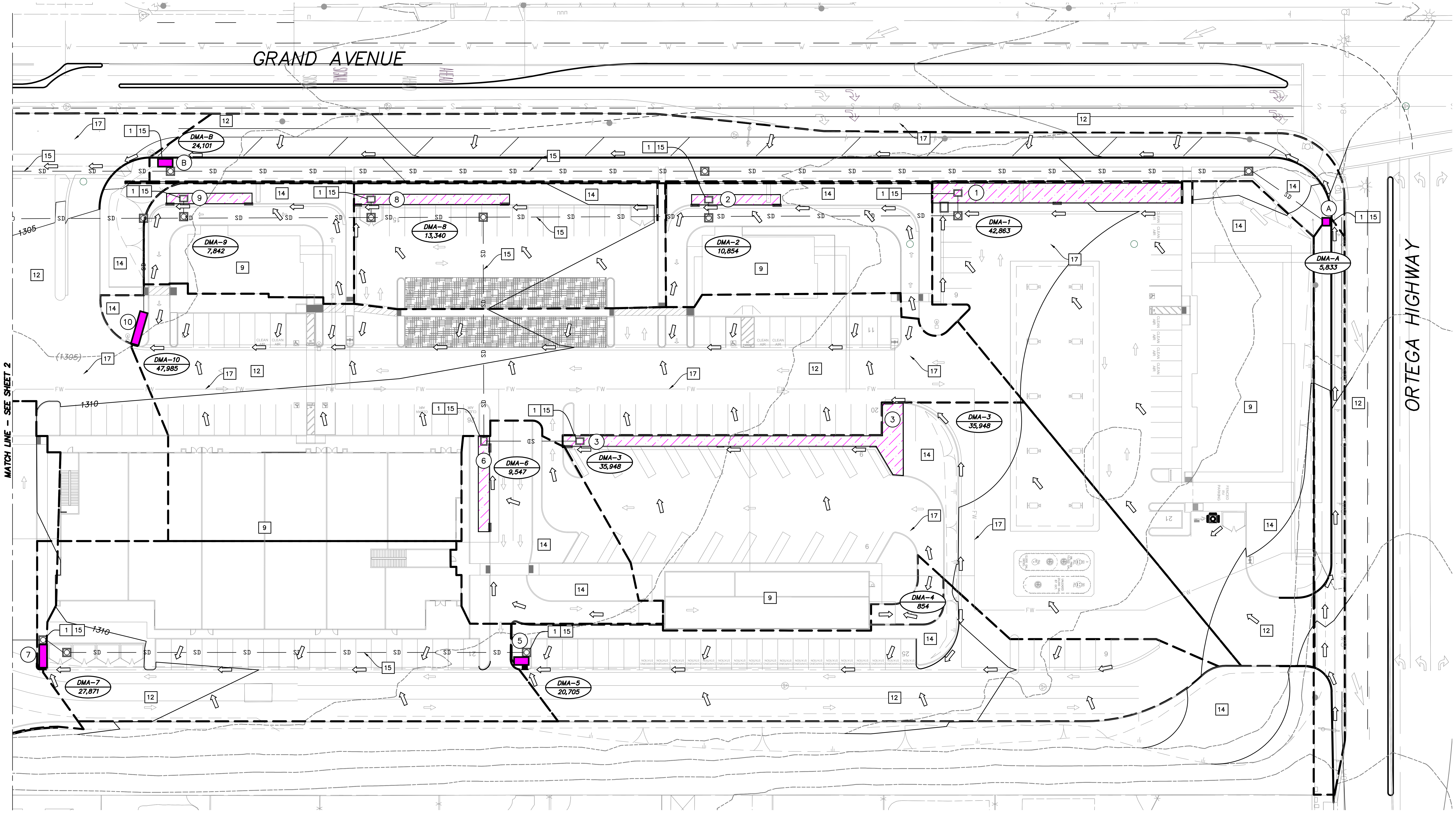
BAMIYAN MARKETPLACE

STREET FRONTAGE

BMP ID	DMA DESCRIPTION	DMA TOTAL AREA (SF)	DMA IMPERV AREA (SF)	EFFECTIVE IMPERV FRACTIONS	RUNOFF FACTOR	DMA x RUNOFF FACTOR	DESIGN STORM (IN)	DCV, V_{BMP} (CF)	SURFACE AREA (SF)	SOIL DEPTH (IN)	PROPOSED VOLUME (CF)	DESIGN FLOWRATE (IN/HR)	REQUIRED CAPACITY (CFS)	PROPOSED CAPACITY (CFS)	BIOCLEAN MWS UNIT
A	*ORTEGA WIDENING FROM PROJECT DRIVEWAY TO PCR AT GRAND*	*5,833*	*4,704*	*0.892, 0.110*	*0.741*	*4,321*	*0.93*	*335*	-	-	*N/A*	*0.2*	*0.020*	*0.052*	*MWS-L-4-4*
B	*GRAND WIDENING IN FRONT OF RESTAURANTS INCLUDING ORTEGA CURB RETURN*	*24,101*	*17,817*	*0.892, 0.110*	*0.688*	*16,587*	*0.93*	*1,285*	-	-	*N/A*	*0.2*	*0.076*	*0.115*	*MWS-L-4-8*
C	*GRAND WIDENING IN FRONT OF RESIDENTIAL INCLUDING MAIN PROJECT ENTRANCE*	*47,487*	*41,346*	*0.892, 0.110*	*0.791*	*37,559*	*0.93*	*2,911*	-	-	*N/A*	*0.2*	*0.172*	*0.206*	*MWS-L-4-17*
D	*MACY STREET WIDENING*	*6,837*	*5,259*	*0.892, 0.110*	*0.712*	*4,865*	*0.93*	*377*	-	-	*N/A*	*0.2*	*0.022*	*0.052*	*MWS-L-4-4*

ONSITE DEVELOPMENT

BMP ID	DMA DESCRIPTION	DMA TOTAL AREA (SF)	DMA IMPERV AREA (SF)	EFFECTIVE IMPERV FRACTION	RUNOFF FACTOR	DMA x RUNOFF FACTOR	DESIGN STORM (IN)	DCV, V_{BMP} (CF)	PROPOSED SURFACE AREA (SF)	SOIL DEPTH (IN)	PROPOSED VOLUME (CF)	DESIGN FLOWRATE (IN/HR)	REQUIRED CAPACITY (CFS)	PROPOSED CAPACITY (CFS)	BIOCLEAN MWS UNIT
1	*AM/PM TO C.I. AT CORNER PAST PUMPS*	*42,863*	*33,833*	*0.892, 0.110*	*0.727*	*31,176*	*0.93*	*2,416*	*1,700*	*30*	*2,805*				
2	*REST-1 ACROSS FROM CAR WASH*	*10,854*	*6,150*	*0.892, 0.110*	*0.553*	*6,005*	*0.93*	*465*	*312*	*30*	*515*				
3	*CAR WASH AND PARKING AND PUMP AREA*	*35,948*	*30,884*	*0.892, 0.110*	*0.782*	*28,108*	*0.93*	*2,178*	*1,600*	*30*	*2,640*				
4	*CAR WASH RECYCLED WATER AT EXIT*	*854*	*854*	*0.892*	*0.892*	*762*	*0.93*	*59*	-	-	*SELF RETAINING*				
5	*ORTEGA ENTRANCE DRIVE AND BEHIND CAR WASH*	*20,705*	*18,150*	*0.892, 0.110*	*0.796*	*16,472*	*0.93*	*1,277*	-	-	*N/A*	*0.2*	*0.076*	*0.115*	*MWS-L-4-8*
6	*CAR WASH LOW END*	*9,547*	*6,269*	*0.892, 0.110*	*0.624*	*5,954*	*0.93*	*461*	*315*	*30*	*520*				
7	*TRUCK ROAD BEHIND MIXED USE BUILDING*	*27,871*	*26,208*	*0.892, 0.110*	*0.845*	*23,561*	*0.93*	*1,826*	-	-	*N/A*	*0.2*	*0.108*	*0.144*	*MWS-L-4-13*
8	*COVERED PARKING*	*13,340*	*10,810*	*0.892, 0.110*	*0.744*	*9,922*	*0.93*	*769*	*545*	*30*	*899*				
9	*RESTAURANT-2 ACROSS FROM MIXED USE*	*7,842*	*5,990*	*0.892, 0.110*	*0.707*	*5,548*	*0.93*	*430*	*305*	*30*	*503*				
10	*MAIN DRIVE AISLE BETWEEN RESTAURANTS AND MIXED USE*	*47,985*	*46,252*	*0.892, 0.110*	*0.864*	*41,448*	*0.93*	*3,212*	-	-	*N/A*	*0.2*	*0.190*	*0.237*	*MWS-L-4-19*
11	*IN FRONT OF RES ENTRANCE*	*14,406*	*9,752*	*0.892, 0.110*	*0.640*	*9,213*	*0.93*	*714*	*515*	*30*	*850*				
12	*TRUCK ROAD AND RES. ENTRANCE*	*15,916*	*10,970*	*0.892, 0.110*	*0.649*	*10,332*	*0.93*	*801*	*565*	*30*	*932*				
13	*SECOND ON TRUCK FROM MACY*	*8,224*	*4,557*	*0.892, 0.110*	*0.544*	*4,470*	*0.93*	*346*	*232*	*30*	*383*				
14	*MACY STREET ENTRANCE DRIVE*	*5,468*	*4,097*	*0.892, 0.110*	*0.696*	*3,806*	*0.93*	*295*	*230*	*30*	*380*				
15	*RESIDENTIAL AREA*	*176,108*	*123,924*	*0.892, 0.110*	*0.660*	*116,304*	*0.93*	*9,014*	*6,215*	*30*	*10,255*				



NOTE: ALL CATCH BASINS TO HAVE FULL TRASH CAPTURE DEVICES.

SOURCE CONTROL NOTES

1	NON-STORMWATER DISCHARGES (SC-10)
2	SPILL PREVENTION, CONTROL & CLEANUP (SC-11), SITE-WIDE
3	VEHICLE AND EQUIPMENT FUELING (SC-20)
4	VEHICLE AND EQUIPMENT CLEANING (SC-21)
5	OUTDOOR LOADING/UNLOADING (SC-30), SITE-WIDE
6	OUTDOOR CONTAINER STORAGE (SC-31), SITE-WIDE
7	OUTDOOR EQUIPMENT MAINTENANCE (SC-32), SITE-WIDE
8	WASTE HANDLING/DISPOSAL (SC-34), SITE-WIDE
9	BUILDING & GROUNDS MAINTENANCE (SC-41), SITE-WIDE
10	PARKING/STORAGE AREA MAINTENANCE (SC-43), SITE-WIDE
11	HOUSEKEEPING PRACTICES (SC-60), SITE-WIDE
12	ROAD/STREET MAINTENANCE (SC-70), SITE-WIDE
13	PLAZA/SIDEWALK CLEANING (SC-71), SITE-WIDE
14	LANDSCAPE MAINTENANCE (SC-73), SITE-WIDE
15	DRAINAGE SYSTEM MAINTENANCE (SC-74), SITE-WIDE
16	WASTE HANDLING & DISPOSAL (SC-75), SITE-WIDE
17	WATER & SEWER UTILITY MAINTENANCE (SC-76), SITE-WIDE

LEGEND

DMA-A 41,067	Drainage Subarea Subarea (FT²)
①	BMP ID
━ ━ ━	DRAINAGE AREA BOUNDARY
■	MODULAR WETLAND
▨	BIORETENTION BASIN
⇨	FLOW ARROWS

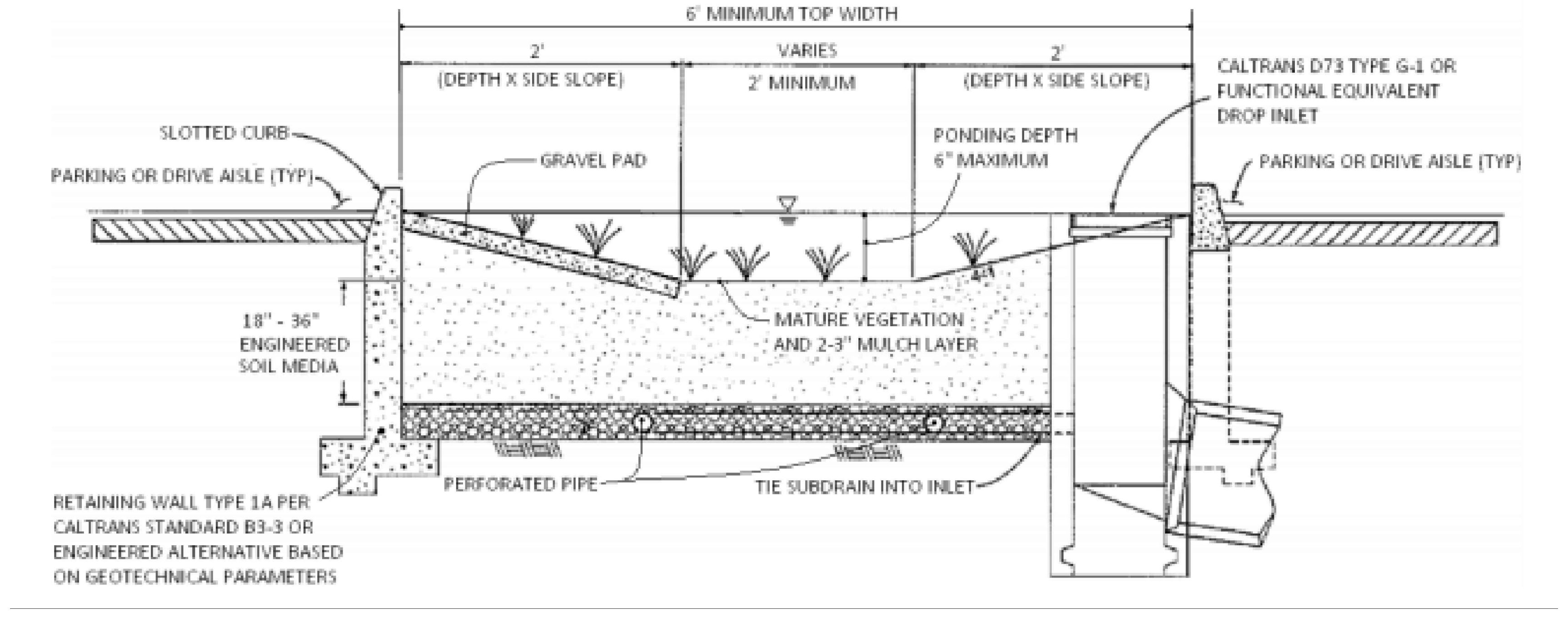
STREET FRONTAGE

BMP ID	REQUIRED CAPACITY (CFS)	PROPOSED CAPACITY (CFS)	BIOCLEAN MWS UNIT
A	0.022	0.052	MWS-L-4-4
B	0.085	0.115	MWS-L-4-8
C	0.193	0.206	MWS-L-4-17
D	0.025	0.052	MWS-L-4-4

ONSITE DEVELOPMENT

BMP ID	DCV, V_{BMP} (CF)	PROPOSED VOLUME (CF)	REMAINING (CF)
1	2,692	2,805	---
2	513	515	---
3	2,433	2,640	---
4	66	SELF RETAINING	---
5	1,426	N/A	MWS-L-4-8
6	511	520	---
7	2,044	N/A	MWS-L-4-13
8	857	899	---
9	479	503	---
10	3,598	N/A	MWS-L-4-19
11	792	850	---
12	889	932	---
13	382	383	---
14	328	380	---
15	10,009	10,255	---

PWQMP 2021-0005



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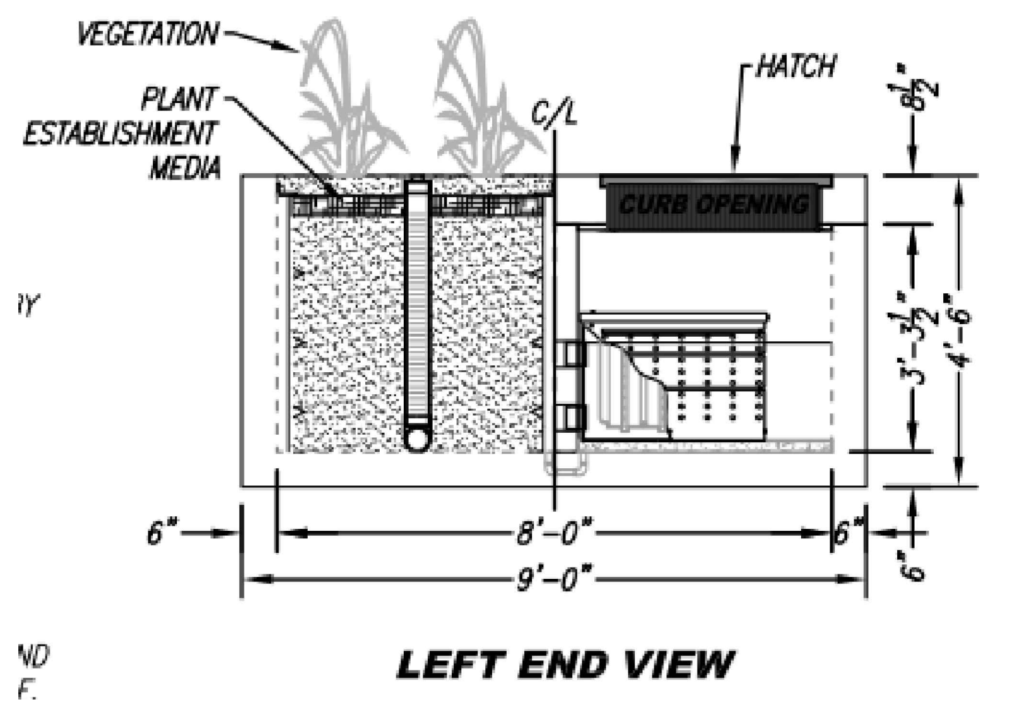
NO SCALE



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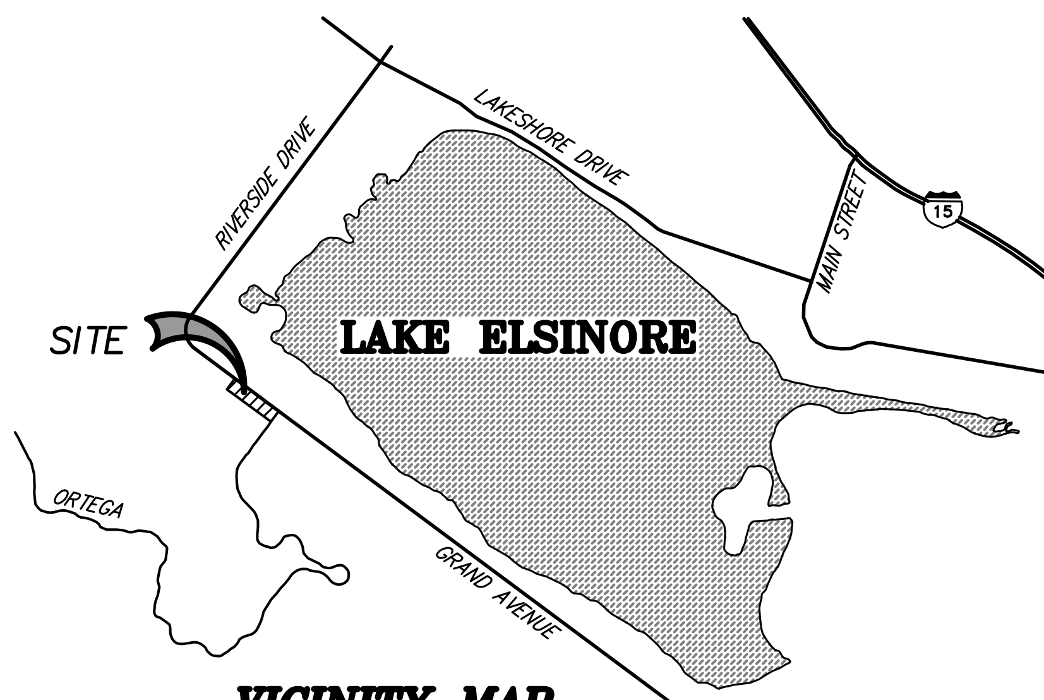

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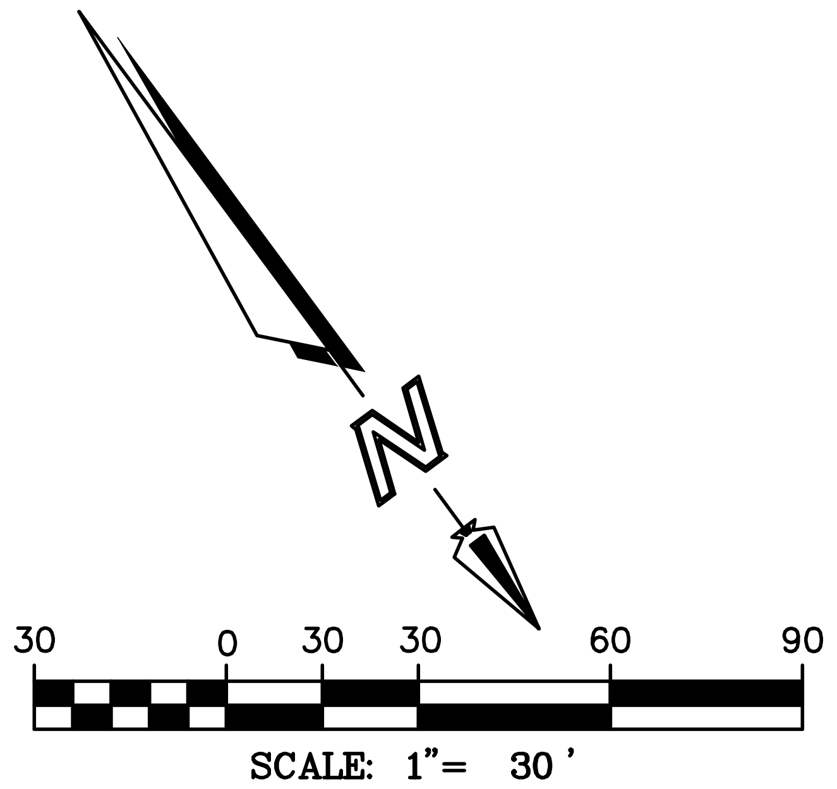
THOMAS GUIDE REF.:
PAGE 865, GRID J6, J7, H6, H7
NOT TO SCALE



SCALE: 1"= 30'

SB&O INC.
PLANNING ENGINEERING SURVEYING
3990 Ruffin Road, Suite 120
San Diego, Ca. 92123
858-560-1141
858-560-8157 Fax

REGISTERED PROFESSIONAL ENGINEER
STEPHEN C. OTT
No. C70666

STEPHEN C. OTT ____________ DATE

SHEET 1	CITY OF LAKE ELSINORE	SHEETS 2

WQMP SITE PLAN
APN 381-320-020/023
BAMIYAN MARKETPLACE
CITY OF LAKE ELSINORE, CA

3-1-21

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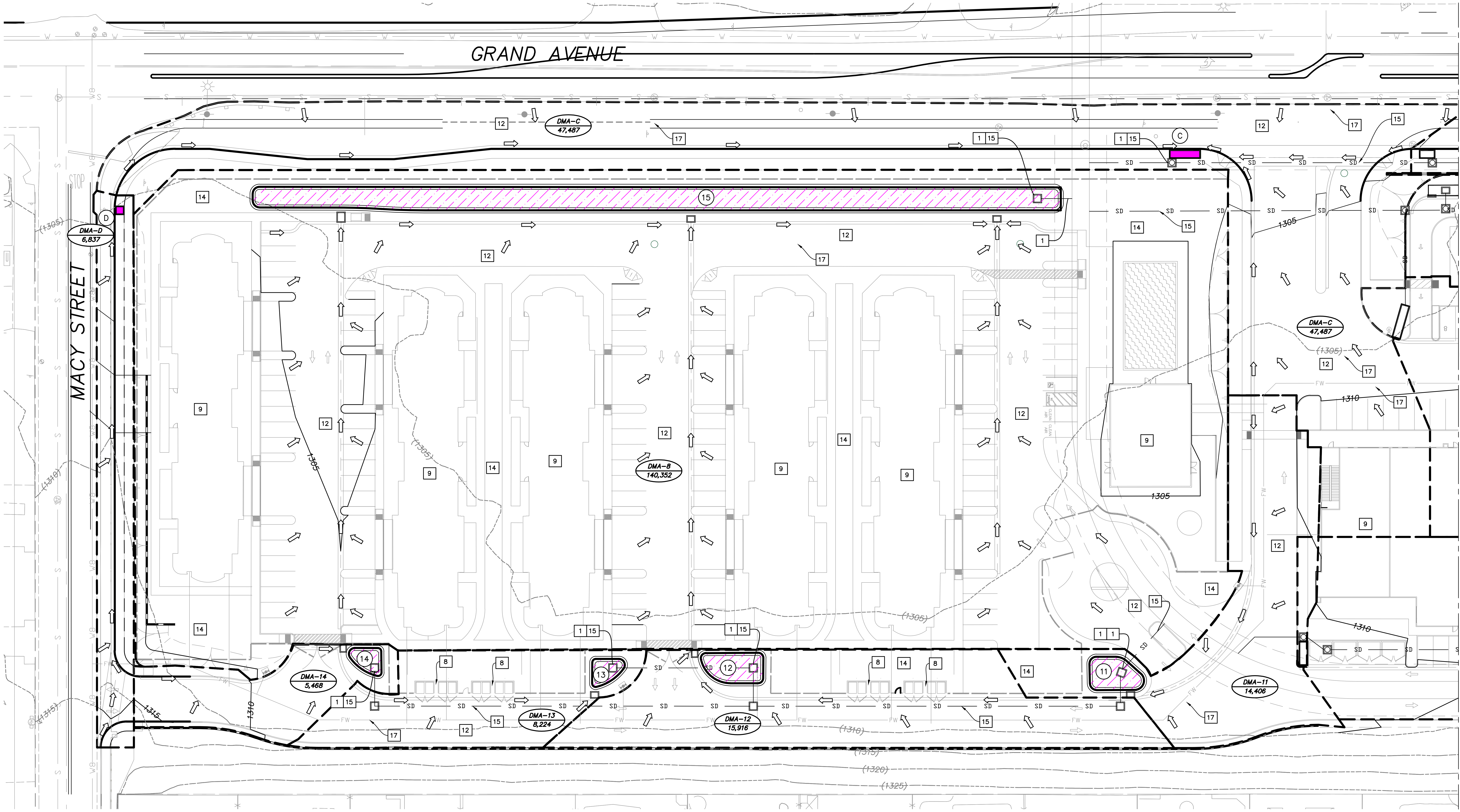

NOTE: ALL CATCH BASINS TO HAVE FULL TRASH CAPTURE DEVICES.

SOURCE CONTROL NOTES

1	NON–STORMWATER DISCHARGES (SC–10)
2	SPILL PREVENTION, CONTROL & CLEANUP (SC–11), SITE–WIDE
3	VEHICLE AND EQUIPMENT FUELING (SC–20)
4	VEHICLE AND EQUIPMENT CLEANING (SC–21)
5	OUTDOOR LOADING/UNLOADING (SC–30), SITE–WIDE
6	OUTDOOR CONTAINER STORAGE (SC–31), SITE–WIDE
7	OUTDOOR EQUIPMENT MAINTENANCE (SC–32), SITE–WIDE
8	WASTE HANDLING/DISPOSAL (SC–34), SITE–WIDE
9	BUILDING & GROUNDS MAINTENANCE (SC–41), SITE–WIDE
10	PARKING/STORAGE AREA MAINTENANCE (SC–43), SITE–WIDE
11	HOUSEKEEPING PRACTICES (SC–60), SITE–WIDE
12	ROAD/STREET MAINTENANCE (SC–70), SITE–WIDE
13	PLAZA/SIDEWALK CLEANING (SC–71), SITE–WIDE
14	LANDSCAPE MAINTENANCE (SC–73), SITE–WIDE
15	DRAINAGE SYSTEM MAINTENANCE (SC–74), SITE–WIDE
16	WASTE HANDLING & DISPOSAL (SC–75), SITE–WIDE
17	WATER & SEWER UTILITY MAINTENANCE (SC–76), SITE–WIDE

LEGEND

DMA–A 41,067	Drainage Subarea Subarea (FT²)
①	BMP ID
▬ ▬ ▬	DRAINAGE AREA BOUNDARY
■	MODULAR WETLAND
▨	BIORETENTION BASIN
⇨	FLOW ARROWS

STREET FRONTAGE

BMP ID	REQUIRED CAPACITY (CFS)	PROPOSED CAPACITY (CFS)	BIOCLEAN MWS UNIT
A	0.022	0.052	MWS-L-4-4
B	0.085	0.115	MWS-L-4-8
C	0.193	0.206	MWS-L-4-17
D	0.025	0.052	MWS-L-4-4

ONSITE DEVELOPMENT

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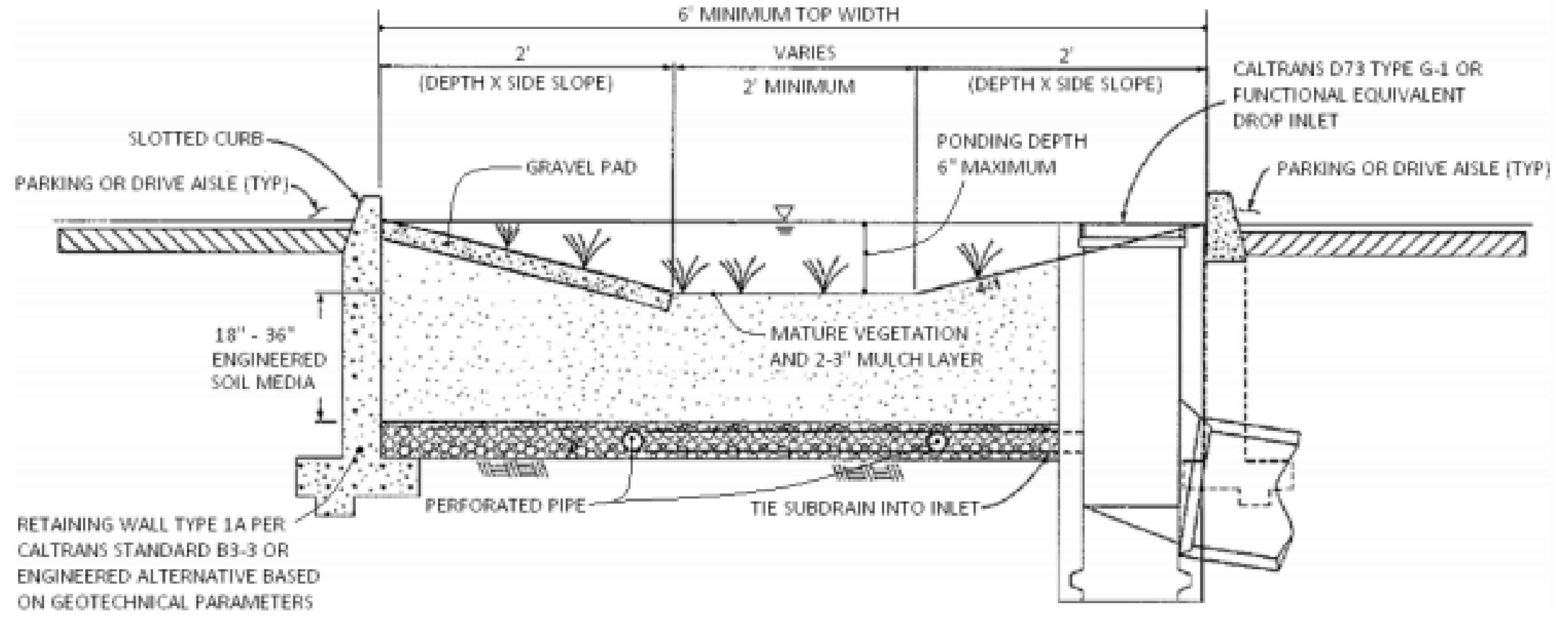

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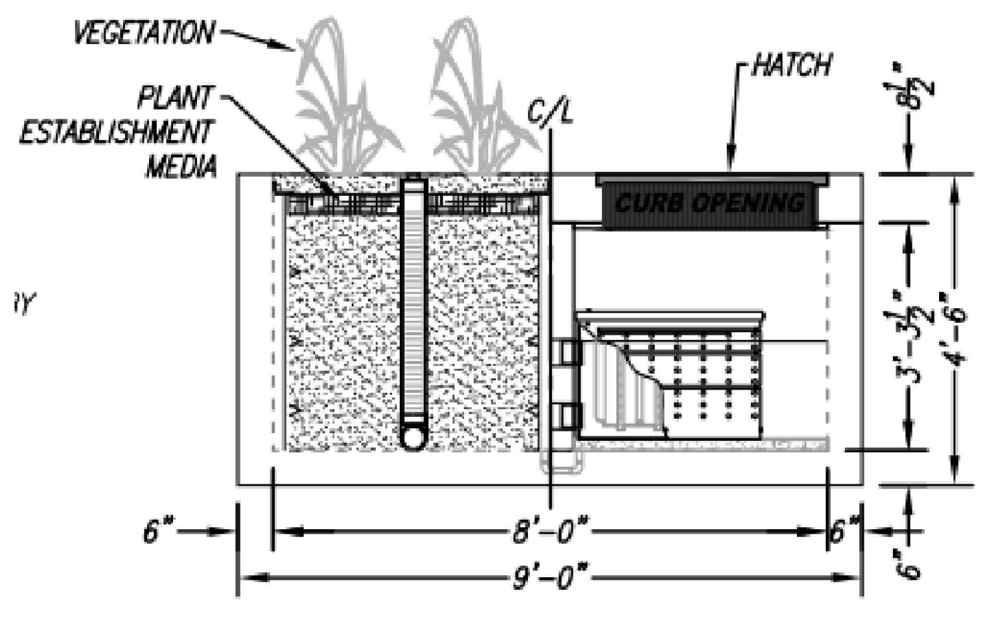
NO SCALE



LEFT END VIEW

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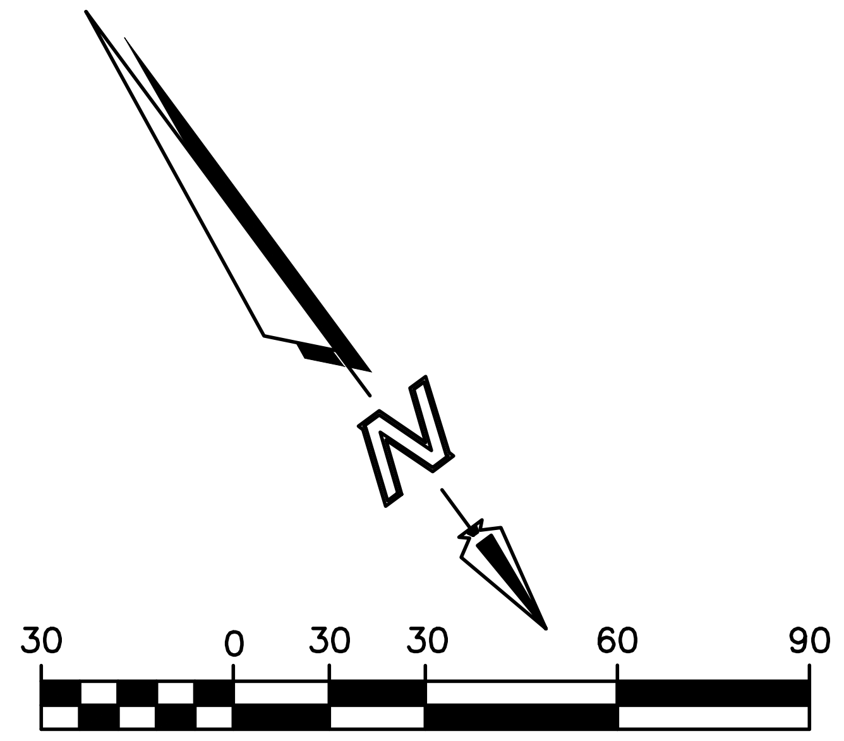
NO SCALE



SCALE: 1"= 30'

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STEPHEN C. OTT No. C70666

STEPHEN C. OTT DATE

PWQMP 2021–0005

SHEET 2
CITY OF LAKE ELSINORE
SHEETS 2
WQMP SITE PLAN–CONT.
APN 381–320–020/023
BAMIYAN MARKETPLACE
CITY OF LAKE ELSINORE, CA

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3–1–21

76020.10

Appendix 2: Construction Plans

Grading and Drainage Plans

See WQMP / DMA Exhibit for Discretionary Phase

Appendix 3: Soils Information

Geotechnical Study and Other Infiltration Testing Data

Mr. Ahmad Zaki
45 Cinch Road
Bell Canyon, California 91307

Geotechnical Engineering and Percolation Testing Report
Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

January 17, 2019

File No.: 302169-002
Doc. No.: 19-01-707

Earth Systems
1680 Illinois Avenue, Suite 20 | Perris, CA 92571 | Ph: 951.928.9799 | www.earthsystems.com

January 17, 2019

File No.: 302169-002
Doc No.: 19-01-707

Mr. Ahmad Zaki
45 Cinch Road
Bell Canyon, California 91307

Attention: Mr. Ahmad Zaki

Subject: **Geotechnical Engineering and PercolationTesting Report**

Project: **Proposed Bamiyan Marketplace**
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Earth Systems Pacific (Earth Systems) is pleased to submit this geotechnical engineering and percolation report for the referenced project located on the northwest corner of Grand Avenue and Ortega Highway in the city of Lake Elsinore, Riverside County, California. This report presents our findings and recommendations for site grading and foundation design, incorporating the information provided to our office. The site is suitable for the proposed development, provided the recommendations in this report are followed in design and construction. This report should stand as a whole, and no part of the report should be excerpted or used to the exclusion of any other part.

This report completes our scope of services in accordance with our proposal (PER-18-3-007AR) with an authorization date of May 28, 2018. Other geotechnical related services that may be required, such as plan reviews, responses to agency inquiries, and grading observation and testing are additional services and will be billed according to the Fee Schedule in effect at the time services are provided. Unless requested in writing, the Client is responsible to distribute the report to the appropriate governing agency and other members of the design team. Please review the Limitations (Section 6) of this report as they are vital to the understanding of this report.

We appreciate the opportunity to provide our professional services. Please contact our office if there are any questions or comments concerning this report or its recommendations.

Respectfully submitted,
Earth Systems Pacific

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Distribution: 5/Mr. Ahmad Zaki
1/PER File

TABLE OF CONTENTS

Geotechnical Engineering and Percolation Testing Report
Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Section 1
INTRODUCTION

1.1 Project Description

This geotechnical engineering and percolation testing report has been prepared for the proposed Bamiyan Marketplace development located at the northwest corner of Grand Avenue and Ortega Highway (Highway 74) in the city of Lake Elsinore, Riverside County, California, see Plate 1 (Site Vicinity Map). We understand the property is proposed to be developed as mixed-use with residential, retail, and commercial purposes. Based upon the Preliminary Site Plan provided, seven commercial structures (including a gas station) and associated improvements will encompass the southern two-thirds of the site. Approximately 20 residential units are proposed for the northern one-third of the site. Appurtenant site work is anticipated to include underground utilities, Water Quality Management Plan (WQMP) improvements, hardscape, parking drive improvements, a 6 foot high retaining wall along the western property line boundary slope, and landscaping. We have assumed site grades will be similar in elevation to the surrounding street grades (+-5 feet). The proposed site layout along with our exploration locations is presented in Plate 2.

We have assumed masonry, wood-framed or metal construction founded on shallow permanent foundations, and there will be no below grade basement levels. Column loads are anticipated not to exceed approximately 90 kips for spread footings and 5 kip/LF for continuous footing loads. As the basis for the foundation recommendations, all loading is assumed to be dead plus actual live load.

No preliminary design loading was provided by the structural engineer. If actual structural loading exceeds these assumed values, we will need to re-evaluate the given recommendations.

1.2 Site Description

The project is located on the northwest corner of Grand Avenue and Ortega Highway in the city of Lake Elsinore. The site has an approximate latitude and longitude of 33.6591°N/117.3782°W. The project contains two legal lots (APN 381-320-020 and 381-320-023) and they are currently vacant. The area of the parcels is approximately 7.91 acres and 4.64 acres for APN 381-320-020 and 381-320-023, respectively. The site is bounded by Grand Avenue to the northeast, Ortega Highway to the southeast, Macy Street to the northwest, and residential developments atop an approximately 15-foot slope to the southwest. The 15-foot ascending slope is within the property boundary. It is also our understanding that there is a utility easement through the property for an existing underground storm drain (see Plate 2). We estimate depths on the order of 10 feet deep for the storm channel/drain system. From google imagery, the elevation at the project site varies from approximately 1,300 to 1,320 feet above Mean-Sea-Level (MSL). Drainage appears to be by sheet flow to the northeast. The site is approximately 1400 feet from the current shoreline of Lake Elsinore which is at approximate elevation 1,245 feet.

1.3 Site Reconnaissance

Earth Systems personnel visited the site on various days from June to December 2018. Earth Systems personnel also reviewed select historic aerial photographs of the project site. Historical aerial photographs (Google Images, "Historic Aerials" between 1938 and 2018, and stereo photographs on file with the County of Riverside Flood Control District) revealed items of interest. Based on our review of these historical photographs, it is our opinion that agricultural activities began at the site prior to 1962. The site underwent significant grading between 1984 and 1990 resulting in variable fill and cut thickness across the site. The site has remained relatively unchanged from 1990 to 2018 based on our review of aerial photos.

1.4 Purpose and Scope of Services

The purpose for our services was to evaluate the site soil and geologic conditions at our exploration locations and to provide professional opinions and recommendations, from a geologic and geotechnical point of view, regarding the proposed development of the site. We understand that these proposed site improvements will be developed under the regulation of the current California Building Code (2016).

The conclusions and recommendations included in this report are based upon the data collected for this commission. The scope of services included:

Task 1 - Literature and Photograph Reviews

We began our services by reviewing select geologic and geotechnical literature pertaining to the project. This included a review of various hazard, fault, and geologic maps prepared by the California Geological Survey, the U.S. Geological Survey, the County of Riverside and other governmental agencies as they relate to the project area. Select historical aerial photographs were reviewed using the Google Earth Pro website and Historical Aerials website as well as Riverside County Flood Control. The aerial photographs reviewed are listed in the References section of this report.

Task 2 – Utility Clearance, USA Dig Alert

Each of our proposed field exploration locations was located and marked in the field and cleared with known utility lines as identified by Underground Service Alert (USA), "Dig Alert". Our exploration locations were located in the field by consumer grade Global Positioning System (GPS) accurate to ± 15 feet in conjunction with pacing based upon the control provided or sighting from landmarks identified on the project topographic map.

Task 3 – Field Exploration

We evaluated the general subsurface conditions at the site by drilling fourteen small diameter borings, from approximately 11½ feet to 50½ feet in depth, excavating four test pits and two fault trenches. The field exploration also included a visual site reconnaissance of the project area and immediate surroundings. Plate 2 shows the approximate location of each boring, test pit, fault trench and the percolation test locations. The fault trench locations were surveyed by Inland Empire Survey & Engineering, Inc.

Task 4 – Laboratory Testing

Laboratory tests were performed on selected samples to evaluate the physical characteristics of the materials encountered during our field exploration. Laboratory testing included moisture content, dry unit weight, maximum dry density/optimum moisture content, sieve analysis, consolidation/collapse potential, Expansion Index, and R-value. The testing was performed in general accordance with American Society for Testing and Materials (ASTM) or appropriate test procedures. Selected samples were also tested for a preliminary screening level of corrosion potential (pH, electrical resistivity, water-soluble sulfates and water-soluble chlorides). Earth Systems does not practice corrosion engineering; however, these test results may be used by a qualified engineer in designing an appropriate corrosion plan for the project.

Task 5 – Percolation Testing

Five borings were drilled within the proposed stormwater infiltration locations, as designated by Inland Empire Survey & Engineering, Inc. for percolation testing. These holes were drilled on December 10, 2018 with the same drill rig as the exploration borings. Plate 2 shows the approximate location of each test.

Task 6 – Analysis and Report

Earth Systems analyzed the field data obtained, performed engineering analyses, and provided recommended design parameters for earthwork and foundations for the structures as described within. Our report includes:

- A description of the proposed project including a site plan showing the approximate boring, test pit, and fault trench locations;
- A description of the surface and subsurface site conditions including groundwater conditions, as encountered in our field exploration;
- A description of the site geologic setting and possible associated geology-related hazards, including liquefaction, subsidence, and seismic settlement analysis;
- A discussion of regional geology and site seismicity;
- A description of local and regional active faults, their distances from the site, their potential for future earthquakes;
- A discussion of other geologic hazards such as ground shaking, landslides, flooding, and tsunamis;
- A discussion of site conditions, including the geotechnical suitability of the site for the general type of construction proposed;
- A seismic analysis including recommendations for geotechnical seismic design coefficients and soil profile type in accordance with the 2016 California Building Code;
- Recommendations for imported fill for use in compacted fills;

- Recommendations for foundation design including parameters for shallow foundations and subgrade preparation;
- Anticipated total and differential settlements for the recommended foundation system;
- Recommendations for lateral load resistance (earth pressures and drainage);
- Recommendations for site preparation, earthwork, and fill compaction specifications;
- Discussion of anticipated excavation conditions;
- Recommendations for underground utility trench backfill;
- Recommendations for stability of temporary trench excavations;
- Recommendations for location-specific infiltration rates;
- Recommendations for slabs-on-grade, including recommendations for reducing the potential for moisture transmission through interior slabs;
- Recommendations for collapsible or expansive soils (if applicable);
- Recommendations for asphalt concrete and Portland cement concrete parking and drives;
- A discussion of the corrosion potential of the near-surface soils encountered during our field exploration;
- An appendix, which includes a summary of the field exploration (computer generated boring logs) and laboratory testing program (computer generated plots).

Not Contained in This Report: Although available through Earth Systems, the current geotechnical scope of our services does not include:

- ➢ An environmental Phase 1 assessment.
- ➢ An investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater, or air on, below, or adjacent to the subject property.

Section 2
METHODS OF EXPLORATION AND TESTING

2.1 Field Exploration

Exploratory Borings

The subsurface exploration program included advancing 14 exploratory borings. The borings were drilled to depths ranging from approximately 11½ to 50½ feet below existing grades using a Mobile B-61 truck-mounted drill rig equipped with 6-inch hollow-stem augers provided by Cal-Pac Drilling of Calimesa, California. The borings were advanced to observe soil profiles and obtain samples for laboratory testing. The approximate boring locations are shown on Plate 2, in Appendix A. The locations shown are approximate, established by consumer grade Global Positioning System (GPS) accurate to ± 15 feet in conjunction with pacing based upon the control provided.

Staff from Earth Systems maintained a log of the subsurface conditions encountered and obtained samples for visual observation, classification and laboratory testing. Subsurface conditions encountered in the borings were categorized and logged in general accordance with the Unified Soil Classification System [USCS] and ASTM D 2487 and 2488 (current edition). Our typical sampling interval within the borings was approximately every 2½ or 5 feet to the full depth explored; however, sampling intervals were adjusted depending on the materials encountered onsite. Samples were obtained within the test borings using a Modified California [MC] ring sampler (ASTM D 3550 with those similar to ASTM D 1586). The MC sampler has an approximate 3-inch outside diameter and 2.4-inch inside diameter. The ring sampler was mounted on a drill rod and driven using a rig-mounted 140-pound automatic hammer falling for a height of 30 inches. The number of blows necessary to the MC type ring sampler within the borings was recorded.

Design parameters provided by Earth Systems in this report have considered an estimated 70% hammer efficiency based on data provided by the drilling subcontractor and limits per SP117A. Since the MC sampler was used in our field exploration to collect ring samples, the N-values (blow count) using the California sampler can be roughly correlated to SPT N-values using a conversion factor that may vary from about 0.5 to 0.7. In general, a conversion factor of approximately 0.63 from a study at the Port of Los Angeles (Zueger and McNeilan, 1998 per SP 117A) is considered satisfactory. A value of 0.63 was applied in our calculations for this project.

Bulk samples of the soil materials were obtained from the drill auger cuttings, representing a mixture of soils encountered at the depths noted. The depth to groundwater, if any, was measured in the boreholes. Following drilling, sampling, and logging, the borings were backfilled with the cuttings and tamped upon completion. Where water was encountered, borings were sealed with bentonite. Our field exploration was provided under the direction of a State of California Registered Geotechnical Engineer from our firm.

The final logs of the borings represent our interpretation of the contents of the field logs and the results of laboratory testing performed on the samples obtained during the subsurface exploration. The final logs are included in Appendix A of this report. The stratification lines represent the approximate boundaries between soil types, although the transitions may be gradual. In reviewing the logs and legend, the reader should recognize the legend is intended as a guideline only, and there are a number of conditions that may influence the soil characteristics observed during drilling. These include, but are not limited to cementation, variations in soil moisture, presence of groundwater, and other factors.

The boring logs present field blow counts per 6 inches of driven embedment (or portion thereof) for a total driven depth attempted of 18 inches. The blow counts on the logs are uncorrected (i.e. not corrected for overburden, sampling, etc.). Consequently, the user must correct the blow counts per standard methodology if they are to be used for design and exercise judgment in interpreting soil characteristics, possibly resulting in soil descriptions that vary somewhat from the legend.

Test Pit Excavations and Compaction Tests

Four test pits were excavated using a rubber-tire backhoe to approximate depths of 15 to 18 feet below the existing ground surface. The test pits were advanced to observe soil profiles for estimating soil ages and anticipated depths for the fault hazard exploration trenching. The approximate test pit locations are shown on Plate 2, in Appendix A. In addition, compaction tests (ASTM D 6938) were taken on the western slope face to obtain density data. A demarcation line between higher and lower densities was seen about mid-slope height with higher densities seen in the suspected fill over the native cut. Densities for each zone were averaged and are shown on the slope stability output.

Fault Trench Excavations

The Willard fault has been mapped to cross or come very close to the subject site. The Willard fault is not currently considered to be an active fault (movement within the last 11,000 years). However, the County of Riverside has designated that most of the site is within a special study zone for faulting. The City of Lake Elsinore has subcontracted a private geotechnical firm (NV5) to perform geologic reviews for this project. Prior to performance of fault hazard exploration by trenching, Earth Systems collaborated with NV5's geologist to develop an exploration program. NV5 concurred that an exploration program by geologic trenching is necessary to determine if active faults exist within the site. Prior to excavating the exploration trench, the location for the proposed trench was presented to NV5 for their review and concurrence.

This main fault trench is identified as T-1 and a small secondary fault trench (T-2) was excavated adjacent to T-1. The main exploration trench extended in a northeast to southwest direction, generally perpendicular to the regional fault trends and extended across most of the site, excluding the ascending graded slope and the Grand Avenue easement. The trench was excavated with a large excavator and was benched for OSHA compliance. The depth was approximately 10 feet. Trench walls were scraped to remove loose soil and expose the geologic strata. The trench walls were allowed to weather to allow for more subtle features to be revealed. Graphic logs of the exposed materials were prepared by our certified engineering geologists and are included in Appendix A.

The T-2 fault trench was performed for clarifying some of the geologic features observed in T-1. The T-1 fault trench was excavated to an approximate depth of 10 feet, where-as T-2 was excavated to a depth of approximately 5 feet. An engineering geologist from NV5 performed a site visit (September 9, 2018) after completion of the trenching and geologic logging to review the exposed geologic units and discuss our conclusion that no faulting was observed. The units exposed consisted of minor fill, alluvium and older alluvium. The older alluvium exposed in both trenches is in our opinion older than 11,000 years based on the development of paleo B soil horizons and within the older alluvium. The NV5 geologist verbally indicated that in general he agreed with our opinion that the older alluvium exposed in the fault trenches is older than 11,000 years and no evidence of faulting was observed.

Percolation Test Holes

Five shallow borings were drilled within the proposed stormwater infiltration locations for percolation testing. These holes were drilled on December 10, 2018 with the same drill rig as the exploration borings. Test holes reached depths of approximately 5 feet bgs. Percolation testing was performed in general accordance with the Riverside County Design Handbook for Low Impact Development Best Management Practices (Riverside County Flood Control and Water Conservation District, 2011). We installed 3-inch diameter perforated pipe along the entire length of the test holes. Then we backfilled the holes between the pipe and borehole sidewalls with clean gravel. After the gravel placement, we inundated the borehole with clean potable water. The percolation locations are shown on the Boring Location Map (Plan View), Plate 2, in Appendix A. The locations shown are approximate, established by pacing and line-of-sight bearings from adjacent landmarks and consumer grade GPS coordinates (+/- 15 feet). Refusal and groundwater were not encountered at the test hole locations.

Staff from Earth Systems maintained a log of the subsurface profile encountered in the test zone and performed visual observation of the soils. Subsurface conditions encountered were categorized and logged in general accordance with the Unified Soil Classification System [USCS] and ASTM D 2487 and 2488 (current edition).

2.2 Laboratory Testing

Samples were reviewed along with field logs to select those that would be analyzed further. Those selected for laboratory testing include, but were not limited to, soils that would be exposed and those deemed to be within the influence of the proposed structures. Test results are presented in graphic and tabular form in Appendix B of this report. Testing was performed in general accordance with American Society for Testing and Materials (ASTM) or other appropriate test procedure. Selected samples were also tested for a screening level of corrosion potential (pH, electrical resistivity, water-soluble sulfates, and water-soluble chlorides). Earth Systems does not practice corrosion engineering; however, these test results may be used by a qualified corrosion engineer in designing an appropriate corrosion control plan for the project.

Our testing program consisted of the following:

- Density and Moisture Content of select samples of the site soils (ASTM D 2937 & 2216).
- Maximum Dry Density/Optimum Moisture Content tests to evaluate the moisture-density relationship of typical soils encountered (ASTM D 1557).
- Particle Size Analysis to classify and evaluate soil composition. The gradation characteristics of selected samples were made by sieve analysis procedures (ASTM D 6913).
- Plasticity Index in accordance with ASTM D 4318.
- Consolidation and Collapse Potential to evaluate the compressibility and hydroconsolidation (collapse) potential of the soil upon wetting (ASTM D 5333).
- Direct Shear to evaluate the relative frictional strength of the surficial slope soils. Specimens were in a saturated condition prior to and during testing and were sheared under normal loads ranging from 1.0 to 4.0 kips per square foot (ASTM D 3080).
- Expansion Index tests to evaluate the expansive nature of the soil. The samples were surcharged under 144 pounds per square foot at moisture contents of near 50% saturation. Samples were then submerged in water for 24 hours and the amount of expansion was recorded with a dial indicator (ASTM D 4829).
- Screening Level Chemical Analyses (Soluble Sulfates and Chlorides (ASTM D 4327), pH (APHA 2320-B), and Electrical Resistivity/Conductivity (ASTM G 187) to evaluate the potential for adverse effects of the soil on concrete and steel.
- R-Value for pavement section analysis (CTM 301).

Section 3
DISCUSSION

3.1 Soil Conditions

The field exploration indicates that site soils consist predominantly of alluvial type soils of silty sand with lesser poorly graded sand and clayey sand (Unified Soils Classification System symbols of SM, SP, SP-SM, and SC) to the maximum depth of exploration of 50½ feet below the ground surface. Fill, which appears to be locally derived and undifferentiated from the alluvium, overlies the alluvium and is variable in thickness up to approximately 5 feet. The boring logs provided in Appendix A includes more detailed descriptions of the soils encountered. Site soils are classified as Type C in accordance with Cal OSHA.

3.2 Groundwater

Free groundwater was encountered during our field exploration at approximately 28 and 47.5 feet bgs (maximum drill depth 50½ feet). Significant perched moisture conditions were encountered in various areas within site soils in the form of those soils at or near saturation (based on % calculation). Free water is defined as visible excess water on or in the sample of sample collection devices. Perched moisture was variable in depth.

Based on calculation of percent saturation of soil samples tested considering moisture content and density, isolated zones of increased moisture were observed. The perched water appears only to be impeding the downward migration of water, but does not appear to be mounding it. This is due to the non-observation of saturated, free water above high moisture content zones, and the observation of soils with significantly less moisture and percent saturation above these high moisture zones. The perched water also does not appear to be laterally continuous as seen by the variability of moisture content in our borings in the area despite ongoing irrigation of adjacent properties for at least 50 years. The perched conditions are likely a result of farming and irrigation throughout the years. The boring logs in Appendix A present locations of calculated near saturated or saturated conditions, shown as “very moist” or “wet”.

Nearby State monitoring wells were researched for their recent and historic well readings. The following is a summary of our findings for the two wells closest to the site.

- Well No. 06S05W02A001S is located approximately 1.8 miles northeast of the project site. The surface elevation of this well is approximately 1,277 feet and the groundwater readings as measured from 2011 to 2018 varied from 1,000 to 1,076 feet above mean sea level.
- Well No. 06S04W19F001S is located approximately 2.3 miles southeast of the project site. The surface elevation of this well is approximately 1,288.5 feet and the groundwater readings as measured from 2012 to 2018 varied from 1,249.5 to 1,267.5 feet above mean sea level.

Based on the above data, groundwater is not anticipated to be encountered during construction. Based on the fault trench study, mottled soil conditions suggestive of past shallow groundwater were observed as shallow as 5 feet deep, however conditions were variable. The historic groundwater depth is estimated to be approximately 5 feet deep at the site based on the fault trench study. Fluctuations of the groundwater level and localized zones of increased soil moisture content should be anticipated during and following the rainy season or from irrigation.

3.3 Collapse Potential/Consolidation Potential

Collapsible soil deposits generally exist in regions of moisture deficiency. Collapsible soils are generally defined as soils that have potential to suddenly decrease in volume upon increase in moisture content even without an increase in external loads. Soils susceptible to collapse include loess, weakly cemented sands and silts where the cementing agent is soluble (e.g. soluble gypsum, halite), valley alluvial deposits within semi-arid to arid climate, and certain granite residual soils above the groundwater table. In arid climatic regions, granular soils may have a potential to collapse upon wetting. Collapse (hydro-consolidation) may occur when the soils are lubricated or the soluble cements (carbonates) in the soil matrix dissolve, causing the soil to densify from its loose configuration from deposition.

The degree of collapse of a soil can be defined by the Collapse Potential [CP] value, which is expressed as a percent of collapse of the total sample using the Collapse Potential Test (ASTM Standard Test Method D 5333). Based on the Naval Facilities Engineering Command (NAVFAC) Design Manual 7.1, the severity of collapse potential is commonly evaluated by the following Table 1, Collapse Potential Values.

Table 1
Collapse Potential Values

Collapse Potential Value	Severity of Problem
0-1%	No Problem
1-5%	Moderate Problem
5-10%	Trouble
10-20%	Severe Trouble
> 20%	Very Severe Trouble

Table 1 can be combined with other factors such as the probability of ground wetting to occur on-site and the extent or depth of potential collapsible soil zone to evaluate the potential hazard by collapsible soil at a specific site. A hazard ranking system associated with collapsible soil as developed by Hunt (1984) is presented in Table 2, Collapsible Soil Hazard Ranking System.

Table 2
Collapsible Soil Hazard Ranking System

Degree of Hazard	Definition of Hazard
No Hazard	No hazard exists where the potential collapse magnitudes are non-existent under any condition of ground wetting.
Low Hazard	Low hazards exist where the potential collapse magnitudes are small and tolerable, or the probability of significant ground wetting is low.
Moderate Hazard	Moderate hazards exist where the potential collapse magnitudes are undesirable, or the probability of substantial ground wetting is low, or the occurrence of the collapsible unit is limited.
High Hazard	High hazard exists where potential collapse magnitudes are undesirably high and the probability of occurrence is high.

The results of collapse potential tests performed on nine selected samples from depths ranging from 5 to 20 feet below the ground surface indicated a collapse potential on the order of 0.4 to 2.4 percent. The goal of the collapse testing was to identify soils and densities where the potential for collapse decreased to accepted levels. This accepted level is defined as where on-site soils had collapse potential less than 1% to 2% or the estimated relative compaction is greater or equal to 80 to 85%, which is the typical standard of care based on the above Table 1 (1%) or where soil collapse becomes a concern for structural soils (2%) (County of Los Angeles, 2013). Plotting and analysis of the of the results of the 9 tests indicates that collapse potential is generally less than 2% when the dry density is greater than 109 pcf (relative to ASTM D 1557), and generally less than 1% when the dry density is greater than 121 pcf (relative to ASTM D 1557).

Based on the field and laboratory testing performed, Earth Systems provides key items of interest that supports Earth Systems recommendations regarding collapse potential at this site:

1. Soils are generally granular in nature and no significant cementation was observed. Older alluvial soils with high blow counts predominate at the site: however low blow count, and lower density layers exist, with predominate voids in the upper 5 feet which are less significant with depth.
2. High dry densities (DD > 109 pcf) of the soils determined during the laboratory testing generally had lower potential for collapse (less than 2%).
3. Collapsible soils were generally classified as Silty Sand (SM).
4. Soil collapse at the site appears to be directly related to in-place density (relative compaction) which exists in site soils in the upper approximately 5 to 10 feet.

For some deposits without cementation, studies suggest some sites with densities above 103 pounds per cubic foot (pcf) are “not likely to collapse” and N_{60} Values > 10 do not fit into the category of “Likely Collapsible” (Lommler, C. J. and Bandini). In addition, soils with greater than 85 percent relative compaction are compact, and it is accepted that they are not likely to settle, especially after initial inundation.

Based on the above criteria and our field and laboratory findings, we estimate there is a “Moderate” collapse potential from soil layers between 0 and 10 ft below the ground surface (bgs). Without collapse mitigation efforts, the collapse potential is variable in the borings and layers but up to approximately 0.9 inches. Assuming the recommended grading is accomplished according to Section 5.1 of this report, we estimate the collapse potential differential settlement is building structure areas on the order of approximately 0.3 inches.

3.4 Expansive Soils

Expansive soils are characterized by their ability to undergo significant volume change (shrink or swell) due to variations in moisture content. Changes in soil moisture content can result from rainfall, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors, and may cause unacceptable settlement or heave of structures, concrete slabs supported-on-grade, or pavements supported over these materials. Depending on the extent and location below finished subgrade, expansive soils can have a detrimental effect on structures. Based on our laboratory testing and experience with the project, the expansion potential of the on-site soils tested is generally “very low” as defined by ASTM D 4829 and the 2016 California Building Code.

Testing and/or observation of the subgrade soils during grading within the building pad and at the footing grade should be performed to further evaluate the expansion potential and confirm or modify the recommendations presented herein.

3.5 Corrosion Potential

Two samples of the near-surface soils were tested for potential corrosion of concrete and ferrous metals. Soils in the upper 0 to 5 feet were tested as a blended (composite) sample. The tests were conducted in general accordance with the ASTM Standard Test Methods to evaluate pH, resistivity, and water-soluble sulfate and chloride content. The test results are presented in Appendix B. These tests should be considered as only an indicator of corrosivity for the samples tested. Other earth materials found on site may be more, less, or of a similar corrosive nature.

Water-soluble sulfates in soil can react adversely with concrete. ACI 318 provides the relationship between corrosivity to concrete and sulfate concentration, presented in the table below:

Table 3

Water-Soluble Sulfate in Soil (ppm)	Corrosivity to Concrete
0-1,000	Negligible
1,000 – 2,000	Moderate
2,000 – 20,000	Severe
Over 20,000	Very Severe

In general, the lower the pH (the more acidic the environment), the higher the soil corrosivity will be with respect to ferrous structures and utilities. As soil pH increases above 7 (the neutral value), the soil is increasingly more alkaline and less corrosive to buried steel structures, due to protective surface films, which form on steel in high pH environments. A pH between 5 and 8.5 is generally considered relatively passive from a corrosion standpoint. High chloride levels tend to reduce soil resistivity and break down otherwise protective surface deposits, which can result in corrosion of buried steel or reinforced concrete structures. Soil resistivity is a measure of how easily electrical current flows through soils and is the most influential factor. Based on the findings of studies presented in ASTM STP 1013 titled "Effects of Soil Characteristics on Corrosion" (ASTM, 1989), the approximate relationship between soil resistivity and soil corrosivity was developed as shown in Table 4.

Table 4

Soil Resistivity (Ohm-cm)	Corrosivity to Ferrous Metals
0 to 900	Very Severely Corrosive
900 to 2,300	Severely Corrosive
2,300 to 5,000	Moderately Corrosive
5,000 to 10,000	Mildly Corrosive
10,000 to >100,000	Very Mildly Corrosive

Test results show pH values ranging from 7.2 to 7.3, chloride contents of 2.9 to 6.4 ppm, sulfate contents of 2.7 to 16 ppm and minimum resistivity's of 13,200 to 17,200 Ohm-cm. Although Earth Systems does not practice corrosion engineering, the corrosion values from the soil tested are normally considered as being "very mildly" corrosive to buried metals and as possessing a "negligible" exposure to sulfate attack for concrete as defined in American Concrete Institute [ACI] 318, Section 4.3. The results of all chemical testing have been provided in Appendix B. The above values can potentially change based on several factors, such as importing soil from another job site and the quality of construction water used during grading and subsequent landscape irrigation.

3.6 Stormwater Percolation Testing

As indicated in Section 2.1 of this report, five test holes were drilled using the same drill rig as the exploration borings. Test holes were excavated on December 10, 2018 and reached depths of approximately 5 feet below the ground surface. These test locations represent the soils at the assumed bottom of the proposed infiltration systems. The percolation boring locations are shown on the Boring Location Map (Plate 2), in Appendix A.

The presence of gravel and the PVC pipe (inserted in the boring) were accounted for in the percolation test results. The borings were pre-saturated with potable water at least 24 hours prior to testing and again immediately prior to testing. Test results were taken with a water surface at approximate depths between 3 and 5 feet below existing grade at the test location, respectively (see Table 5).

Test procedures followed the procedures for deep boring percolation testing according to the Riverside County Flood Control and Water Conservation District Design Handbook for Low Impact Development Best Management Practices, September 2011. The soils encountered at each test location and the percolation rates as well as empirically correlated infiltration rate are presented in Table 5. A factor of safety of 3 in accordance with the Riverside County Manual (2011) was applied to the tested empirical infiltration rate in order to determine the design infiltration rate.

Table 5
Infiltration Rate Results

Test	Soil Condition	USCS Soil Description in Test Zone	Test Zone Below Existing Surface (feet)	Percolation Rate (min/in)	Porchet Empirical Infiltration Rate (in/hr)	Design Infiltration Rate (in/hr) (FOS = 3)
P-1	(Native)	Silty Sand (SM)	3.5 to 5	12.5	0.33 in/hr	0.11 in/hr
P-2	(Native)	Silty Sand (SM)	3 to 5	8.1	0.54 in/hr	0.18 in/hr
P-3	(Native)	Silty Sand (SM)	3.5 to 5	14.9	0.32 in/hr	0.11 in/hr
P-4	(Native)	Silty Sand (SM)	3 to 5	18.5	0.23 in/hr	0.08 in/hr
P-5	(Native)	Silty Sand (SM)	3.5 to 5	10.1	0.47 in/hr	0.16 in/hr

3.7 Geologic Setting

Regional Geology: The site is located within the Elsinore Trough, which in turn is located within a larger structural block known as the Perris Block. The Perris Block, which is a part of the Peninsular Ranges Geomorphic Province, is bounded on the northeast by the San Jacinto fault, on the north by the Cucamonga fault, and on the southwest by the Santa Ana Mountains.

Local Geology: The Elsinore Trough has been filled with up to approximately 2,300 feet of alluvial materials of sand, silty sand, clayey, silt and clay. The site is underlain with younger and older alluvial materials which consist of slightly consolidated to weakly cemented silty sand, clayey sand, and poorly graded sand. Morton and Weber (2003), has identified these alluvial units as younger alluvial valley deposits which overlie the older alluvial fan deposits. The older alluvial fan deposits are late Pleistocene. The site is near the Santa Ana Mountains located west of Lake Elsinore which are generally comprised of granitic bedrock. In Borings B-1 and B-2 it appears that highly weathered granitic bedrock may have been encountered near the bottom of each boring. Due to the small samples obtained, the material could also be highly weathered cobble or boulder. The depth of the granitic rock was 25 feet and 45 feet, respectively. The "granitic bedrock" was only encountered in these two borings and it appears the contact between older alluvium and granitic bedrock could be highly variable, if it exists at these locations.

Within the exploration trench T-1, older alluvium was exposed. The presence of poorly to moderately developed paloesols is indicative of a pre-Holocene age, confirming the Pleistocene or pre-Holocene designation.

3.8 Geologic Hazards

Geologic hazards that may affect the region include seismic hazards (ground shaking, surface fault rupture, soil liquefaction, and other secondary earthquake-related hazards), slope instability, flooding, ground subsidence, and erosion. A discussion follows on the specific hazards to this site.

3.8.1 Seismic Hazards

Seismic Sources: Several active faults or seismic zones lie within 40 miles of the project site as shown on Table A-1 in Appendix A. The primary seismic hazard to the site is strong ground shaking from earthquakes along the Elsinore, Chino, Whittier and San Jacinto fault zones.

Surface Fault Rupture: The project site does not lie within a currently delineated State of California, Alquist-Priolo Earthquake Fault Zone (CGS, 2018). Well-delineated fault lines cross through this region as shown on California Geological Survey [CGS] maps (Jennings, 2010), a copy of a portion of this map is attached in Appendix A). The Willard fault, a segment of the Elsinore fault zone is mapped through the edge of this site, close to or under Grand Avenue. The Willard fault has not been identified by the State of California as an Active fault. The main or primary Elsinore fault (Glen Ivy) is mapped approximately 0.2 miles northeast of the site. The closest Alquist-Priolo (A-P) Special Studies Zone is approximately 2.75 miles north of the site and the A-P Special Studies Zone for the Wildomar fault is located approximately 3.4 miles southeast of the site. However, the County of Riverside has identified almost the entire site as a special study zone for faulting, so the fault trenching performed is intended to address the Riverside County Special Study requirement, as well as the requirements by NV5.

Based on our lineament analysis and fault trench observations, it our professional opinion that "active" fault rupture has not occurred within the subject site. Previous fault trenching by Lewis S. Lohr & Associates (1978) on the property immediately northwest of the project, also did not encounter evidence of active faulting across a previously mapped trace of the Willard fault. While fault rupture generally occurs on previously known faults, there is no guarantee that future fault rupture will not occur at other locations. Fault trench logs are presented in Appendix A. NV5 was also onsite to observe the weathered trench and discuss, for concurrence of, our finding of no active fault rupture.

Lineament Analysis (Aerial Photograph Review): A lineament analysis was performed for this site by reviewing historical aerial photographs from Google Earth, Historical Aerials website and stereo photographs on file with the Riverside County Flood Control District. The exact photographs reviewed are listed in the References Section of this report. Based on our review of these historical photographs, it is our opinion that agricultural activities began at the site prior to 1962. The site underwent significant grading between 1984 and 1990 resulting in removal of soil in the southeast (south) corner, the cuts taper northward and westward. On the eastern side they taper from the maximum in the south corner to natural at about Grand Avenue. On the west side, along Macy Street the maximum cut is within the western corner and tapers to about natural grade about midway between the property line and Grand Avenue.

A storm drain was observed on an image that was reviewed at Riverside County Flood Control District. The storm drain coincides with 2 manholes observed on site. The grading on site may have been necessary to install this storm drain, identified as Ortega Channel (laterals A and A-1); or the site may have been used as a borrow site to achieve grades for the development to the southwest. Depths of the channel are estimated to be on the order of up to approximately 10 feet below existing grades.

No evidence of lineaments, suggestive of faulting was noted on the reviewed photographs.

Historic Seismicity: The site is located within an active seismic area in southern California where large numbers of earthquakes are recorded each year. Many of the major historic earthquakes felt in the vicinity of western Riverside County have originated from faults located outside the area. These include the 1857 Fort Tejon, 1933 Long Beach, 1952 Arvin-Tehachapi, 1971 San Fernando, 1987 Whittier Narrows, 1992 Landers, 1994 Northridge, and 1999 Hector Mine earthquakes.

Over 11,000 recorded earthquakes (mostly small earthquakes) have occurred within 30 miles of the Lake Elsinore area since 1931 (Homefacts website, 2019). Approximately 40 historic earthquakes of magnitude 5.5 or greater have occurred within 65 miles of the site usually originating on or near the San Andreas, San Jacinto, or Elsinore faults. These include the 1812 Wrightwood, 1894 Lytle Creek, 1899 San Jacinto, 1910 Elsinore (Glen Ivy, Hot Springs), 1918 San Jacinto, and 1923 North San Jacinto earthquakes.

Of significance are the multiple earthquake events along the San Jacinto fault at the turn of the century in 1890, 1892, 1899, and 1923. Additional earthquakes in the region along this fault zone occurred in 1937 and 1954 suggesting that the San Jacinto fault is a significant source of large to major earthquakes. Of interest, the only significant historic earthquake along the local Elsinore fault was in 1910.

Historically, the San Andreas fault is responsible for two of the three great earthquakes experienced in the southern California area. These are the 1812 Wrightwood and the 1857 Fort Tejon earthquakes. The 1857 rupture extended along the San Andreas fault from Parkfield to Cajon Pass and was felt throughout most of California. While the epicenter of this earthquake is assumed to be located near Parkfield, California, approximately 180 miles northwest of Lake Elsinore, the fault rupture extended southeastward to the vicinity of Cajon Pass, just 44 miles northeast of the site. No significant earthquakes or fault movements have been attributed to this segment of the San Andreas fault since 1857. A great earthquake that occurred in 1812 near Wrightwood in the eastern San Gabriel Mountains also originated on the nearby San Andreas fault.

The 1899 San Jacinto earthquake, although not well located due to poor documentation at the turn of the century, was estimated to have had a local magnitude of approximately 6.5. Significant damage to structures in San Jacinto and Hemet occurred, especially to unreinforced brick or adobe buildings. This earthquake is thought to have originated from fault rupture along the San Jacinto fault.

In 1910, the large Glen Ivy Hot Springs (Elsinore) earthquake occurred near Lake Elsinore. Estimated to have had a local magnitude of approximately 6, this earthquake was preceded by two foreshocks and did damage to structures in Wildomar, Corona, and Temescal. The earthquake was felt in San Diego and Los Angeles. The causative fault is thought to be the Elsinore fault, a fault with no other documented historic earthquakes of magnitude 6 or greater.

The 1918 San Jacinto earthquake again shook the towns of San Jacinto and Hemet where most of the damage occurred. This local magnitude 6.8 earthquake caused significant cracking to roadways, canals, and the ground. Landslides were common. The San Jacinto fault was the causative fault.

In 1923, a magnitude 6.2 earthquake occurred along the northern portion of the San Jacinto fault zone. The towns of San Bernardino and Redlands were most affected. Most damage was minor, although the San Bernardino Hospital and Hall of Records were significantly damaged.

The 1933 Long Beach earthquake was the result of a 6.4 magnitude earthquake on the Newport-Inglewood fault zone near present day Huntington Beach. Most damage occurred to unreinforced masonry buildings including many school buildings.

The 1971 San Fernando earthquake resulted in extensive damage to structures in parts of San Fernando and the Santa Clarita Valley. The epicenter of the earthquake was located near Soledad Junction approximately 60 miles northwest of the site. Strong motion accelerographs recorded ground accelerations as high as 1.25g at Pacoima Dam near the epicenter of the earthquake. Some structures designed in accordance with the Building Code in affect at the time were extensively damaged.

The 1987 Whittier Narrows earthquake shook the Corona area for several seconds. The epicenter of this 5.9 magnitude earthquake, located near Monterey Park, was approximately 32 miles northwest of the site. This earthquake occurred on an unsuspected seismogenic feature known as a buried, or "blind", thrust fault underlying the Elysian Park-Montebello Hills area.

The major 1992 Landers/Big Bear earthquakes also shook the Corona area. Damage was minimal. This earthquake was generated by a system of strike-slip faults in the mountain and desert areas over 69 miles northeast of the site.

The 1994 Northridge earthquake and related aftershocks significantly shook the Corona area. Like the Whittier Narrows earthquake, this event was produced by a buried thrust fault that underlies portions of the San Fernando Valley and the Santa Susana Mountains. No actual fault rupture associated with the main thrust faulting occurred at the surface. Primary fault rupture terminated approximately 3 to 4.3 miles (5 to 7 km) below the ground surface.

Seismic Risk: While accurate earthquake predictions are not possible, various agencies have conducted statistical risk analyses. In 2002 and 2008, the California Geological Survey [CGS] and the United States Geological Survey [USGS] completed probabilistic seismic hazard maps. We have used these maps in our evaluation of the seismic risk at the site. The Working Group of California Earthquake Probabilities (WGCEP, 2007) estimated a 59 percent conditional probability that a magnitude 6.7 or greater earthquake may occur between 2008 and 2038 along the southern segment of the San Andreas fault, 11 percent for the Elsinore fault, and 31 percent along the San Jacinto fault. Recent estimates suggest a nearly 98% probability of a nearby 5.0 in the next 50 years.

Soil Liquefaction and Lateral Spreading: Liquefaction is the loss of soil strength from sudden shock (usually earthquake shaking), causing the soil to become a fluid mass. Liquefaction describes a phenomenon in which saturated soil loses shear strength and deforms as a result of increased pore water pressure induced by strong ground shaking during an earthquake.

Dissipation of the excess pore pressures will produce volume changes within the liquefied soil layer, which can cause settlement. Shear strength reduction combined with inertial forces from the ground motion may also result in lateral migration (lateral spreading). Factors known to influence liquefaction include soil type, structure, grain size, relative density, confining pressure, depth to groundwater, and the intensity and duration of ground shaking. Soils most susceptible to liquefaction are saturated, loose sandy soils and low plasticity clay and silt.

In general, for the effects of liquefaction to be manifested at the surface, groundwater levels must be within 50 feet of the ground surface and the soils within the saturated zone must also be susceptible to liquefaction. We consider the potential for liquefaction to occur at this site as moderate to high because historic groundwater is generally less than 50 feet below the ground surface. The site is within a “moderate” liquefaction hazard zone as defined by Riverside County (Geographic Information Services, 2018). Liquefaction output considering historic high groundwater levels of 5 feet and soils above the groundwater are presented in Appendix A. Results indicate a worst case liquefaction potential at depths greater than 7.5 and 9.5 feet with estimated dry seismic and liquefaction induced settlement of 1 inch in B-2 and 1.9 inches in B-13. The potential for lateral spreading to the nearby lake is considered low under a screening evaluation due to the blowcount >15 N_{160} for the liquefiable layer (Youd & Bartlett, 2002). Due to the density of overlying soils, the potential for sand boils is considered low. Due to the depth of liquefaction and layer settlement in relation to the footing influence zone for the maximum footing sizes presented within, the potential for bearing failure is considered low.

Dry Seismic Settlement: The amount of dry seismic settlement is dependent on relative density of the soil, ground motion, and earthquake duration. In accordance with current CGS policy (Earth Systems discussion with Jennifer Thornburg, CGS May 2014), we used a site peak ground acceleration of ⅔ PGA_M (PGA_M = 0.91) and an earthquake magnitude of 7.7 to evaluate dry seismic settlement potential. The design peak ground acceleration values were obtained from the SEAOC online application (https://seismicmaps.org/).

Based upon methods presented by Tokimatsu and Seed (1987), the potential for seismically induced dry settlement of soils above the full dry groundwater table for the full soil column height (50 feet) was calculated and estimated to be 0.5 inches in Boring B-2 and 0.5 inches in Boring B-13. The remaining deeper borings onsite had similar potential. Seismic settlement is based on post grading recommendations stated in Section 5.1. Due to the general uniformity of the soils encountered, seismic settlement is expected to occur on an areal basis and as such per Special Publication 117A (CGS, 2008), the differential settlement is estimated to be approximately ½ of the total estimated dry seismic settlement (¼ inch) considering soil remediation as recommended in Section 5.1.

Fissuring and Ground Subsidence: The Riverside County Parcel report indicates that the site is within a “Susceptible” potential subsidence area. In areas of fairly uniform thickness of alluvium, fissures are thought to be the result of tensional stress near the ground surface and generally occur near the margins of the areas of maximum subsidence. Surface runoff and erosion of the incipient fissures augment the appearance and size of the fissures. Fissuring was not observed onsite or in aerial photo review.

Changes in pumping regimes can affect localized groundwater depths, related cones of depression, and associated subsidence such that the prediction of where fissures might occur in the future is difficult. In the project area, groundwater depths remain fairly deep and we consider the current subsidence potential low. However, in the event of future nearby aggressive groundwater pumping and utilization, the occurrence of deep subsidence cannot be ruled out. Changes in regional groundwater pumping could result in areal subsidence. The risk of areal subsidence in the future is more a function of whether groundwater recharge continues and/or over-drafting stops, than geologic processes, and therefore the future risk cannot be predicted or quantified from a geotechnical perspective.

Seismic Hazard Zones: This portion of Riverside County has been mapped for the California Seismic Hazard Mapping Act (Ca. PRC 2690 to 2699) for earthquake faults, but not liquefaction or slope instability.

3.8.2 Other Hazards

Landslides and Slope Instability: The site is relatively flat except the existing approximate 15 to 17-feet high ascending graded slope located along the southwest margin of the site. This graded 2:1 slope is likely a fill over cut slope graded for the subdivision located southwest of the project and appeared intact with no evidence of gross or surficial instability despite being in-place for nearly 30 years. Earth Systems performed static, seismic, and temporary construction slope stability analysis for a 2:1 slope having a slope height of 20 feet (20 feet due to inaccuracy in height measurement available). Two soils (compacted fill and native) were used in the study and given engineering soil parameters based on laboratory data, SPT blow counts, and classifications determinations. Soil property values varied depending on the analysis performed. Saturated Ultimate direct shear values were used for static analysis and saturated direct Peak values were used for seismic and temporary construction. A lightly loaded shear was run for native soil analysis, and surficial analysis. Surcharge loads were not included at the top of slope as significant structure (home) loads are setback at least 15 feet and the yards too small to allow heavy development right near the top of slopes (15 feet, 1:1 setback). Pools exist but unload soils. A 100 psf surcharge per the CBC was included for flatwork. Laboratory soil strength cohesion parameters were reduced by 30% in accordance with typical practice and SP117. Historic groundwater levels were considered. Pseudostatic “k” values of 0.3 horizontal and 0.1 vertical were utilized and considered guidance in the Riverside County Technical Guidelines for Review of Geotechnical and Geologic Reports (2000).

For the slope analysis, we used the Janbu and Bishop Simplified Methods in the Slide 8 (Roscience) software, which provided the results for static, seismic, and temporary construction modeling. Results included in Appendix A provide the engineering soil parameters and Factor of Safety for the static, seismic loading, and temporary construction conditions. Note, acceptable Factor of Safety for static loading conditions are 1.5, 1.1 for pseudo static conditions, and 1.2 for temporary construction. Results indicate a factor of safety above 1.5 for static conditions, 1.1 for seismic conditions, and 1.2 for postulated temporary construction conditions. Therefore, the potential for global static and pseudo static slope instability of the present conditions are considered to be low. Due to the “low” potential for lateral flow failure, slope stability under these conditions was not evaluated.

Surficial stability analysis for the 2:1 slope indicates a Factor of Safety of 1.03 (greater than 1) in an unprotected slope face. This is below the mandated Factor of Safety of 1.5. While a Factor of Safety of 1.03 indicates an inherent stability, as confirmed by the lack of evidence for surficial instability, the low factor of safety does suggest a potential hazard assuming full-depth saturation of the slope face (4'). Currently the slope is partially vegetated, including large trees that improve the overall stability of the slope. Erosion and minor sluffing of slopes could occur.

Flooding: Most of the project site lies in an area designated as Zone X: "Areas of 0.2% annual chance floodplain; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood." A small portion of the project site located to the northwest lies in an area designated as Zone D: "Areas in which flood hazards are undetermined, but possible." This project area and Zone X and Zone D are identified on FEMA Map No.: 06065C2017G, Panel 2017 of 3805, Map Revised August 28, 2008. Appropriate project design by the project civil engineer, construction, and maintenance can minimize the site sheet flooding potential.

Seiches: Seiching is defined as a periodic oscillation of liquid within a container or reservoir. Its period is determined by the resonant characteristics of the container, as controlled by its physical dimensions. Swimming pools are located on the residential lots immediately southwest of the site. Any pool seiches related flooding could exit the back yards and flow over the southwest margin slope, resulting in erosion and minor flooding.

The site is elevated approximately 60 above the Lake Elsinore high water elevation and about 1460 feet laterally from the shoreline. Thus, the on-site hazards from seiching of Lake Elsinore is considered low.

Section 4
CONCLUSIONS

The following is a summary of our conclusions and professional opinions based on the data obtained from a review of selected technical literature and the field explorations.

General: Based on our field exploration, laboratory testing, and geotechnical analyses conducted for this study, it is our professional opinion that the site is suitable, from a geotechnical and geologic standpoint, for construction as proposed, provided the recommendations presented in this report are incorporated into project design and construction.

The recommendations presented in this report may change pending a review of final grading plans and foundation plans. Recommendations presented in this report should not be extrapolated to other areas or be used for other projects (beyond those expressly identified within) without our prior review and comment.

Geotechnical Constraints and Mitigation:

- The primary geologic hazard is moderate to severe ground shaking from earthquakes originating on regional southern California faults. A major earthquake originating on the nearby segments of the Elsinore, San Jacinto, and San Andreas fault zones and other associated faults would be the critical seismic events that may affect the site within the design life. Engineered design and earthquake-resistant construction increase safety and allow development within seismic areas.
- The underlying geologic condition for seismic design is Site Class D. The site is about 0.2 miles from a Type A seismic source as mapped by the California Geological Survey. However, the site is approximately 2.75 miles from a Type A seismic source and an Alquist-Priolo Special Studies Zone. A qualified professional should design any permanent structure constructed on the site. The minimum seismic design should comply with the 2016 edition of the California Building Code.
- The site is within a County of Riverside designated fault zone, but is not within a currently designated Alquist-Priolo Earthquake Fault Zone. Evidence of faulting, including active faulting was not observed in the fault hazard exploration trenches excavated for this project. Nor were there any significant aerial photograph lineaments noted on the historic aerial photographs suggestive of active faulting. Therefore, the potential for surface fault rupture at the site is considered very low.
- The potential for ground subsidence and liquefaction settlement hazards are considered moderate for this project. The site is not within an area of documented areal subsidence.
- Other geologic hazards, including flooding, and landslides, are considered low potential on this site. Surficial instability of the existing ascending 2:1 graded slope along the southwest margin of the property is considered a moderate hazard. However, assuming construction of the planned retaining wall along the toe of this slope and slope protection is implemented, the potential for slumps and soil creep is reduced, and a general maintenance issue.
- Based on current conditions, groundwater is not anticipated to be encountered during

construction.

- Much of the existing on-site fill and alluvial soils are very low in Expansion Index and suitable for location under structures or hardscape after remedial grading. Building structure recommendations provided within are based upon using a very low in expansion potential fill material.
- The upper site soils have variable blow counts, low in-place densities, and associated potential for hydrocollapse. In our opinion, the upper loose alluvial soils are considered compressible and will require over-excavation within the proposed building pads, storm drain channels, hardscape, parking, drives and other settlement sensitive areas. In-place density test results of 85% or higher (or firm soils) will need to be attained within the bottom of the structure over-excavations before an over-excavation is approved for fill placement.
- Laboratory testing of two samples showed potentially “very mild” corrosivity to buried metallic elements and “negligible” for sulfate exposure to concrete. See Section 3.5 for further information. Site soils should be reviewed by an engineer competent in corrosion evaluation.
- In our professional opinion, structure foundations can be supported on shallow foundations bearing on a zone of properly prepared and compacted soils placed as recommended in Section 5.1. The recommendations that follow are based on “very low” expansion category soils.
- Setbacks are provided for structures, including setback from the onsite storm channel easement.
- Specific retaining wall foundation design recommendations are provided to minimize disturbance and back cuts into existing slopes providing support for up-slope properties and homes.

Section 5
RECOMMENDATIONS

5.1 Site Development – Grading

A representative of Earth Systems should observe site clearing, grading, and the bottoms of excavations before placing fill. Local variations in soil conditions may warrant increasing or decreasing the depth of recompaction and over-excavation. Proper geotechnical observation and testing during construction is imperative to allow the geotechnical engineer the opportunity to verify assumptions made during the design process, to verify that our geotechnical recommendations have been properly interpreted and implemented during construction and is required by the 2016 California Building Code. Preventative measures to reduce seasonal flooding and erosion should be incorporated into site grading plans. Dust control should also be implemented during construction. Site grading should be in strict compliance with the requirements of the South Coast Air Quality Management District [SCAQMD].

Observation of fill placement by the Geotechnical Engineer of Record should be in conformance with Section 17 of the 2016 California Building Code. California Building Code requires full time observation by the geotechnical consultant during site grading (fill placement). Therefore, we recommend that Earth Systems be retained during the construction of the proposed improvements to provide testing and observe compliance with the design concepts and geotechnical recommendations, and to allow design changes in the event that subsurface conditions or methods of construction differ from those assumed while completing this study. Additionally, the California Building Code requires the testing agency to be employed by the project owner or representative (i.e. architect) to avoid a conflict of interest if employed by the contractor. Unless noted otherwise, grading should be performed in general accordance with Appendix J of the 2016 CBC.

Clearing and Grubbing: At the start of site grading, existing vegetation, trees (including the entire rootball), large roots, overly wet and/or soft soil, undocumented fill, pavements, foundations, construction debris, septic tanks, leach fields, deleterious material, trash, and abandoned underground utilities should be removed from the proposed building areas. Organic growth should be stripped off the surface and removed from the construction area. Areas disturbed during demolition and clearing should be properly backfilled and compacted as described below.

Undocumented fill, and buried utilities may be located in the vicinity of the planned structures and within other areas of the project site. All buried structures which are removed should have the resultant excavation backfilled with soil compacted as engineered fill described herein or with a minimum 2-sack sand slurry approved by the project geotechnical engineer. Abandoned utilities should be removed entirely, or pressure-filled with concrete or grout and be capped. Abandoned buried utilities structures, or foundations should not extend under building limits.

After stripping and grubbing operations, areas to receive fill should be stripped of loose or soft earth materials until a firm subgrade is exposed, as evaluated by the geotechnical engineer or geologist (or their representative). Before the placement of fill or after cut, the existing surface soils within the building pads and improvement areas should be over-excavated as follows:

Building Pad Preparation: Due to the non-uniform and variable low-density of shallow soils, the existing soils within the building pad and foundation areas should be over-excavated a minimum of 5 feet below existing grade or 3 feet below the bottom of the footings, whichever is lower. The exposed undisturbed subgrade bottom should be observed and tested by the geotechnical engineer or his representative to verify an in-place density of the subgrade is at or greater than 85% relative compaction per ASTM D 1557 or soils are firm (as determined by the geotechnical engineer or his representative). Deeper over-excavation may be recommended if the required in-place density is not achieved, soils are not firm, or undocumented fill exists.

The approved bottom of the sub-excavation should then be scarified 12 inches; moisture conditioned to near optimum moisture content, and recompacted to at least 90% relative compaction (ASTM D 1557) prior to fill placement. Moisture conditioned and compacted engineered fill should then be placed to finish subgrade elevation in suitable compacted lifts. Compaction should be to at least 90% relative compaction. Compaction should be verified by testing.

Auxiliary Structures Subgrade Preparation: Auxiliary structures such as garden or retaining walls, etc. should have the foundation subgrade prepared similar to the building pad recommendations given above. The over-excavation should extend horizontally for 2 feet beyond the outer edge. The exposed soils should then be moisture conditioned to near optimum moisture content, and recompacted to at least 90 percent relative compaction (ASTM D 1557). Moisture conditioned, engineered fill may then be placed to finished subgrade in suitable, compacted lifts. Compaction should be verified by testing.

Subgrade Preparation: In areas to receive fill not supporting structures or hardscape the subgrade should be scarified; moisture conditioned and compacted to at least 90% relative compaction (ASTM D 1557) for a depth of 1 foot below existing grade, or finished subgrade, whichever is deeper. Compaction should be verified by testing.

Pavement and Hardscape Area Preparation: In street, drive, permanent parking, and hardscape areas the subgrade should be over-excavated a minimum depth of two feet below existing grade or finish grade (whichever is deeper). The excavation bottom should be scarified 12 inches, moisture conditioned to near or over optimum moisture content and be recompacted to at least 90% relative compaction. Engineered fill should then be moisture conditioned, placed in suitable lifts, and compacted to a minimum of 90% relative compaction to finish grade, with the upper 1 foot compacted to at least 95% relative compaction in parking and drive areas. Compacted fill should be placed to finish subgrade elevation. Compaction should be verified by testing.

Retention Basin and Infiltrator Bottom Preparation: Compaction effort should be kept to a minimum at retention basin bottom areas and bottom areas used for any infiltrators (except under foundations). The subgrade below the bottom of basins and infiltrator bottoms should be compacted to approximately 85% relative compaction. Side slopes and any other fill or foundation subgrade should be compacted to at least 90% relative compaction. Slope construction should be per this report. Loose rock, such as pea gravel or open graded rock placed in the basin bottoms does not require compaction testing, but should be placed in lifts no greater than 2 feet and consolidated by thoroughly wetting and consolidating by passes with heavy equipment (such as a loader with full bucket or full water truck) until firm such that none to minimal deformation (less than 1 inch) occurs under the weight of passing of equipment. Basins are recommended to have hydrocollapsible soils removed to competent soil or be located at least 20 feet from foundations. Infiltrator bottoms are recommended to be at least 6 feet deep below existing grades and have hydrocollapsible soils removed to competent soil. Competent soil is defined as soil meeting the compaction or density criteria as described for *Building Pads*.

Slope Construction: Please see Section 5.5 for detailed slope preparation recommendations.

All over-excavations should extend to a depth where the project geologist, engineer or his representative has deemed the exposed soils as being suitable for receiving compacted fill. The materials exposed at the bottom of excavations should be observed by a geotechnical engineer or geologist from our office prior to the placement of any compacted fill soils to verify that all old fill is removed. Additional removals may be required as a result of observation and/or testing of the exposed subgrade subsequent to the required over-excavation.

Engineered Fill Soils: The existing fill and native soils when processed appropriately are considered to be suitable for use as engineered fill. Engineered fill should be generally free from expansive soil (Expansive defined as Expansive Index (EI) greater than 20), vegetation, trash, large roots, overly wet and/or soft soil, clods larger than 3 inches, construction debris, oversized rock (greater than 6 inches) and other deleterious material as determined by the geotechnical engineer or his representative. Deleterious materials should be hauled offsite. Engineered fill soils should have a “very low” Expansion Index.

Engineered fill (and any import) should be placed in maximum 8-inch lifts (loose) and compacted to at least 90 percent relative compaction (ASTM D 1557) near its optimum moisture content prior to placement of a subsequent loose lift. Within pavement areas, the upper 12 inches of subgrade should be compacted to at least 95 percent relative compaction (ASTM D 1557). Compaction should be verified by testing. Rocks larger than 6 inches in greatest dimension should be removed from fill or backfill material, with the exception of playfield areas, where criteria necessitating a smaller oversize allowance may apply. Typically, in play field areas, the maximum oversize allowed is 1 inch.

Imported fill soils should be “very low” expansion potential granular soils meeting the USCS classifications of ML (as pre-approved by the geotechnical engineer), SM, SP-SM, or SW-SM with a maximum rock size of 3 inches and 5 to 35-percent passing the No. 200 sieve (unless otherwise approved by the geotechnical engineer). The geotechnical engineer should evaluate the import fill soils before hauling to the site. However, because of the potential variations within the borrow source, import soil will not be prequalified by Earth Systems.

A program of compaction testing, including frequency and method of test, should be developed by the project geotechnical engineer at the time of grading. Acceptable methods of testing may include Nuclear methods such as those outlined in ASTM D 6938 (Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods). Alternative methods may include methods outlined in ASTM D 1556 (Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method) or correlation probing with a hand probe.

All soils should be moisture conditioned prior to application of compactive effort and prior to foundation, slab-on-grade and pavement placement. Moisture conditioning of soils refers to adjusting the soil moisture to or just above optimum moisture content. If the soils are overly moist so that instability occurs, or if the minimum recommended compaction cannot be readily achieved, it may be necessary to aerate to dry the soil to optimum moisture content or use other means to address soft soils (as approved by the geotechnical engineer prior to use).

Shrinkage and Oversize Loss: The shrinkage factor for earthwork for the alluvial soil materials is expected to range from -3 to 18 percent for the upper excavated or scarified *site* soils based upon evaluation of 23 in-place densities (one standard deviation = 5, 95% Confidence Interval). This estimate is based on compactive effort to achieve a weighted average relative compaction of about 93 percent.

Shrinkage is highly dependent on and may vary with contractor methods for compaction. Losses from site clearing, oversize rock removal, and removal of existing site improvements, as well as the addition of excavated soil (footings, piers, etc.) may significantly affect earthwork quantity calculations and should be considered.

Dust Control: The proposed site lies within an area of high potential for wind erosion. The site soils have a fine-grained component of their composition. As such, exposed soil surfaces may be subject to disturbed fine particulate matter (PM_{10}) which can create airborne dust if the soil surface or roadways are not maintained. During construction, watering the soil surface can reduce airborne dust. Alternatively, a dust control palliative may be spray applied to the soil surface to act as a tackifier which contains loose soil particles. Palliatives must be reapplied periodically as they weather and degrade. Further guidance for dust palliatives can be found in reviewing the United States Department of Agriculture publication *Dust Palliative Selection and Application Guide*, Document No. 9977-1207-SDTDC. The recommended soil input parameters are Plasticity Index <3, and fines content 20-30 percent.

5.2 Excavations and Shoring

Excavations should be made in accordance with Cal/OSHA requirements. Using the Cal/OSHA standards and general soil information obtained from the field exploration, classification of the near surface on-site soils will likely be characterized as Type C. Actual classification of site specific soil type per Cal/OSHA specifications as they pertain to trench safety should be based on real-time observations and determinations of exposed soils by the contractors *Competent Person* (as defined by OSHA) during grading and trenching operations.

Our site exploration and knowledge of the general area indicates there is a moderate potential for caving and sloughing of site excavations (over excavation areas, utilities, footings, etc.) due to dry and also overly moist/wet conditions. Where excavations in soils over 4 feet deep are planned, lateral bracing or appropriate cut slopes of 1.5:1 (horizontal/vertical) should be provided. No surcharge loads from stockpiled soils or construction materials should be allowed within a horizontal distance measured from the top of the excavation slope and equal to the depth of the excavation. Excavations should be protected from water flow over the exposed surface and saturation.

Excavations which parallel structures, pavements, or other flatwork, should be planned so that they do not extend into a plane having a downward slope of 1:1 (horizontal: vertical) from the bottom edge of the footings, pavements, or flatwork. Shoring or other excavation techniques may be required where these recommendations cannot be satisfied due to space limitations or foundation layout. Where overexcavation will be performed adjacent to existing structures, ABC slot cutting techniques may be used as pre-approved by the project geotechnical engineer.

Shoring: Shoring may be required where soil conditions, space, or other restrictions do not allow a sloped excavation or slot cutting is not an option. A braced or cantilevered shoring system may be used. Trench boxes should not be placed below or within the pipe zone elevation as their removal may loosen compacted backfill. Positive trench shoring may be required (jacks and plates).

A temporary cantilevered shoring system should be designed to resist an active earth pressure equivalent to a fluid weighing as shown in the table below. Braced or restrained excavations above the groundwater table should be designed to resist a uniform horizontal equivalent soil pressure as presented in the table below.

Table 6
Temporary Cantilevered and Braced Shoring System Parameters

Equivalent Fluid Pressure pounds per cubic foot (pcf)	
Cantilevered	**Braced**
42	64

The values provided above assume a level ground surface adjacent to the top of the shoring and do not include a factor of safety. Fifty percent of an areal surcharge placed adjacent to the shoring may be assumed to act as an additional uniform horizontal pressure against the shoring. Special cases such as combinations of slopes and shoring or other surcharge loads may require an increase in the design values recommended above. These conditions should be evaluated by the project geotechnical or shoring engineer on a case-by-case basis. Retaining walls subjected to traffic loads should include a uniform surcharge load equivalent to at least 240 psf for auto or delivery truck (2 axle) traffic kept at least 3 feet from the back of the wall. Retaining walls with closer traffic or heavier traffic loads should be designed for a 450 psf surcharge load. Retaining walls should be designed with a minimum factor of safety of 1.5.

The wall pressures above the groundwater do not include hydrostatic pressures; it is assumed that drainage will be provided. If drainage is not provided, shoring extending below the groundwater level should be evaluated on a case-by-case basis.

Cantilevered shoring must extend to a sufficient depth below the excavation bottom to provide the required lateral resistance. We recommend required embedment depths be determined using methods for evaluating sheet pile walls and based on the principles of force and moment equilibrium. For this method, the allowable passive pressure against shoring, which extends below the level of excavation, may be assumed to be equivalent to a fluid weighing 350 pcf.

Additionally, we recommend a factor of safety of at least 1.2 be applied to the calculated embedment depth and that passive pressure be limited to 2,000 psf.

The contractor should be responsible for the structural design and safety of all temporary shoring systems. The contractor should carefully review the exploration logs in this report, and perform their own assessment of potential construction difficulties, and methods should be selected accordingly. Shoring should be sealed to prevent the piping of soil material and potential soil loss conditions which can cause settlement. The method of excavation and support is ultimately left to the contractor with guidance and restrictions provided by the designer and owner. We recommend that existing structures be monitored for both vertical and horizontal movement.

The method of excavation and support is ultimately left to the contractor with guidance and restrictions provided by the designer and owner. A representative from our firm should be present during grading operations to monitor site conditions; substantiate proper use of materials; evaluate compaction operations; and verify that the recommendations contained herein are met.

5.3 Utility Trenches

Backfill of utilities within roads or public right-of-ways should be placed in conformance with the requirements of the governing agency (water district, public works department, etc.). Utility trench backfill within private property should be placed in conformance with the provisions of this report. Backfill operations should be observed and tested to monitor compliance with these recommendations.

Trench Width and Vertical Loads on Pipelines: Vertical loads to the pipeline are highly dependent upon the geometry of the trench. In general, the narrower the trench is at the top of the pipe/conduit with respect to the diameter of the conduit, the less vertical load is applied to the conduit. This is because as the trench backfill and bedding compress or consolidate over time, the weight of the soil mass is partially offset by the frictional resistance along the trench sidewalls. In addition, the type of bedding supporting the pipeline affects the bearing strength of the conduit. This is accounted by a load factor that is multiplied to the design strength of the conduit. The pipe manufacturer recommendations for trench installation and maximum width should be followed to reduce the potential for overloading the pipe due to excess backfill load.

Pipe Subgrade and Bedding: Pipeline subgrade should be compacted to a minimum of 90% relative compaction (ASTM D 1557) or to a firm condition as evaluated by the geotechnical engineer or his representative for a depth of 6 inches below any bedding. Bedding material shall consist of sand 100 percent passing a No. 4 sieve and less than 5 percent fines (passing a No. 200 sieve), and a sand equivalent of 30 or more or as approved by the project inspector and geotechnical engineer. The unprocessed native soils are not typical of that used for bedding and import will be required if needed.

Pipe-Zone, Trench–Zone, Trench Backfill and Compaction: Backfill of utilities should be placed in conformance with the requirements of the specifications. Backfill of utilities within roads or public right-of-ways should be placed in conformance with the requirements of the governing agency (water district, public works department, etc.).

Pipe zone backfill material (the pipe area from the bedding to 12 inches above the top of pipe) may consist of native soils screened to a ¾" maximum particle size or import sand (as described above for bedding) as dictated by the pipe designer or manufacturer. The pipe zone backfill material should be placed in maximum 8-inch lifts (loose) and compacted near its optimum moisture content prior to the placement of subsequent lifts. Pipe zone backfill should be compacted to a minimum of 90% relative compaction (ASTM D 1557) or to a firm condition as evaluated by the geotechnical engineer or his representative. Compaction should be assured in the pipe haunches.

The native soil is suitable for use as trench zone and street zone (and manholes) backfill (from the top of pipe zone up to finished grade), provided it is free of significant organic or deleterious matter and oversize materials. This backfill shall contain no particles larger than 3 inches in greatest dimension. The final backfill material should be placed in maximum 8-inch lifts (loose) and compacted to at least 90% relative compaction (ASTM D 1557) near its optimum moisture content for the trench zone and 95% for the street zone (upper 12 inches) where below pavement. Compaction should be verified by testing.

Backfill materials should be brought up at substantially the same rate on both sides of the pipe or conduit. Reduction of the lift thickness may be necessary to achieve the above recommended compaction. Care should be taken to not overstress the piping during compaction operations. Mechanical compaction is recommended; ponding or jetting is not recommended.

Alternatively, if the utility cannot accommodate the increased stress, or if compaction is difficult, we recommend the pipe be encased by at least 1 foot of 2-sack cement-sand slurry (at least 1 foot as measured from the top of pipe). Backfill operations should be observed and tested to monitor compliance with these recommendations.

In general, coarse-grained sand and/or gap graded gravel (i.e. ¾-inch rock or pea-gravel, etc.) should not be used for pipe or trench zone backfill due to the potential for soil migration into the relatively large void spaces present in this type of material and water seepage along trenches backfilled with coarse-grained sand and/or gravel. Gravel should be separated from backfill with a filter fabric such as Mirafi 140N or equivalent as approved by the soils engineer. Water seepage or soil migration will cause settlement of the overlying soils.

Compaction should be verified by testing. Backfill operations should be observed and tested to monitor compliance with these recommendations. Trench backfill compacted per these requirements can be expected to settle 0.1 to 0.3 percent of the trench depth. This can cause an elevation difference between backfilled trenches and the surrounding soil or pavement. Increased relative compaction can reduce settlement if the potentials presented are not acceptable. The geotechnical engineer should be consulted on a case-by-case basis to provide further recommendations to reduce the settlement potential.

STRUCTURES

In our professional opinion, structure foundations can be supported on shallow foundations bearing on a zone of properly prepared and compacted soils placed as recommended in Section 5.1. The recommendations that follow are based on "very low" expansion category soils.

5.4 Foundations

Footing design of widths, depths, and reinforcing are the responsibility of the Structural Engineer, considering the structural loading and the geotechnical parameters given in this report. A minimum footing depth of 18 or 24 inches (below lowest adjacent grade) should be maintained and considers a "very low" Expansion Index soil. Lowest adjacent grade is the lowest grade within 3 feet laterally of the footing edge. A representative of Earth Systems should observe foundation excavations to verify compaction (minimum 90% per ASTM D 1557) before placement of reinforcing steel or concrete. Loose soil or construction debris should be removed from footing excavations before placement of concrete. *All footing excavations should be probed for uniformity. Soft or loose zones should be excavated and recompacted to finish foundation bottom subgrade. The bottom of all foundations should be tested to confirm compaction effort and moisture contents as stated in Section 5.1 of this report are met.* The moisture contents should be at least the indicated moisture content 24 hours prior to and immediately prior to placing concrete for a depth of at least 12 inches below the foundation subgrade. If the moisture condition is less than indicated, it shall be brought up to or above the indicated moisture content.

Minimum Slope Setback for Foundations: Earth Systems recommends a minimum setback distance of 5 feet. The 2016 California Building Code provides setback distances for foundations along slopes. Setback distances are measured differently for foundations located above the slope and those located below the slope. For foundations located at the top of the slope, the measurement is taken horizontally from the outside face of the foundation footing to the face of the slope. For foundations located below the slope, the horizontal distance is measured from the face of the structure foundation to the toe of the slope. For pools and slopes steeper than 1(H):1(V), please contact Earth System for these setbacks with submittal of detailed information using plan form. We recommend a structure setback of at least 20 feet from the onsite storm channel easement, or 30 feet from the edge of pipe or channel, whichever is greater.

Conventional Spread Foundations: Allowable soil bearing pressures are given below for foundations bearing on recompacted soils as described in Section 5.1 and considered historic water conditions. Allowable bearing pressures are net (weight of footing and soil surcharge may be neglected).

- Continuous wall foundations, 1 foot minimum and 2.5 foot maximum width and 18-inch minimum depth below grade:

  1,500 psf for dead plus design live loads

- Pad foundations, 2 x 2-foot minimum and 7 x 7-foot maximum in plan and 24 inches below grade:

  1,850 psf for dead plus design live loads

A one-third (⅓) increase in the allowable bearing pressure may be used when calculating resistance to wind or seismic loads.

Retaining wall foundations along the existing slope to the west should be designed as an eccentric foundation with the foundation located away from the slope to minimize disturbance and backcuts within the existing slope supporting homes and improvements. Subsurface tanks should be designed for the potential high groundwater conditions detailed within which may require "deadmen" or other means to resist buoyant forces.

If the anticipated loads exceed the estimated values stated in Section 1.1 (90 kips for Isolated Footings and 5 kip/linear-ft for continuous footings), the geotechnical engineer must reevaluate the allowable bearing values as the allowable bearing was controlled by the allowable total differential settlement from dry seismic, collapse, and static loads. Underground utilities should be designed for an anticipated settlement within the building areas.

The spacing between any large spread footings should be evaluated by the geotechnical engineer during the plan review stage to confirm or modify the settlement estimates and bearing capacity due to large footings and the influences from adjacent footings. A preliminary analysis suggests spacing the footings (adjacent edge to adjacent edge) a lateral distance from one another of the width of the largest footing from any adjacent footing, such that influence effects are minor.

Maximum foundation sizes given above are based on settlement due to Dead + Live loads. Transient loads such as earthquake or wind loads are not subject to the stated size limitations; however, the allowable bearing pressure (including ⅓ increase) should be followed considering the relevant foundation sizes given above.

An average modulus of subgrade reaction, k, of 150 pounds per cubic inch (pci) can be used to design lightly loaded footings, beams, pavement, and slabs founded upon compacted fill. Other foundations such as mat slabs, will require the use of differing modulus of subgrade reaction values than used for lightly loaded slabs. Please contact Earth Systems for k values used for mat foundations.

The table below is based upon the above presented allowable, short term, and ultimate bearing pressures. Values may be increased by the provisions given above. Short Term allowable bearing may use the values presented below (based on Allowable Stress Design) or be based on Code mandated structural reductions, whichever is less. Ultimate bearing capacities consider a factor of safety of 3 (ASD design) to control settlement and bearing failure considering high groundwater (4,500 to 5,550 psf ultimate) and a safety factor of 2.25 on transient loads (2,000 to 2,450 psf). Ultimate bearing to soil failure depends on foundation size and could be greater than 5,550 psf. The restrictions of Section 1605A.1.1 apply to the cited bearing values for Allowable Stress Design (ASD).

Table 7

	Allowable Bearing Capacity (psf) (FS = 3)	**Short Term (Wind/Seismic) (FS = 2.25)**	**Ultimate Bearing Capacity (FS = 1)**
Continuous Foundations	1,500	2,000	4,500
Isolated Pad Foundations	1,850	2,450	5,550

FS = Factor of Safety

Footings should be designed and reinforced by the structural engineer for the specific loading, settlement, or collapse soil conditions defined herein.

Stepped foundations should be designed in accordance with the 2016 CBC. CBC 2016 and ACI Section 4.3, Table 4.3.1 should be followed for recommended cement type, water cement ratio, and compressive strength. Seismic Design Category for compressive strength determination is 'E'. Due to the negligible sulfates in the site soils, normal cements may be and should be proportioned in accordance with ACI recommendations considering the time of year for placement. Hot weather proportions should be used during high ambient heat days during placement and curing.

Expected Settlement: Estimated total static, and collapse settlement should be approximately 1 inch, based on footings founded on firm soils as recommended. Differential static settlement between similar bearing members should be less than ½ inch. As such, considering static, and collapse differential settlement applied over a typical foundation distance of 40 feet, we recommend the structural engineer design for a standard angular distortion of 1:480. Considering the static, collapse, and seismic case, we recommend the structural engineer design for 1.7 inches in 40 feet or an angular distortion of 1:280. Settlement will not result in the complete loss of soil support, but will be manifested as a tilting of the structure over the applied distance.

Seismic settlements are considered "small scale" as per SP117A and as such, structural solutions may be used to resist such hazards.

Settlement calculations are presented in Appendix A and collapse results are provided in Section 3.3. The actual settlement of large spread footings should be evaluated by the geotechnical engineer during the plan review stage based on the actual column loads to confirm or modify the settlement estimates presented. Due to the generally granular nature of the site soils, a substantial portion of the total static settlement is expected to occur during construction.

Earthquake Performance Statement: Depending upon the extent of structural and geotechnical design, some damage due to seismic events will occur. We recommend a standard statement for purchasers or end users of the property and within title reports that seismic induced damage may occur. Note that all of southern California in general is in earthquake country. Site developments in southern California are typically not designed to mitigate anticipated seismic events without some damage. In fact, the Building Code is intended to provide Life-Safety performance, not complete damage-free design. In other words, some damage from earthquakes in the form of structural damage, settlement, cracking, and disruption of utilities is expected and that repair after an earthquake event will likely be required. It is not the current standard of care for site developers to fully mitigate all anticipated earthquake induced hazards. It is incumbent on the developer to advise the end-users of the project of the anticipated hazards in the form of disclosure statements during the initial and subsequent purchase processes.

According to literature from Robert W. Day, doors and windows may stick at distortion angles between 1:240 and 1:175. In this situation, a human being could be put in a life-threatening situation. Therefore, Earth Systems recommends (for shallow foundation design) the maximum distortion angle using all the settlement conditions including seismic settlements be 1:240. The estimated angular distortions for this project are better than this threshold.

Minor Deep Foundations: Although no specific elements were identified by the architect, for miscellaneous structural components such as light poles, gate posts, temporary retaining walls, and flag poles, may be supported on cast-in-place piles, or direct embed in drilled holes filled with concrete, and the design be based on parameters presented in the subsequent sections of this report. Construction employing poles or posts may utilize design methods presented in Section 1807A of the CBC for Silty Sand (SM) material class. For designs utilizing allowable frictional resistance, Earth Systems recommends the use of Section 1810.3.3.1.4 of the CBC. For piles with an axial load, these design methods apply for piles spaced at least 3 pile diameters center to center for axial loads as graded in accordance with Section 5.1. Piles spaced closer than these limits could have soil strength reduction and should be evaluated on a case-by-case basis by geotechnical engineer.

For piers founded in areas with native soil at the surface, an additional 1.5 feet should be added to the calculated pile embedment due to the potential effects of long-term surficial disturbance and erosion. Additionally, where piers are constructed adjacent to the tops of slopes, there should be a minimum distance between the top of the slope and the closest edge of the pier of H/3, where 'H' is the height of the slope, otherwise a lateral resistance reduction must be applied. For piers founded closer than a distance H/3 to the crest or within the slope area itself, the calculated lateral resistance of the soil should be reduced by 30 percent. The above recommendations have considered slopes no steeper than 2:1 (horizontal:vertical). Steeper slopes will require additional analysis and may change the recommendations presented.

Drilled piers should have a minimum 3 inches of clearance between the embedded post and the soil side wall to allow for adequate placement and flow of concrete.

Drill holes may end up oversize. Casing or other means may be required in a drilled hole. Any "slough" or loose soils at the bottom of the shaft must be removed or tamped prior to setting rebar cages and placing concrete. Extreme care must be exercised to carefully position reinforcing steel cages and place concrete without disturbing the sidewalls of the drilled shafts. We recommend centralizers be used to positively locate rebar cages within the pier shaft. It is recommended that pier excavations that have not received concrete, not be left open and concrete should be placed immediately. Caving is a very high concern.

Normally, drilled pier excavations should be made without the use of water. If necessary, water may be used to facilitate removal of cuttings unless it aggravates caving problems. Added water that may accumulate at the bottom of the hole should be removed from the drilled hole prior to placing the concrete. Sidewalls which have softened from the addition of water should be cleaned of the soft/loose material. Each excavation should be completed in a continuous operation and the concrete should be placed without undue delay. The contractor should use appropriate means to clean the bottom of the excavation so that no loose material is present at the base of the pier. We do not recommend overdrilling beyond specified pier tip elevations to eliminate the need for bottom cleaning in order to account for slough or loose materials at the excavation bottom. To reduce the potential for caving and sidewall sloughing which may contaminate concrete during placement, and segregation, concrete should be placed by tremie methods and not directly chute-dumped into the hole.

Where casing is used with drilled holes and cannot be withdrawn, the skin friction capacity is theoretically reduced, as are passive resistance and stiffness. The amount of reduction is subject to assessment by the geotechnical consultant. The use of casing with drilled holes should be approved prior to use by the geotechnical engineer.

If casing is required, it should be withdrawn as the concrete is being placed, maintaining a 3-foot minimum head of concrete within the casing. This is to prevent reduction in the diameter of the drilled shaft due to earth pressure on the fresh concrete and to prevent extraneous material from falling in from the sides and mixing with the concrete. Concrete placement should continue in this manner until suitable concrete extends to the top of the excavation or forms. The upper eight feet of the pier should be consolidated by vibratory means.

Pier capacity is greatly dependent on the soil conditions at the location of the pier and upon contractor means and methods of placement. It is recommended that drilling operations and concrete placement be performed in the continuous presence of the geotechnical consultant or his representative to confirm that suitable materials for pier support are penetrated, that the dimensions of the installed piers meet the design dimensions, and that the installation has been performed as specified by the 2016 California Building Code. Observation during drilling is required by the 2016 California Building Code on a full-time basis by the geotechnical engineer or his representative. If subsurface conditions noted during drilled pier installation are significantly different than those encountered in our borings, it may be necessary to adjust the overall length of the pier.

Prior to the placement of steel, and again prior to and during the placement of concrete, the excavation must be examined by the geotechnical consultant before proceeding with construction. The contractor should provide all aid and assistance required by the geotechnical and geologic consultants for field monitoring of the drilled pier operations.

Piers are accepted or rejected based on visual observation and testing during construction. The contractor should not allow nor cause any of this work to be permanently enclosed or covered up until it has been observed, tested, and accepted by the geotechnical engineer and all legally constituted authorities having jurisdiction.

5.5 Slope Construction

New slopes are not generally proposed for this project; however, minor slopes (less than 5 feet in height) may be constructed. Modification of the existing 2:1 slope may occur to accommodate a retaining wall. For remedial grading of the slope, new fills should be benched into firm existing soils. A backdrain behind the retaining wall is recommended.

Site soils are highly susceptible to erosion. Compacted fill slopes protected against erosion (per approved methods such as significant planting, facing, or erosion blankets, etc.) should be constructed at 2:1 (horizontal: vertical) or flatter inclinations. Unprotected slopes with exposed native soils or compacted fill at the surface should be expected to require repair after heavy nuisance or storm runoff occurs due to significant erosion. Slope recommendations may change pending a more in-depth geotechnical evaluation once design plans are developed. Slopes used as nuisance or storm drainage channel slopes which should be no steeper than 3:1 or protected with heavy 12" minimum rip-Rap at 2:1 inclination. Site soils are granular and generally free draining such that "rapid draw down" strength loss will not occur.

Compacted fill should be placed at near optimum moisture content and compacted to a minimum 90 percent of the maximum dry unit weight, as measured in relation to ASTM D 1557 test procedures. The exposed face of any cut or fill slope (upper 12 inches) should have a minimum relative compaction of 90 percent, as measured in relation to ASTM D 1557 test procedures, and be compacted at near optimum moisture content. Due to the erodible site soils, slope faces should be protected with facing or densely spaced vegetation to reduce the erosion potential.

Surficial Slope Failures: Site soils are highly susceptible to erosion from wind and water sources. All slopes will be exposed to weathering, resulting in decomposition of surficial earth materials, thus potentially reducing shear strength properties of the surficial soils. In addition, these slopes become increasingly susceptible to rodent burrowing. As these slopes deteriorate, they can be expected to become susceptible to surficial instability such as soil slumps, erosion, soil creep, and debris flows. Development areas immediately adjacent to ascending or descending slopes should address future surficial sloughing of soil material and erosion. Such measures may include debris fences, slope facing, catchment areas or walls, diversion ditches or berms, soil planting, velocity reducers or other techniques to contain soil material away from developed areas and reduce erosion. Additionally, foundations should be set back at least 5 feet from the edge of slope or as per the 2016 CBC, whichever is greater.

Operation and maintenance inspections should be done after a significant rainfall event and on a time-based criteria (annually or less) to evaluate distress such as erosion, slope condition, rodent infestation burrows, etc. Inspections should be recorded and photographs taken to document current conditions. The repair procedure should outline a plan for fixing and maintaining surficial slope failures, erosional areas, gullies, animal burrows, etc. Repair methods could consist of excavating and infilling with compacted soil erosional features, track walking the slope faces with heavy equipment, as determined by the type and size of repair. These repairs should be performed in a prompt manner after their occurrence. Slope inclinations should be maintained and a maintenance program should include identifying areas where slopes begin to steepen. Where future maintenance is not possible, slopes should be faced to reduce the erosion and degradation potential.

Slope faces are highly erodible even if compacted and will gradually erode and move down slope presenting maintenance issues and debris deposited in drainage devices and flatwork areas. The minimum material necessary to support landscaping should be specified by the landscape consultant (typically less than 6 inches).

More detailed stability and value engineering analysis of the retaining wall/ascending slope is recommended once grading plan and retaining wall plans are progressing. Backcut configurations during construction of the retaining wall will need to be stable to prevent instability of the adjacent lots at the top of the slope.

5.6 Slabs-on-Grade

Subgrade: Concrete slabs-on-grade and flatwork should be supported by compacted and moisture conditioned soil placed in accordance with Section 5.1 of this report. The moisture content below slabs should be at least optimum moisture content 24 hours prior to and immediately prior to placing concrete for a depth 12 inches. If the moisture condition is less than indicated, it shall be brought up to or above the indicated moisture content.

Vapor Retarder: In areas of moisture-sensitive floor coverings, coatings, adhesives, underlayment, goods or equipment stored in direct contact with the top of the slab, bare slabs, humidity controlled environments, or climate-controlled cooled environments, an appropriate vapor retarder that maintains a permeance of 0.01 perms or less after ASTM E1745's mandatory conditioning tests should be installed to reduce moisture transmission from the subgrade soil to the slab. For these areas, a vapor retarder (Stego wrap 15-mil thickness or equal) should underlie the floor slabs. If a Class A vapor retarder (ASTM E 1745) is specified, the retarder can be placed directly on non-expansive soil, and be covered with a minimum 2 inches of clean sand.

Clean sand is defined as well or poorly-graded sand (ASTM D 2488) of which less than 5 percent passes the No. 200 sieve and all the material passes a No. 4 sieve. The site soils do not fulfill the criteria to be considered clean sand. Alternatively, the slab designer may consider the use of other vapor retarder systems that are recommended by the American Concrete Institute.

Low-slump concrete should be used to help reduce the potential for concrete shrinkage. The effectiveness of the membrane is dependent upon its quality, the method of overlapping, its protection during construction, the successful sealing of the membrane around utility lines, and sealing the membrane at perimeter terminations and of all penetrations. Capillary breaks, if any, beneath slabs should consist of a minimum of at least four inches of permeable base material with the following specified gradation.

Table 8

Percent Passing Sieve Size

Sieve Size	Percent Passing
1 inch	100
¾ Inch	90-100
3/8 Inch	40-100
#4	25-40
#8	18-33
#30	5-15
#50	0-7
#200	0-3

Where vapor retarders are placed directly on a gravel capillary break, they should be a minimum of 15 mil thickness.

Where concrete is placed directly on the vapor retarder "plastic", proper curing techniques are essential to minimizing the potential of slab edge curl and shrinkage cracking. The edges of slabs can curl upward because of differential shrinkage when the top of the slab dries to lower moisture content than the bottom of the slab. Curling and cracking are caused by the difference in drying shrinkage between the top and bottom of the slab. Curling and cracking can be exacerbated by hot weather, or dry condition concrete placement, even with proper curing techniques.

The following minimum slab recommendations are intended to address geotechnical concerns such as potential variations of the subgrade and are not to be construed as superseding any structural design. A design engineer should be retained to provide building specific systems to handle subgrade moisture to ensure compliance with SB800 with regards to moisture and moisture vapor.

Slab Thickness and Reinforcement: Structure slabs should be a minimum of 4 inches in actual thickness and be reinforced with # 3 bars at 18 inches on center both ways. Slabs in contact with earth should use closer joints to control cracking or be thickened to allow adequate earth to rebar clearance. Reinforcing bars should extend at least 40 bar diameters into the footings and slabs. Concrete slabs-on-grade and flatwork should be supported by compacted and moisture conditioned soil placed in accordance with this report. If slabs are structural, they should be designed for the specific settlement conditions presented within.

Slab thickness and reinforcement of slabs-on-grade are contingent on the recommendations of the structural engineer or architect and the Expansion Index of the supporting soil. Based upon our findings, a modulus of subgrade reaction of approximately 150 pounds per cubic inch can be used in concrete lightly loaded (not mat) slab design for the expected compacted subgrade. Mat slab design will require differing modulus values. ACI Section 4.3, Table 4.3.1 should be followed for recommended cement type, water cement ratio, and compressive strength.

If heavily loaded flatwork is proposed (forklift drive areas, heavy racking, etc.), the actual thickness should be designed by the structural engineer utilizing techniques of the American Concrete Institute (ACI) and may be greater than 4 inches in thickness. Concrete floor slabs may either be monolithically placed with the foundations or doweled (No. 4 bar embedded at least 40 bar diameters) after footing placement. The thickness and reinforcing given are not intended to supersede any structural requirements provided by the structural engineer. The project architect or concrete inspector should continually observe all reinforcing steel in slabs during placement of concrete to check for proper location within the slab. The minimum concrete rebar cover should be as per the project architect or structural engineer.

Slab-On-Grade Control Joints: Control joints should be provided in all regular concrete slabs-on-grade at a maximum spacing of 26 to 36 times the slab thickness (12 feet maximum on-center each way, 4 to 6 feet for sidewalks) as recommended by American Concrete Institute [ACI] guidelines. All joints should form approximately square patterns to reduce the potential for randomly oriented shrinkage cracks. Control joints in the slabs should be tooled at the time of the concrete placement or saw cut (¼ of slab depth) as soon as practical but not more than 8 hours from concrete placement.

Construction (cold) joints should consist of thickened butt joints with ¾-inch dowels at 18 inches on center embedded per ACI or a thickened keyed-joint to resist vertical deflection at the joint. All control joints in exterior flatwork should be sealed to reduce the potential of moisture or foreign material intrusion. These procedures will reduce the potential for randomly oriented cracks, but may not prevent them from occurring.

Curing and Quality Control: The contractor should take precautions to reduce the potential of curling and cracking of slabs in this arid desert region using proper batching, placement, and curing methods. Curing is highly affected by temperature, wind, and humidity.

Quality control procedures should be used, including trial batch mix designs, batch plant inspection, and on-site special inspection and testing. Curing should be in accordance with ACI recommendations contained in ACI 211, 304, 305, 308, 309, and 318. Additionally, the concrete should be vibrated during placement. Concrete should be wet cured for at least 7 days with burlap or plastic and not allowed to dry out to minimize surface cracking.

5.7 Retaining Walls and Lateral Earth Pressures

Walls which are restrained at the top such as retaining wall returns, below-grade walls and walls tied to floor slabs should be designed with “at rest” earth pressures. Retaining walls, free to tilt at the top, may be designed for “active” earth pressures.

The following list presents lateral earth pressures for use in wall design. The values are given as equivalent fluid pressures ***without*** surcharge loads or hydrostatic pressure. Clay soils are not suitable for wall backfill as they are not free draining. Native sand material may be used for backfill or free draining material imported as wall backfill. For native or import free draining material, active and restrained walls equivalent fluid pressures are as follows:

- Conventional cantilever retaining walls may be backfilled with compacted on-site soils verified by the contractor to be “very low” in expansion potential. Provided the wall is backfilled at a 1:1 projection upward from the heels of the wall footings with onsite sand, an active pressure of 42 pcf of equivalent fluid weight for well-drained, level backfill may be used. Similarly, an active pressure of 52 pcf of equivalent fluid weight may be used for well-drained backfill sloping at 2H:1V (horizontal to vertical). For the restrained level backfill condition, a pressure of 64 pcf of equivalent fluid weight should be used.
- In addition to the active or at rest soil pressure, the proposed wall structures should be designed (where not excepted) to include forces from dynamic (seismic) earth pressure. Dynamic pressures are additive to active and at-rest earth pressure and should be considered as 63 pcf for flexible walls, and 80 pcf for rigid walls. Seismic pressures are based on PGA_M of 0.91g, Friction Soil Angle of 31°, and a maximum dry density of 133 pcf.
- Retaining wall foundations should be placed upon compacted fill described in Section 5.1.
- A backdrain or an equivalent system of backfill drainage should be incorporated into the wall design, whereby the collected water is conveyed to an approved point of discharge. Design should be in accordance with the 2016 California Building Code. Drain rock should be wrapped in filter fabric such as Mirafi 140N as a minimum and should have a volume of 1 cubic foot per foot of length. Backfill immediately behind the retaining structure should be a free-draining granular material. Waterproofing should be according to the designer’s specifications. Water should not be allowed to pond or infiltrate near the top of the wall. To accomplish this, the final backfill grade should divert water away from retaining walls.

- Compaction on the retained side of the wall within a horizontal distance equal to one wall height (to a maximum of 6 feet) should be performed by hand-operated or other lightweight compaction equipment (90% compaction relative to ASTM D 1557 at near optimum moisture content). This is intended to reduce potential locked-in lateral pressures caused by compaction with heavy grading equipment or dislodging modular block type walls.
- The above recommended values do not include compaction or truck-induced wall pressures. Care must be taken during the compaction operation not to overstress the wall. Heavy construction equipment should be maintained a distance of at least 3 feet away from the walls while the backfill soils are placed. Upward sloping backfill or surcharge loads from nearby footings can create larger lateral pressures. Should any walls be considered for retaining sloped backfill or placed next to foundations, our office should be contacted for recommended design parameters. Surcharge loads should be considered if they exist within a zone between the face of the wall and a plane projected 45 degrees upward from the base of the wall. The increase in lateral earth pressure should be taken as 50% of the surcharge load within this zone. Retaining walls subjected to traffic loads should include a minimum uniform surcharge load equivalent of 240 psf for auto and 450 psf for truck traffic kept back at least 3 feet from the wall back edge. Retaining walls should be designed with a minimum factor of safety of 1.5.

Frictional and Lateral Coefficients:

- Resistance to lateral loads (including those due to wind or seismic forces) may be provided by frictional resistance between the bottom of concrete foundations and the underlying soil, and by passive soil pressure against the foundations. An allowable coefficient of friction of 0.35 may be used between cast-in-place concrete foundations and slabs and the underlying soil. An allowable coefficient of friction of 0.30 may be used between pre-cast or formed concrete foundations and slabs and the underlying soil
- Allowable passive pressure may be taken as equivalent to the pressure exerted by a fluid weighing 350 pounds per cubic foot (pcf). The upper 1 foot of soil should not be considered when calculating passive pressure unless confined by overlying asphalt concrete pavement or Portland cement concrete slab. The soils pressures presented have considered onsite fill soils. Testing or observation should be performed during grading by the soils engineer or his representative to confirm or revise the presented values.
- Passive resistance for thrust blocks bearing against firm natural soil or properly compacted backfill can be calculated using an equivalent fluid pressure of 350 pcf. The maximum passive resistance should not exceed 2,000 psf.
- Construction employing poles or posts (i.e. lamp posts) may utilize design methods presented in Section 1807.3 of the CBC for Sandy soils (SM) material class.
- The passive resistance of the subsurface soils will diminish or be non-existent if trench sidewalls slough, cave, or are over widened during or following excavations. If this condition is encountered, our firm should be notified to review the condition and provide remedial recommendations, if warranted.

5.8 Seismic Design Criteria

This site is subject to strong ground shaking due to potential fault movements along regional faults including the San Andreas fault zone. Engineered design and earthquake-resistant construction increase safety and allow development of seismic areas. The minimum seismic design should comply with the 2016 edition of the California Building Code and ASCE 7-10 using the seismic coefficients given in the table below. General Procedure seismic parameters are presented below per ASCE7-10 exception, considering a Site Class D (based on Vs shear wave velocity) for structures not greater than 0.5 seconds in period. For foundations described within, site soils are not subject to bearing failure.

2016 CBC (ASCE 7-10) Seismic Parameters

Seismic Design Category:	E
Site Class:	D (F*)
Maximum Considered Earthquake [MCE] Ground Motion	
Short Period Spectral Response S_s:	2.288 g
1 second Spectral Response, S_1:	0.921 g
Code Design Earthquake Ground Motion	
Short Period Spectral Response, S_{DS}	1.525 g
1 second Spectral Response, S_{D1}	0.921 g
Peak Ground Acceleration (PGA_M)	0.91 g

*Site is potentially liquefiable and for structures greater than 0.5 seconds in period, Site Class is F applies and the above values do not apply. For Site Class F, site specific evaluation is required. Please contact Earth Systems should this case apply.

The intent of the CBC lateral force requirements is to provide a structural design that will resist collapse to provide reasonable life safety from a major earthquake but may experience some structural and nonstructural damage. A fundamental tenet of seismic design is that inelastic yielding is allowed to adapt to the seismic demand on the structure. In other words, *damage is allowed*. The CBC lateral force requirements should be considered a *minimum* design. The owner and the designer may evaluate the level of risk and performance that is acceptable. Performance based criteria could be set in the design. The design engineer should exercise special care so that all components of the design are fully met with attention to providing a continuous load path. An adequate quality assurance and control program is urged during project construction to verify that the design plans and good construction practices are followed. This is especially important for sites lying close to the major seismic sources.

Estimated peak horizontal site accelerations are based upon a probabilistic analysis (2 percent probability of occurrence in 50 years) is approximately 0.9 g for a stiff soil site. Actual accelerations may be more or less than estimated. Vertical accelerations are typically ⅓ to ⅔ of the horizontal accelerations, but can equal or exceed the horizontal accelerations, depending upon the local site effects and amplification.

5.9 Driveways and Parking Areas

Pavement structural sections for associated drive areas including recommendations for standard asphalt concrete, and Portland cement concrete are provided below and are based upon on-site soils as described in Section 5.1. Soils differing from those described will require differing pavement sections. The appropriate pavement section depends primarily on the shear strength of the subgrade soil exposed after grading in the near finished subgrade elevation and the anticipated traffic over the useful life of the pavement. R-value testing or observation of subgrade soils should be performed of near finished subgrade elevation soils to verify and/or modify the preliminary pavement sections presented within this report.

Pavement Area Preparation: In street, drive, and parking areas, the exposed subgrade should be overexcavated as recommended in Section 5.1, moisture conditioned, and compacted. Compaction should be verified by testing. Aggregate base should be compacted to a minimum 95% relative compaction (ASTM D 1557).

Automobile Traffic and Parking Areas: Pavement sections presented in the following table for automobile type traffic areas and are based on a tested R-value and current Caltrans design procedures. Traffic Indices (TI) of 5 and 7 were used to facilitate the design of asphalt concrete pavements for parking and main drives, including fire lanes. The fire lane calculation assumed a conservative traffic flow of one fire truck per day entering and exiting the site on the same path (20 year life cycle), and a maximum loading of an 80,000 lb Tandem Axle apparatus (approximate 20,000 lb front axle load and two 30,000 lb rear axles loads) which is based upon the *Emergency Vehicle Size and Weight Regulation Guideline*, dated November 22, 2011, prepared by the Fire Apparatus Manufacturers' Association.

Based on the above stated traffic pattern and apparatus loads, a Traffic Index of 4.6 is calculated for fire lanes. For comparison, a 40 year fire lane life cycle analysis results in a Traffic Index of 5. The TI's assumed below should be reviewed by the project Civil Engineer to evaluate the suitability for this project. All design should be based upon an appropriately selected traffic index. Changes in the traffic indices will affect the corresponding pavement section.

Table 9
Preliminary Flexible Pavement Section Recommendations On-site/Interior Automobile Drive Areas

R-Value of Subgrade Soils - 52 (Tested) Design Method – CALTRANS

Traffic Index (Assumed)*	**Pavement Use**	**Flexible Pavements****	
		Asphaltic Concrete Thickness (inches)	**Aggregate Base Thickness (inches)**
5	Parking Areas & Fire Lanes***	3	4
7	Main Drive Areas	4	4

*The presented Traffic Indices should be confirmed by the project civil engineer. Changes to the Traffic Index will result in a differing pavement section required.

**Pavement Sections were calculated using Caltrans software CalFP Version 1.5.

***Where fire lanes will be a part of a main drive use with other traffic, busses, or trucks, the Main Drive Area pavement section should be used.

Conventional, rigid pavements, i.e. Portland cement concrete (PCC) pavements, are recommended in areas that will be subject to relatively high static wheel loads and/or heavy vehicle loading and unloading and turning areas (i.e. truck/bus lanes). This is due to rutting and shoving that can occur due to the heavy vehicle loads and the repetitious set path which is followed at the bus/delivery trucks areas where the same wheel track and stopping occurs generally in the same spot each time. The vehicle load combined with hot summer asphalt (AC) concrete causes the upper surface of the AC to creep forming ruts in conjunction with the braking and accelerating forces which shove the AC. Turning forces also do the same.

The pavement section below is based upon the American Concrete Institute (ACI) *Guide for Construction of Concrete Parking Lots, ACI 330R*, and the assumptions outlined below.

Table 10
Preliminary Portland Cement Concrete Pavement Sections

Area	**Minimum Pavement PCC Thickness (inches)**	**Minimum 28 Day Flexural Strength (psi)**	**Concrete Compressive Strength (psi)**
Truck/Bus Access or Loading/Unloading Areas (Traffic Category C, ADTT =100)	6.5	525	3,250

Should the actual traffic category vary from those assumed and listed above, these sections should be modified. All above recommended preliminary pavement sections are contingent on the following recommendations being implemented during construction:

- Pavement should be placed upon compacted fill processed as described in Section 5.1. The upper 12 inches of subgrade soils beneath the asphalt concrete and conventional PCC pavement section should be compacted to a minimum of 95% relative compaction (ASTM D 1557).
- Subsequent to utility installation, the entire pavement (including PCC) final subgrade should be scarified 12 inches, moisture conditioned to near optimum moisture content, and compacted to a minimum 95% relative compaction immediately prior (within a few days) to the placement and compaction of aggregate base to re-establish proper moisture content and compaction in site soils.
- Subgrade soils and aggregate base should be in a stable, non-pumping condition at the time of placement and compaction. Exposed subgrades should be proof-rolled to verify the absence of soft or unstable zones.
- Aggregate base materials should be compacted at near optimum moisture content to at least 95 percent relative compaction (ASTM D 1557) and should conform to Caltrans Class II criteria. Standard Specifications for Public Works Construction “Greenbook” standards (Crushed Aggregate Base class) may be used in lieu of Caltrans. Compaction efforts should include rubber tire proof-rolling of the aggregate base with heavy compaction-specific equipment (i.e. fully loaded water trucks).
- All concrete curbs separating pavement from landscaped areas should extend at least 6 inches into the subgrade soils to reduce the potential for movement of moisture into the aggregate base layer (this reduces the risk of pavement failures due to subsurface water originating from landscaped areas).
- Asphaltic concrete should be ½-in. or ¾-in. grading and compacted to a minimum of 95% of the 75-blow Marshall density (ASTM D 1559) or equivalent.
- Portland cement concrete pavements should be constructed with transverse joints at maximum spacing of 15 feet. A thickened edge should be used where possible and, as a minimum, where concrete pavements abut asphalt pavements. The thickened edge should be 1.2 times the thickness of the pavement (8 inches for a 6.5-inch pavement), and should taper back to the PCC thickness over a horizontal distance on the order of 3 feet.
- All longitudinal or transverse control joints should be constructed by hand forming or placing pre-molded filler such as "zip strips." Expansion joints should be used to isolate fixed objects abutting or within the pavement area.

  The expansion joint should extend the full depth of the PCC pavement. Joints should run continuously and extend through integral curbs and thickened edges. We recommend that joint layout be adjusted to coincide with the corners of objects and structures. In addition, the following is recommended for concrete pavements:

  1. Slope pavement at least ½ percent to provide drainage;
  2. Provide rough surface texture for traction;
  3. Cure PCC concrete with curing compound or keep continuously moist for a minimum of seven days;

4. Keep all traffic off concrete until PCC compressive strength exceeds 2,000 pounds per square inch (truck traffic should be limited until the concrete meets the design strength (3,250 psi); and
5. Consideration should be given to having PCC construction joints keyed or using slip dowels on 24-inch centers to strengthen control and construction joints. Dowels placed within dowel baskets should be incorporated into the concrete at each saw-cut control joint (i.e. dowel baskets and dowels are set in place prior to placement of concrete).

- Portland cement concrete placement and curing should, at a minimum, be in accordance with the American Concrete Institute [ACI] recommendations contained in ACI 211, 304, 305, 308, 309, and 318.
- Within the structural pavement section areas, positive drainage (both surface and subsurface) should be provided. In no instance should water be allowed to pond on the pavement. Roadway performance depends greatly on how well runoff water drains from the site. This drainage should be maintained both during construction and over the entire life of the project.
- Proper methods, such as hot-sealing or caulking, should be employed to limit water infiltration into the pavement base course and/or subgrade at construction/expansion joints and/or between existing and reconstructed asphalt concrete sections (if any). Water infiltration could lead to premature pavement failure.
- To reduce the potential for detrimental settlement, excess soil material, and/or fill material removed during any footing or utility trench excavation, should not be spread or placed over compacted finished grade soils unless subsequently compacted to at least 90% of the maximum dry unit weight, as evaluated by ASTM D 1557 test procedure, at near optimum moisture content, or 95% if placed under areas designated for pavement.
- Where new roadways will be installed against existing roadways, the repaired asphalt concrete pavement section should be designed and constructed to have at least the pavement and aggregate base section as the original pavement section thickness (for both AC and base) or upon the newly calculated pavement sections presented within, whichever is greater.
- Pavement designs assume that heavy construction traffic will not be allowed on base cap or finished pavement sections.

5.10 Surface and Subsurface Site Drainage and Maintenance

Positive drainage should be maintained away from the structures (5 percent for 10 feet minimum) to prevent ponding and subsequent saturation of the foundation soils. Gutters and downspouts in conjunction with a 1 to 2% hardscape grade can be considered as a means to convey water away from foundations if increased fall is not provided. Drainage should be maintained for paved areas. Water should not pond on or near paved areas or foundations. Ponded water can saturate subgrade soils and lead to pavement failure. The following recommendations are provided in regard to site drainage and structure performance:

- Water control and conveyance is a critical aspect of project design. It is highly recommended that landscape irrigation or other sources of water be collected and conducted to an approved drainage device. Landscaping grades should be lowered and sloped such that water drains to appropriate collection and disposal areas. All runoff water should be controlled, collected, and drained into proper drain outlets. Control methods may include curbing, ribbon gutters, 'V' ditches, or other suitable containment and redirection devices.
- It is highly recommended that landscape irrigation or other sources of water be collected and conducted to an approved drainage device. Site drainage should be devised such that runoff should be directed away from the tops of all graded slopes. Water should not freely flow over slopes or retaining wall faces. Diversion and conveyance structures which can accommodate water and eroded soil should be constructed at the tops and toes of all slopes. Lined swales at the top and bottom of slopes, and at the top of retaining walls are recommended.
- In no instance should water be allowed to flow or pond against structures, slabs or foundations or flow over unprotected slope faces. Adequate provisions should be employed to control and limit moisture changes in the subgrade beneath foundations or structures to reduce the potential for soil saturation. Landscape borders should not act as traps for water within landscape areas. Potential sources of water such as piping, drains, over-spray broken sprinklers, etc, should be frequently examined. Any such leakage, over-spray, or plugging should be immediately repaired.
- Maintenance of drainage systems and infiltration structures can be the most critical element in determining the success of a design. They must be protected and maintained from sediment-laden water both during and after construction to prevent clogging of the surficial soils any filter medium. The potential for clogging can be reduced by pre-treating structure inflow through the installation of maintainable forebays, biofilters, or sedimentation chambers. In addition, sediment, leaves, and debris must be removed from inlets and traps on a regular basis. Since these and other factors (such as varying soil conditions) may affect the rate of water infiltration, it is imperative to apply a conservative factor of safety [FOS] to unfactored Basic Percolation/Infiltration Rates to provide a reliable basis for design. In order to account not only for the unknown factors above but also for changes of conditions during the use of the structures such as potential clogging effects due to washing in of soil fines, a FOS between 3 and 10 should be applied to lower infiltration rates.
- The factor of safety should be selected by the project drainage engineer and may be dependent on agency guidelines and the presence of testing, filters, and sedimentation structures. If these measures are provided, the factor of safety can be reduced.
- The drainage pattern should be established at the time of final grading and maintained throughout the life of the project. Additionally, drainage structures should be maintained (including the de-clogging of piping, basin bottom scarification, soil crust removal, etc.) throughout their design life. Maintenance of these structures should be incorporated into the facility operation and maintenance manual. Structural performance is dependent on many drainage-related factors such as landscaping, irrigation, lateral drainage patterns and other improvements.

Section 6
LIMITATIONS AND ADDITIONAL SERVICES

6.1 Uniformity of Conditions and Limitations

Our findings and recommendations in this report are based on selected points of field exploration, laboratory testing, and our understanding of the proposed project. Furthermore, our findings and recommendations are based on the assumption that soil conditions do not vary significantly from those found at specific exploratory locations. Variations in soil or groundwater conditions could exist between and beyond the exploration points. The nature and extent of these variations may not become evident until construction. Variations in soil or groundwater may require additional studies, consultation, and possible revisions to our recommendations.

The planning and construction process is an integral design component with respect to the geotechnical aspects of this project. Because geotechnical engineering is an inexact science due to the variability of natural processes and because we sample only a small portion of the soil and material affecting the performance of the proposed structure, unanticipated or changed conditions can be disclosed during demolition and construction. Proper geotechnical observation and testing during construction is imperative to allow the geotechnical engineer the opportunity to verify assumptions made during the design process and to verify that our geotechnical recommendations have been properly interpreted and implemented during construction. Therefore, we recommend that Earth Systems be retained during the construction of the proposed improvements to observe compliance with the design concepts and geotechnical recommendations, and to allow design changes in the event that subsurface conditions or methods of construction differ from those assumed while completing this study. If we are not accorded the privilege of performing this review, we can assume no responsibility for misinterpretation or the applicability of our recommendations. The above services can be provided in accordance with our current Fee Schedule.

Our evaluation of subsurface conditions at the site has considered subgrade soil and groundwater conditions present at the time of our study. The influence(s) of post-construction changes to these conditions such as introduction or removal of water into or from the subsurface will likely influence future performance of the proposed project. It should be recognized that definition and evaluation of subsurface conditions are difficult. Judgments leading to conclusions and recommendations are generally made with incomplete knowledge of the subsurface conditions due to the limitation of data from field studies. The availability and broadening of knowledge and professional standards applicable to engineering services are continually evolving. As such, our services are intended to provide the Client with a source of professional advice, opinions and recommendations based on the information available as applicable to the project location and scope. If the scope of the proposed construction changes from that described in this report, the conclusions and recommendations contained in this report are not considered valid unless the changes are reviewed, and the conclusions of this report are modified or approved in writing by Earth Systems.

Findings of this report are valid as of the issued date of the report. However, changes in conditions of a property can occur with passage of time, whether they are from natural processes or works of man, on this or adjoining properties. In addition, changes in applicable standards occur, whether they result from legislation or broadening of knowledge. Accordingly, findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of one year.

This report is issued with the understanding that the owner or the owner's representative has the responsibility to bring the information and recommendations contained herein to the attention of the architect and engineers for the project so that they are incorporated into the plans and specifications for the project. The owner or the owner's representative also has the responsibility to verify that the general contractor and all subcontractors follow such recommendations. It is further understood that the owner or the owner's representative is responsible for submittal of this report to the appropriate governing agencies.

Earth Systems has striven to provide our services in accordance with generally accepted geotechnical engineering practices in this locality at this time. No warranty or guarantee, express or implied, is made. This report was prepared for the exclusive use of the Client and the Client's authorized agents.

Earth Systems should be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications. If Earth Systems is not accorded the privilege of making this recommended review, we can assume no responsibility for misinterpretation of our recommendations. The owner or the owner's representative has the responsibility to provide the final plans requiring review to Earth Systems' attention so that we may perform our review.

Any party other than the client who wishes to use this report shall notify Earth Systems of such intended use. Based on the intended use of the report, Earth Systems may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Earth Systems from any liability resulting from the use of this report by any unauthorized party.

In addition, if there are any changes in the field to the plans and specifications, the Client must obtain written approval from Earth Systems' engineer that such changes do not affect our recommendations. Failure to do so will vitiate Earth Systems' recommendations.

Although available through Earth Systems, the current scope of our services does not include an environmental assessment or an investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater, or air on, below, or adjacent to the subject property.

6.2 Additional Services

This report is based on the assumption that an adequate program of client consultation, construction monitoring, and testing will be performed during the final design and construction phases to check compliance with these recommendations. Maintaining Earth Systems as the geotechnical consultant from beginning to end of the project will provide continuity of services.

The geotechnical engineering firm providing tests and observations shall assume the responsibility of Geotechnical Engineer of Record.

Construction monitoring and testing would be additional services provided by our firm. The costs of these services are not included in our present fee arrangements, but can be obtained from our office. The recommended review, tests, and observations include, but are not necessarily limited to, the following:

- Consultation during the final design stages of the project;
- A review of the building and grading plans to observe that recommendations of our report have been properly implemented into the design;
- Observation and testing during site preparation, grading, and placement of engineered fill as required by CBC Sections 17 and Appendix J or local grading ordinances;
- Consultation as needed during construction.

-o0o-

REFERENCES

Al Atik, L., and Sitar, N., 2010, Seismic Earth Pressures on Cantilever Retaining Structures, Journal of Geotechnical and Geoenvironmental Engineering, ASCE.

American Concrete Institute [ACI], 2004, ACI Manual of Concrete Practice, Parts 1 through 5.

American Concrete Institute (2014) "Building Code Requirements for Structural Concrete (ACI 318-11) and Commentary (ACI 318R-14) and ACI 330R."

American Society of Civil Engineers [ASCE], 2010, Minimum Design Loads for Buildings and Other Structures, ASCE 7-10.

American Society for Testing Materials, 1989, STP 1013, Effects of Soil Characteristics on Corrosion (February, 1989).

Boulanger, R. W., and Idriss, I. M., 2006, Liquefaction susceptibility criteria for silts and clays, J. Geotechnical and Geoenvironmental Eng., ASCE 132 (11), 1413-1426.

Bowles, J.E., 1988, Foundation Analysis and Design, Fourth Edition, McGraw-Hill Book Company.

California Department of Water Resources, 2018, Water Data Library Website, http://www.water.ca.gov/waterdatalibrary/.

California Division of Mines and Geology, 2004, Preliminary Geologic Map of the Santa Ana 30'x60' Quadrangle, Southern California, Open-File Report 99-172, compiled by D. M. Morton, 2004.

California Division of Mines and Geology, 1980, Special Studies Zones, Alberhill Quadrangle, effective January 1, 1980.

California Division of Mines and Geology, 1980, Special Studies Zones, Elsinore Quadrangle, effective January 1, 1980.

California Division of Mines and Geology, 1992, Geologic Map, Alberhill 7½ Quadrangle, Open- File Report 92-10.

California Geologic Survey-SP117A, 2008, Guidelines for Evaluating and Mitigating Seismic Hazards in California.

California Geological Survey, 2018, Fault Rupture Hazard Zones in California, Division of Mines and Geology, Special Publication 42.

California Geological Survey, 2018, Ground Motion Interpolator web site; https://www.conservation.ca.gov/cgs/ground-motion-interpolator.

City of Lake Elsinore, 2011, General Plan, Section 3.0, Public Safety & Welfare.

County of Los Angeles, Department of Public Works, 2013, Manual for the Preparation of Geotechnical Report, July 1, 2013.

County of Riverside, Transportation and Land Management Agency, 2000, Technical Guidelines for Review of Geotechnical and Geologic Reports, 2000 Edition.

Dept. of the Navy, 1986, NAVFAC DM 7.01: Soil Mechanics, Naval Facilities Engineering Command, Alexandria, Virginia.

Dept. of the Navy, 1986, NAVFAC DM 7.02: Foundations and Earth Structures, Naval Facilities Engineering Command, Alexandria, Virginia.

Earth Consultants International, 2000, Seismic Hazards - County of Riverside, Natural Hazards Mapping, Analysis, and Mitigation: a Technical Background Report in Support of the Safety Element of the New Riverside County 2000 General Plan.

Ellsworth, W.L., 1990, "Earthquake History, 1769-1989" in: The San Andreas Fault System, California: U.S. Geological Survey Professional Paper 1515, 283 p.

Envicom Corporation and the County of Riverside Planning Department, 1976, Seismic Safety and Safety General Plan Elements Technical Report, County of Riverside.

FEMA, 2018, Map Service Center website http:*// msc.fema.gov/*

Fire Apparatus Manufacturers' Association (FAMA), 2011, Emergency Vehicle Size and Weight Regulation Guideline,https://fama.org/wp-content/uploads/2015/09/1441593313_55ecf7e17d32d.pdf, November 22, 2011.

Homefacts website, 2019, www.homefacts.com/earthquakes/Riverside-County/Lake-Elsinore.

Hunt, Roy E., 1984, Geotechnical Engineering Practice, McGraw-Hill Book Company.

International Code Council [ICC], 2016, California Building Code, 2016 Edition.

Jennings, C.W, 2010, Fault Activity Map of California and Adjacent Areas: California Division of Mines and Geology, Geological Data Map No. 6, scale 1:750,000.

Lommler, C. J. and Bandini, P. 2015, Characterization of Collapsible Soils, International Foundations Congress and Equipment Expo (IFCEE) 2015 ASCE 2015.

L.S. Lohr, 1978, Fault Hazard Investigation for Tract No. 12406, dated August 22, 1978.

Occupational Safety and Health Standards – Excavations, Final Pub. 1989.

Petersen, M.D., Bryant, W.A., Cramer, C.H., Cao, T., Reichle, M.S., Frankel, A.D., Leinkaemper, J.J., McCrory, P.A., and Schwarz, D.P., 1996, Probabilistic Seismic Hazard Assessment for the State of California: California Division of Mines and Geology Open-File Report 96-08.

Riverside County Flood Control and Water Conservation District, 2011, Design Handbook for Low Impact Development Best Management Practices.

Riverside County Flood Control and Water Conservation District, Aerial Photographs:

- 1/28/62 Photo #s 1-181/182
- 6/20/74 Photo #s 649/650
- 5/4/80 Photo #s 681/682
- 1/3/84 Photo #s 746/747
- 1/22/90 Photo #s 13-8/9
- 1/31/95 Photo #s 13-6/7
- 3/18/00 Photo #s 13-8/9
- 3/29/05 Photo #s 13-7/8
- 3/29/10 Photo # 13-5
- 4/2/10 Photo # 13-7

Riverside County Planning Department, 2003, Geotechnical Element of the Riverside County General Plan.

Riverside County Transportation and Land Management Agency, 2018, Riverside County Land Information Service, http://mmc.rivcoit.org/MMC_Public/Custom/disclaimer/Default.htm

Southern California Earthquake Center (S.C.E.C.), 1999, Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California: available at web site: http://www.scecdc.scec.org.

Southern California Earthquake Center, 2002, Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California.

Southern California Earthquake Center (SCEC), 2018, Earthquake Data Center: http://www.data.scec.org/significant/chron-index.html.

Stickel & Associates, 1977, Report of Engineering Geological Seismicity Study for a Proposed School Site, Grand Ave., Lakeland Village, California, dated November 14, 1977.

Tokimatsu, K, and Seed, H.B., 1987, Evaluation of Settlements in Sands Due To Earthquake Shaking, ASCE, Journal of Geotechnical Engineering, Vol. 113, No. 8, August 1987.

United States Geological Survey, 2008, Documentation for the 2008 Update of the United States National Seismic Hazard Maps: U.S. Geological Survey Open-File Report 2008–1128, 61 p.

United States Geologic Survey, 2018, U.S. Seismic Design Maps Website, http://earthquake.usgs.gov/design maps/us/.

United States Geologic Survey, 2003, Preliminary Geologic Map of the Elsinore Quadrangle, Riverside County, California, Open-File Report 03-282, compiled by D.M. Morton and F.H. Weber.

Wallace, R. E., 1990, the San Andreas Fault System, California: U.S. Geological Survey Professional Paper 1515, 283 p.

Working Group on California Earthquake Probabilities, 2008, The Uniform California Earthquake Rupture Forecast, Version 2 [UCERF 2]: U.S. Geological Survey Open-File Report 2007-1437 and California Geological Survey Special Report 203, 104 p.

Youd, T.L., and Idriss, I.M., 2001, Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 127, No. 10, October 2001.

Youd, T.L., and Garris, C.T., 1995, Liquefaction-Induced Ground-Surface Disruption, Journal of Geotechnical Engineering, Vol. 121, No. 11, November 1995.

Youd, T.L., Hansen, C.M., and Bartlett, S.F., 2002, Revised Multilinear Regression Equations for Prediction of Lateral Spread Displacement, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 128, No. 12, December 2002.

Other Aerial Photographs:

Google Earth: 1994-2018

Historic Aerials: 1938-2014

APPENDIX A

LEGEND

▨ Approximate Site Boundary

Approximate Scale: 1" = 1 Mile

0 1 Mile 2 Miles

N

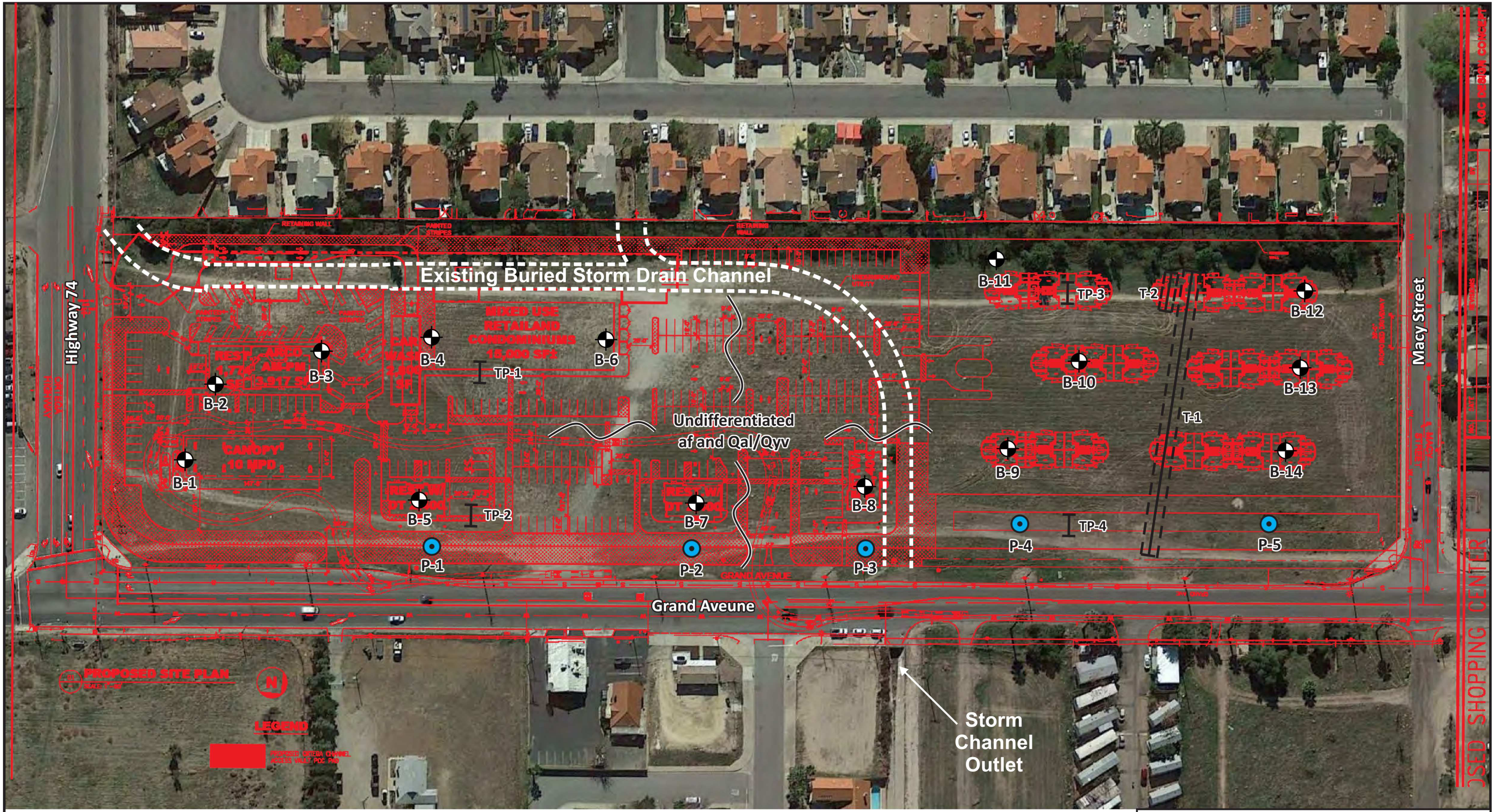
Source: Google Earth satellite image with USGS Topographic Map Overlay.

Plate I
Site Vicinity Map

Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Earth Systems

1/17/2019 | File No.: 302169-002



LEGEND

- **B-14** Approximate Boring Locations
- **P-5** Approximate Percolation Test Locations
- **TP-4** Approximate Test Pit Locations
- **T-2** Approximate Fault Trench Locations

N

Approximate Scale: 1" = 100'

0 100' 200'

Source: Google Earth satellite image dated 2/19/2018 with AGC Design Concept, Inc. Proposed Site Plan, Sheet CUP-1

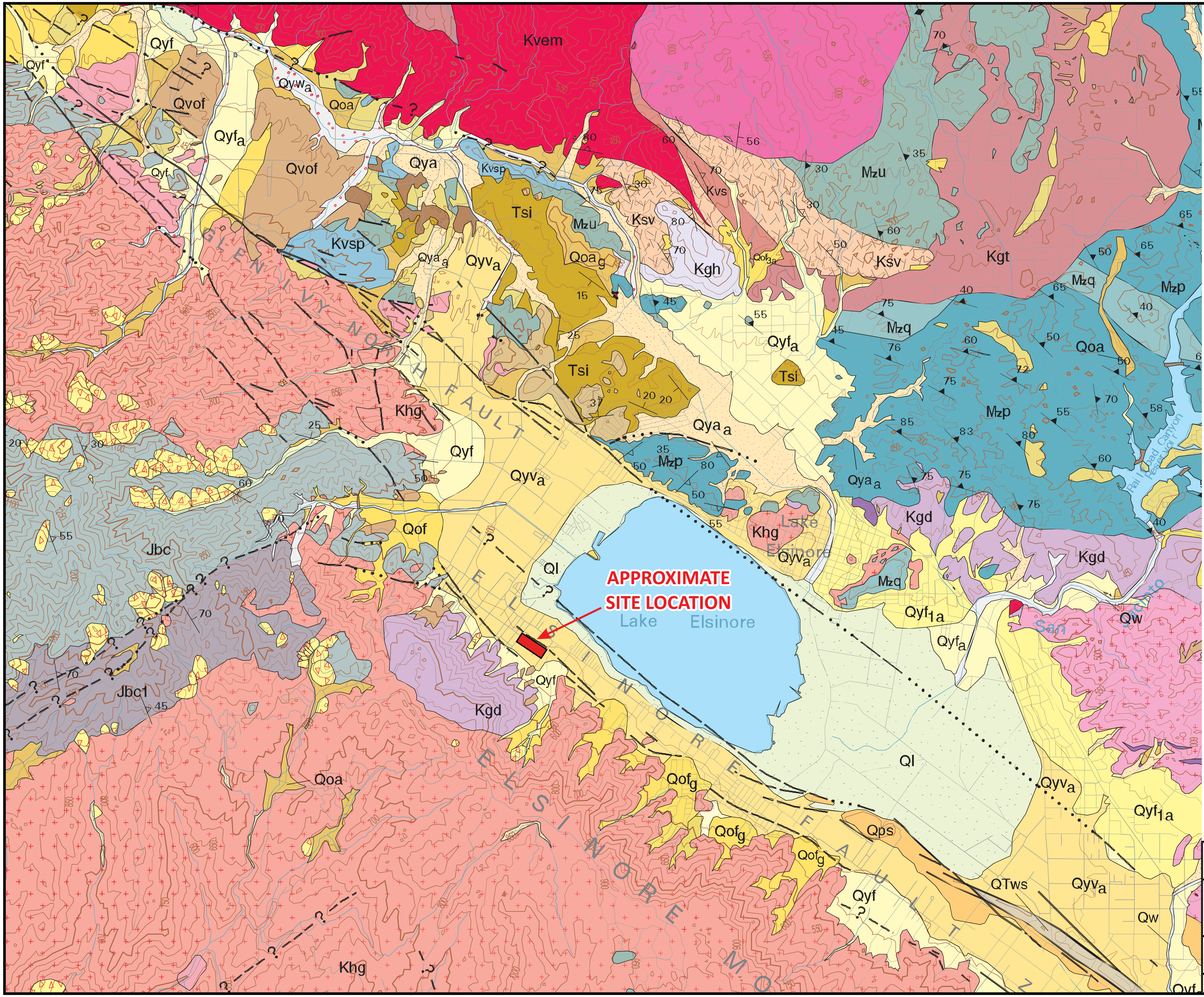
Plate 2
Exploration Location Sketch

Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Earth Systems

1/17/2019

File No.: 302169-002



LEGEND

Qyf	**Young alluvial fan deposits (Holocene and latest Pleistocene)**-Unconsolidated deposits of alluvial fans and headward drainages of fans. Consists predominately of gravel, sand, and silt. Trunk drainages and proximal parts of fans contain higher percentage of coarse-grained sediment than distal parts.
Qyv	**Young alluvial valley deposits (Holocene and late Pleistocene)**-Fluvial deposits along valley floors. Consists of unconsolidated sand, silt, and clay-bearing alluvium.
Qof	**Old alluvial fan deposits (late to middle Pleistocene)** Reddish brown, gravel and sand alluvial fan deposits; indurated, commonly slightly dissected. In places includes thin alluvial fan deposits of Holocene age.
Kqd	**Quartz diorite (Cretaceous)**-Medium- to coarse-grained biotite-hornblende quartz diorite. Most is slightly to well foliated with discoidal to pancake-shaped melanocratic inclusions in foliation plane. Grades into diorite and biotite-hornblende tonalite
Khg	**Heterogeneous granitic rocks (Cretaceous)**-A wide variety of heterogeneous granitic rocks occur in Santa Ana quadrangle. Some heterogeneous assemblages include large proportions of schist and gneiss. Rocks in Santa Ana Mountains include a mixture of monzogranite, granodiorite, tonalite, and gabbro. Tonalite composition rock is most abundant rock type. Tonalite from Hot Springs Canyon (Cañada Gobernadora 7.5' quadrangle), gave zircon age of 119.2 Ma $_{id}$ and 116.5 Ma $_{ip}$ (Pb/U ages, W.R Premo per. commun., 1999). Heterogeneous granitic rocks adjacent to east and south of Lakeview Mountains and Reinhardt Canyon pluton contain large amount of metamorphic rock. Except for southern part, granitic component consists of potassium feldspar-bearing tonalite and granodiorite

N

Approximate Scale 1" = 1 Mile

0 1 Mile 2 Miles

Source: CGS Preliminary Digital Geologic Map of the Santa Ana 30' X 60' Quadrangle, Southern California, Version 2.0, 2004.

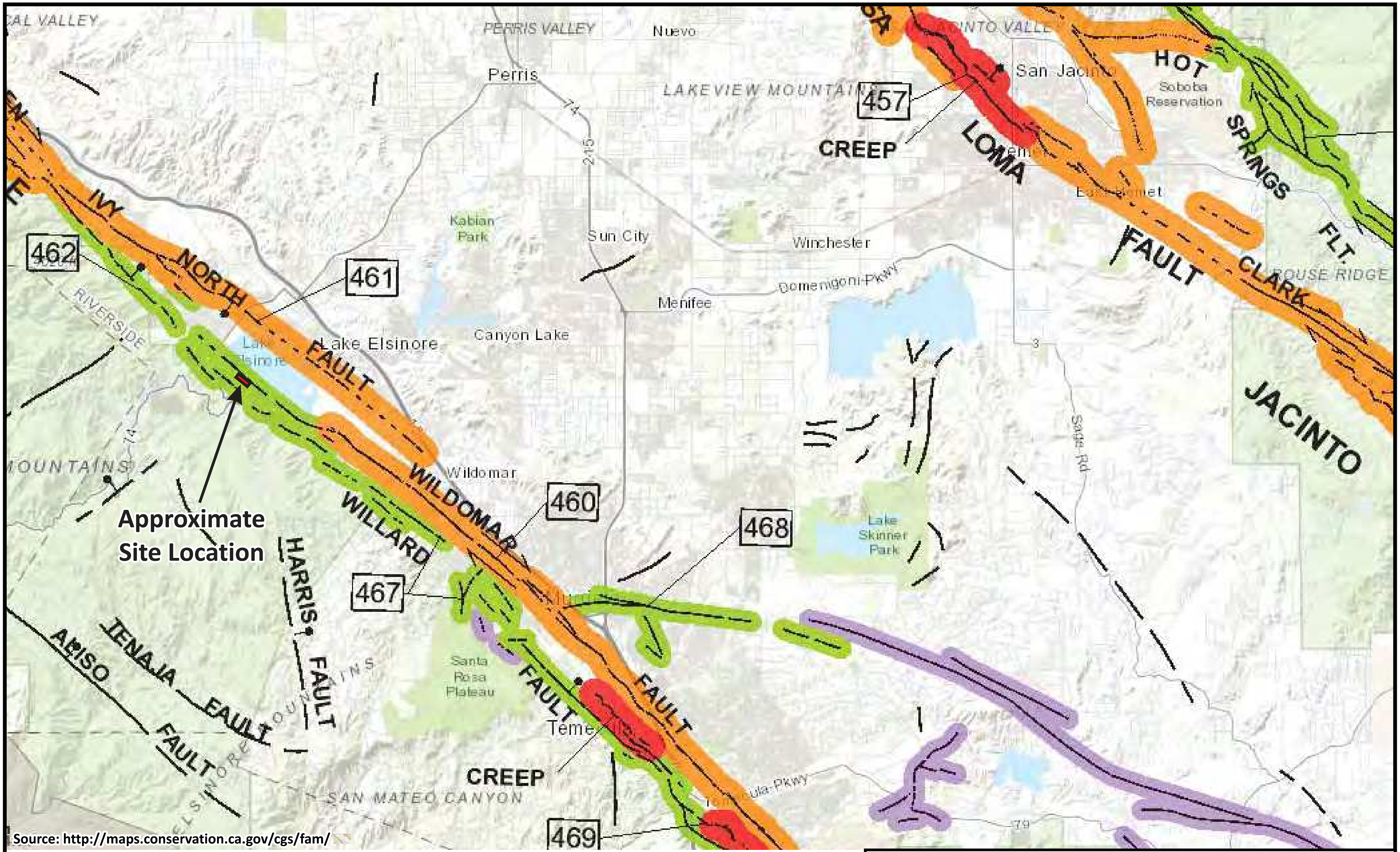
Plate 3
Regional Geologic Map

Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Earth Systems

1/17/2019

File No.: 302169-002



Source: http://maps.conservation.ca.gov/cgs/fam/

LEGEND

🟥	Fault along which historic (last 200 years) displacement has occurred.
🟧	Fault along which Holocene (last 11,700 years) displacement, has occurred.
🟩	Fault along which Late Quaternary (past 700,000 years) displacement has occurred.
🟪	Fault along which Quaternary (past 1.6 million years) displacement has occurred.

N

Plate 4
Regional Fault Map

Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Earth Systems

1/17/2019

File No.: 302169-002

Table A-1
Fault Parameters

Fault Section Name	**Distance**		Avg Dip Angle	Avg Dip Direction	Avg Rake	Trace Length	Fault Type	**Mean Mag**	Mean Return Interval	Slip Rate
	(miles)	(km)	(deg.)	(deg.)	(deg.)	(km)			(years)	(mm/yr)
Elsinore (Temecula stepover)	0.2	0.4	90	212	180	12	A	**7.6**	725	2.5
Elsinore (Stepovers Combined)	1.6	2.6	90	224	180	12	B'	**6.3**		
Elsinore (Glen Ivy stepover)	1.7	2.7	90	216	180	11	A	**7.1**	322	2.5
Elsinore (Glen Ivy) rev	1.8	3.0	90	218	180	26	A	**7.0**	222	5
Elsinore (Temecula) rev	6.5	10.5	90	230	180	40	A	**7.4**	431	5
Chino, alt 2	15.6	25.2	65	234	150	29	B	**6.7**		1
Whittier, alt 1	16.9	27.1	70	24	150	46	A	**7.1**	530	2.5
Whittier, alt 2	16.9	27.1	75	24	150	46	A	**7.1**	530	2.5
San Joaquin Hills	17.5	28.1	23	204	90	27	B	**7.0**		0.5
Chino, alt 1	18.3	29.4	50	236	150	24	B	**6.6**		1
San Jacinto (Anza, stepover)	22.3	35.9	90	224	180	25	A	**7.6**	151	9
San Jacinto (San Jacinto Valley, stepover)	23.7	38.2	90	224	180	24	A	**7.4**	199	9
San Jacinto (Stepovers Combined)	23.7	38.2	90	229	180	25	B'	**6.7**		
San Jacinto (San Jacinto Valley) rev	24.1	38.8	90	223	180	18	A	**7.4**	199	18
Peralta Hills	24.2	38.9	50	3	na	14	B'	**6.5**		
Newport-Inglewood (Offshore)	25.1	40.4	90	227	180	66	B	**6.9**		1.5
Fontana (Seismicity)	25.5	41.0	80	313	na	24	B'	**6.7**		
San Jacinto (San Bernardino)	26.0	41.9	90	225	180	45	A	**7.4**	205	6
Yorba Linda	27.1	43.6	90	153	na	18	B'	**6.5**		
San Jacinto (Anza) rev	27.2	43.8	90	216	180	46	A	**7.6**	151	18
Oceanside	27.4	44.0	23	69	na	120	B'	**7.5**		
Richfield	28.3	45.5	28	353	na	6	B'	**6.2**		
San Gorgonio Pass	28.8	46.3	60	11	na	29	B'	**6.9**		
Elsinore (Julian)	30.6	49.3	84	36	180	75	A	**7.6**	725	3
Newport-Inglewood, alt 2	31.6	50.8	90	49	180	66	B	**7.2**		1
Newport-Inglewood, alt 1	32.1	51.6	88	49	180	65	B	**7.2**		1
Puente Hills (Coyote Hills)	32.5	52.3	26	358	90	17	B	**6.8**		0.7
Anaheim	33.5	54.0	71	45	na	16	B'	**6.3**		
Puente Hills	33.6	54.0	25	20	90	44	B	**7.1**		0.7
San Andreas (San Bernardino S)	34.9	56.1	90	210	180	43	A	**7.6**	150	16
San Andreas (San Bernardino N)	35.1	56.4	90	212	180	35	A	**7.5**	103	22
San Andreas, (North Branch, Mill Creek)	35.1	56.4	76	204	180	106	A	**7.5**	110	17
Elysian Park (Lower, CFM)	35.4	56.9	22	33	na	41	B'	**6.8**		
Cucamonga	35.5	57.2	45	347	90	28	B	**6.6**		5
San Jose	35.6	57.3	74	334	30	20	B	**6.6**		0.5
Earthquake Valley (No Extension)	36.1	58.1	90	221	180	33	B'	**6.9**		
Rose Canyon	37.1	59.8	90	68	180	70	B	**6.8**		1.5
Mission Creek	37.4	60.2	65	5	180	31	B'	**6.9**		
Sierra Madre	38.1	61.4	53	19	90	57	B	**7.2**		2
San Andreas (San Gorgonio Pass-Garnet HIll)	38.9	62.6	58	20	180	56	A	**7.6**	219	10

Reference: USGS OFR 2007-1437 (CGS SP 203) Based on Site Coordinates of 33.659065 Latitude, -117.379207 Longitude

Mean Magnitude for Type A Faults based on 0.1 weight for unsegmented section, 0.9 weight for segmented model (weighted by probability of each scenario with section listed as given on Table 3 of Appendix G in OFR 2007-1437). Mean magntude is average of Ellworths-B and Hanks & Bakun moment area relationship.

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on ASTM Designations D 2487 and D 2488 (Unified Soil Classification System). Information on each boring log is a compilation of subsurface conditions obtained from the field as well as from laboratory testing of selected samples. The indicated boundaries between strata on the boring logs are approximate only and may be transitional.

SOIL GRAIN SIZE

U.S. STANDARD SIEVE

12" 3" 3/4" 4 10 40 200

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

305 76.2 19.1 4.76 2.00 0.42 0.074 0.002

SOIL GRAIN SIZE IN MILLIMETERS

RELATIVE DENSITY OF GRANULAR SOILS (GRAVELS, SANDS, AND NON-PLASTIC SILTS)

Very Loose	*N=0-4	RD=0-30	Easily push a 1/2-inch reinforcing rod by hand
Loose	N=5-10	RD=30-50	Push a 1/2-inch reinforcing rod by hand
Medium Dense	N=11-30	RD=50-70	Easily drive a 1/2-inch reinforcing rod with hammer
Dense	N=31-50	RD=70-90	Drive a 1/2-inch reinforcing rod 1 foot with difficulty by a hammer
Very Dense	N>50	RD=90-100	Drive a 1/2-inch reinforcing rod a few inches with hammer

*N=Blows per foot in the Standard Penetration Test at 60% theoretical energy. For the 3-inch diameter Modified California sampler,140-pound weight, multiply the blow count by 0.63 (about 2/3) to estimate N. If automatic hammer is used, multiply a factor of 1.3 to 1.5 to estimate N. RD=Relative Density (%). C=Undrained shear strength (cohesion).

CONSISTENCY OF COHESIVE SOILS (CLAY OR CLAYEY SOILS)

Very Soft	*N=0-1	*C=0-250 psf	Squeezes between fingers
Soft	N=2-4	C=250-500 psf	Easily molded by finger pressure
Medium Stiff	N=5-8	C=500-1000 psf	Molded by strong finger pressure
Stiff	N=9-15	C=1000-2000 psf	Dented by strong finger pressure
Very Stiff	N=16-30	C=2000-4000 psf	Dented slightly by finger pressure
Hard	N>30	C>4000	Dented slightly by a pencil point or thumbnail

MOISTURE DENSITY

Moisture Condition:	An observational term; dry, damp, moist, wet, saturated.
Moisture Content:	The weight of water in a sample divided by the weight of dry soil in the soil sample expressed as a percentage.
Dry Density:	The pounds of dry soil in a cubic foot.

MOISTURE CONDITION

Dry....................Absence of moisture, dusty, dry to the touch
Damp................Slight indication of moisture
Moist.................Color change with short period of air exposure (granular soil)
Below optimum moisture content (cohesive soil)
Wet....................High degree of saturation by visual and touch (granular soil)
Above optimum moisture content (cohesive soil)
Saturated..........Free surface water

PLASTICITY

DESCRIPTION	FIELD TEST
Nonplastic	A 1/8 in. (3-mm) thread cannot be rolled at any moisture content.
Low	The thread can barely be rolled.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit.
High	The thread can be rerolled several times after reaching the plastic limit.

GROUNDWATER LEVEL

▼ Water Level (measured or after drilling)

▽ Water Level (during drilling)

RELATIVE PROPORTIONS

Trace.............minor amount (<5%)
with/some......significant amount
modifier/and...sufficient amount to influence material behavior (Typically >30%)

LOG KEY SYMBOLS

▮ Bulk, Bag or Grab Sample

▯ Standard Penetration Split Spoon Sampler (2" outside diameter)

▮ Modified California Sampler (3" outside diameter)

◩ No Recovery

Terms and Symbols Used on Boring Logs

Earth Systems
Southwest

MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
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	░	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	▦	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 No. 4 sieve	CLEAN SAND (Little or no fines)	░	SW	Well-graded sands, gravelly sands little or no fines
			▒	SP	Poorly-graded sands, gravelly sands, little or no fines
		SAND 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 low 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
		LIQUID LIMIT GREATER THAN 50	▥	MH	Inorganic silty, micaceous, or diatomaceous fine sand or silty soils
			▨	CH	Inorganic clays of high plasticity, fat clays
			▩	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			▒	PT	Peat, humus, swamp soils with high organic contents
VARIOUS SOILS AND MAN MADE MATERIALS			▦		Fill Materials
MAN MADE MATERIALS			■		Asphalt and concrete

Soil Classification System

Earth Systems
Southwest

Boring No. B-1

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevaton 1,313 feet (MSL)

Drilling Date: December 4, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: D. Hamelehle

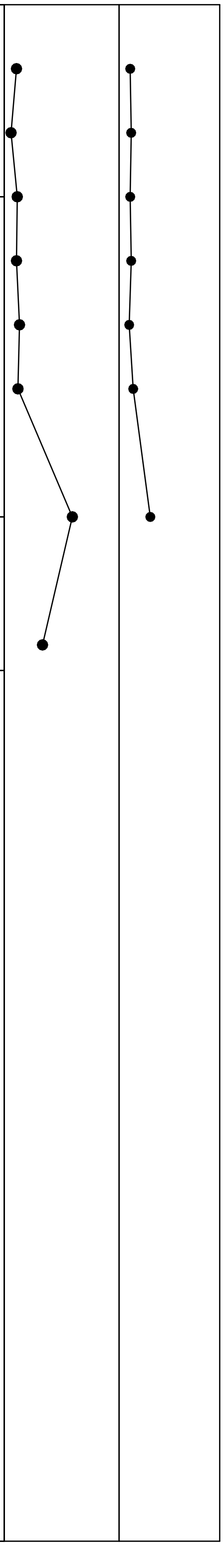
Page 1 of 1

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type Bulk	Sample Type SPT	Sample Type MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0						SM			SILTY SAND: brown, medium dense, slightly moist, fine to coarse grained sand, trace pinholes, Alluvium
			■	7,8,8			111	5	
5			■	4,4,5			112	6	loose
			■	5,7,10		SM	111	4	SILTY SAND: brown, medium dense, damp, fine to medium grained sand
10			■	5,7,9			112	4	
			■	5,7,13			110	7	slightly moist
15			■	7,7,11			114	7	light gray brown, with cobbles, older alluvium
20			■	23,39,50/3"		SP	131	4	SAND: gray brown, very dense, damp, fine to very coarse grained sand, trace gravel, possible decomposed granitic bedrock or boulder
25			■	50/2"					possible moderately weathered granitic rock or bulder

Refusal at 26 feet due to hard drilling
Backfilled with cuttings
No groundwater encountered


Graphic Trend

Earth Systems

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Boring No. B-2

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,311 feet (MSL)

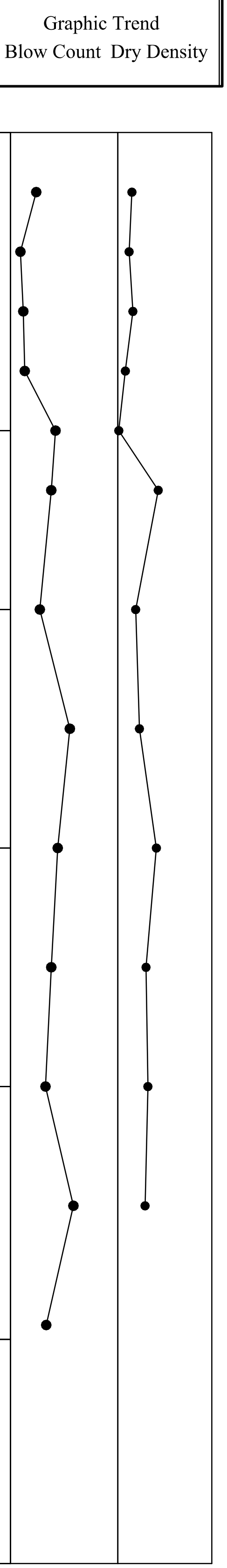
Drilling Date: December 4, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: D. Hamelehle

Page 1 of 1

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type			Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
	Bulk	SPT	MOD Calif.						
0						SM			SILTY SAND: brown, medium dense, dry, fine to medium grained sand, trace clay, Alluvium
			■	17,18,18			115	5	slightly moist
5			■	5,6,8			112	5	loose
			■	5,7,11			116	5	fine to coarse grained sand, medium dense
10			■	7,9,11			108	4	light brown, trace micaceous
			■	7,13,50/3"		SP		5	SAND: light brown, dense, damp to slightly moist, fine to coarse grained sand, trace micaceous, Older Alluvium, sample disturbed
15			■	31,23,34				3	
									highly to moderately weathered granitic cobble
20			■	18,20,21		SM	119	6	SILTY SAND: light gray brown, medium dense, slightly moist, fine to coarse grained sand
25			■	11,33,50/2.5"			123	14	highly weathered granitic cobble, moist
30			■	20,31,35		SM	141	4	SILTY SAND: gray brown, dense, damp, fine to coarse grained sand, trace clay, some cobbles
35			■	15,31,26			130	9	gray, medium dense, moist trace gravel
40			■	12,27,22		SM	132	9	SILTY SAND: brown, dense, moist, fine to coarse grained sand
45			■	34,38,50/4.5"			129	11	possible highly weathered granitic bedrock
	▼								
50			▨	50/6"					no recovery
55									
									Boring completed at 50-1/2 feet Backfilled with cuttings and sealed with bentonite Groundwater encountered at 47-1/2 feet
60									



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Boring No. B-3

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,309 feet (MSL)

Drilling Date: December 4, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: D. Hamelehle

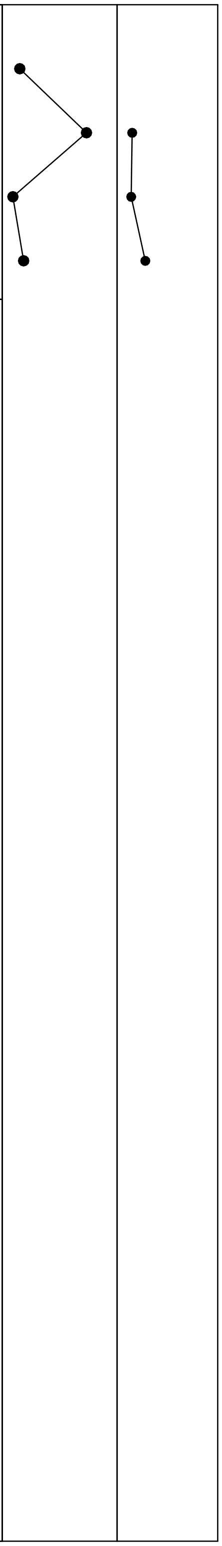
Page 1 of 1

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type Bulk	Sample Type SPT	Sample Type MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0					▒	SM			SILTY SAND: brown, medium dense, dry, fine to coarse grained sand, trace clay, Alluvium
			■	7,10,13	▒				
5			■	4,7,9	▒		115	4	damp
			■	4,6,8	▒		114	7	slightly moist
10			■	4,10,18	▒		128	5	
15									
20									
25									
30									
35									
40									
45									
50									
55									Boring completed at 11-1/2 feet Backfilled with cuttings No groundwater encountered
60									

Graphic Trend
Blow Count Dry Density



Boring No. B-4

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,308 feet (MSL)

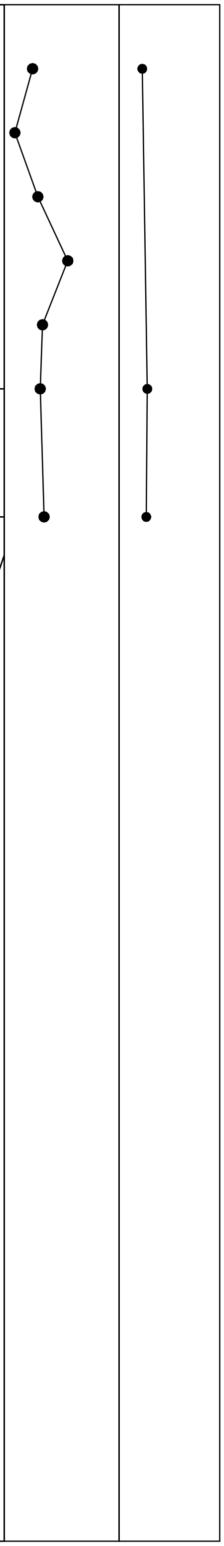
Drilling Date: December 4, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: D. Hamelehle

Page 1 of 1

Depth (Ft.)	Sample Type: Bulk	Sample Type: SPT	Sample Type: MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0						SM			SILTY SAND: brown, medium dense, dry, fine to coarse grained sand, Alluvium
			■	17,21,16			123	2	
5			■	5,5,9					red brown, moist, fine to medium grained sand
	■		⧅	21,25,19					no recovery
10			⧅	13,33,50/5"					no recovery
			⧅	50/5.5"					no recovery
15			■	15,23,24		SP-SM	128	6	SAND WITH SILT: brown, dense, slightly moist, fine to coarse grained sand, Older Alluvium
20			■	12,20,32		SM	127	10	SILTY SAND: gray brown, dense, moist, fine to coarse grained sand with gravel
25									
30									
35									
40									
45									
50									
55									
60									

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Graphic Trend
Blow Count Dry Density



Boring completed at 21-1/2 feet
Backfilled with cuttings
No groundwater encountered

Boring No. B-5

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,303 feet (MSL)

Drilling Date: December 4, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: D. Hamelehle

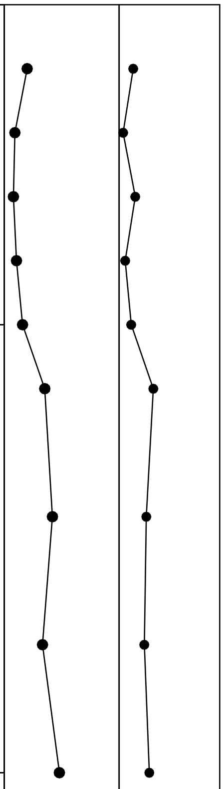
Page 1 of 1

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type Bulk	SPT	MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0					▒	SM			SILTY SAND: brown, medium dense, dry, fine to coarse grained sand, trace clay, Alluvium
			■	26,14,18	▒		114	5	damp
5			■	6,7,7	▒		104	11	moist
			■	4,5,7	▒		116	8	
10			■	4,6,10	▒		106	7	light brown, fine to medium grained sand
	■		■	9,10,14	▒	SM	112	5	SILTY SAND: red brown, medium dense, slightly moist, fine to coarse grained sand, Older Alluvium
15			■	11,27,33	▒		134	6	gray brown, dense
20			■	14,25,38	▒		127	10	brown
25			■	11,21,29	▒		125	10	olive brown, moist, fine to medium grained sand
30			■	16,29,43	░	SP	130	9	SAND: olive gray, very dense, moist, fine to coarse grained sand
35									
40									
45									
50									
55									
60									

Graphic Trend
Blow Count Dry Density



Boring completed at 31-1/2 feet
Backfilled with cuttings
No groundwater encountered

Boring No. B-6
Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,306 feet (MSL)

Drilling Date: December 4, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: D. Hamelehle

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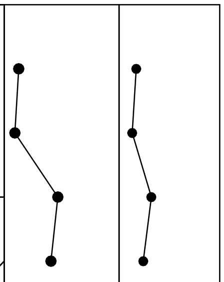
Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type Bulk	SPT	MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0						SM			SILTY SAND: brown, medium dense, moist, fine to coarse grained sand, trace fine gravel, Alluvium
			■	9,9,10			117	7	
5			■	5,5,9			113	10	
			■	13,26,44		SM	132	10	SILTY SAND: olive brown, very dense, very moist, fine to medium grained sand, Older Alluvium
10			■	15,26,35		SP-SM	124	8	SAND WITH SILT: olive brown, dense, moist, fine to coarse grained sand
15									
20									
25									
30									
35									
40									
45									
50									
55									Boring completed at 11-1/2 feet Backfilled with cuttings No groundwater encountered
60									

Graphic Trend
Blow Count Dry Density



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Boring No. **B-7**
Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,301 feet (MSL)

Drilling Date: December 11, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: D. Hamelehle

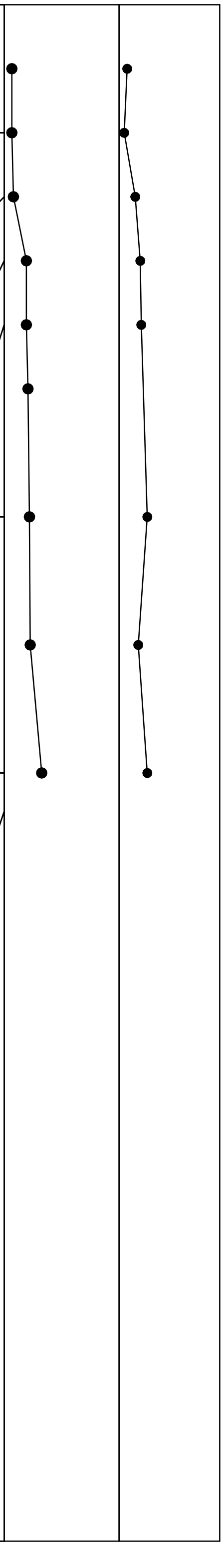
Page 1 of 1

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type: Bulk	Sample Type: SPT	Sample Type: MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0						SM			SILTY SAND: brown, loose, moist, fine to medium grained sand, trace clay, Fill
			■	4,5,5			108	7	
5			■	3,4,6		SM	105	6	SILTY SAND: light brown, loose, moist, fine to medium grained sand, Alluvium
			■	4,6,6		SP-SM	116	18	SAND WITH GRAVEL AND SILT: gray brown, loose, very moist, fine to medium grained sand, fine gravel
10			■	9,12,17		CL	121	13	SILTY SANDY CLAY: olive gray, very stiff, moist, fine to medium grained sand, Older Alluvium
			■	7,12,17		SC	122	13	CLAYEY SAND: brown, medium dense, very moist, fine to medium grained sand
15			■	8,19,21					
20			■	6,13,20		SM	128	11	SILTY SAND: red brown, medium dense, very moist, fine to coarse grained sand
25			■	6,13,21			119	15	red brown to gray brown, fine to medium grained sand
30			■	8,19,30		SP	128	9	SAND WITH GRAVEL: gray, dense, moist, fine to coarse grained sand, slightly micacous
35									
40									
45									
50									
55									
60									

Graphic Trend
Blow Count Dry Density



Boring completed at 31-1/2 feet
Backfilled with cuttings
No groundwater encountered

Boring No. B-8

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,305 feet (MSL)

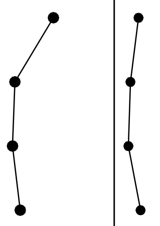
Drilling Date: December 4, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: D. Hamelehle

Page 1 of 1

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type: Bulk	Sample Type: SPT	Sample Type: MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0						SM			SILTY SAND: light brown to brown, very dense, dry, fine to coarse grained sand, Alluvium
			■	21,50/6"			124	4	damp
5			■	8,10,11			116	5	brown, medium dense, slightly moist, fine to medium grained sand
			■	4,5,13		SM	114	9	SITY SAND: gray brown, medium dense, moist, fine to medium grained sand, Older Aluvium
10			■	9,12,16			126	12	very moist



Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

Boring completed at 11-1/2 feet
Backfilled with cuttings
No groundwater encountered

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Boring No. B-9

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,303 feet (MSL)

Drilling Date: December 10, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: S. Clanton

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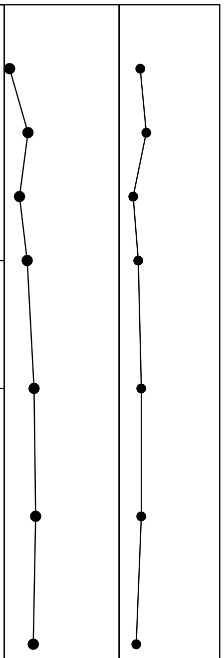
Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type Bulk	Sample Type SPT	Sample Type MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0						SM			SILTY SAND: brown, loose, moist, fine to medium grained sand, Alluvium
			■	4,4,6			121	10	
5			■	10,14,17			127	9	
			■	5,9,11			114	12	
10			■	6,13,17		SC	119	14	CLAYEY SAND: gray brown, medium dense, very moist, fine to medium grained sand
15			■	8,15,24		SM	122	13	SILTY SAND: gray brown, medium dense, very moist, fine to coarse grained sand
20			■	6,16,25			122	12	
25			■	5,14,24			117	12	
30									
35									
40									
45									
50									
55									Boring completed at 26-1/2 feet Backfilled with cuttings No groundwater encountered
60									



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Boring No. B-10

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,300 feet (MSL)

Drilling Date: December 4, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: D. Hamelehle

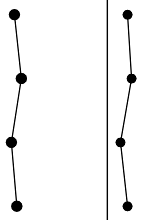
Page 1 of 1

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type: Bulk	Sample Type: SPT	Sample Type: MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0					▨	SM			SILTY SAND: gray brown, medium dense, dry, fine to medium grained sand, Alluvium
			■	10,13,16	▨		120	7	slightly moist
5			■	8,15,23	▨		124	9	light brown, dense, damp, fine to coarse grained sand
			■	8,9,16	▨	SM	113	16	SILTY SAND: mottled orange, gray, brown, medium dense, moist, fine to medium grained sand, Older Alluvium, very moist
10			■	8,12,20	▨		120	14	
15									
20									
25									
30									
35									
40									
45									
50									
55									Boring completed at 11-1/2 feet Backfilled with cuttings No groundwater encountered
60									

Graphic Trend
Blow Count Dry Density



Boring No. **B-11**
Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,314 feet (MSL)

Drilling Date: December 11, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: D. Hamelehle

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Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type Bulk	Sample Type SPT	Sample Type MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0					▒	SM			SILTY SAND: brown, medium dense, dry, fine to coarse grained sand, Older Alluvium
			■	8,16,21	▒				
5			■	10,21,30	▒		121	8	gray brown, dense moist
			■	15,15,19	▒		127	9	medium dense
10			■	16,21,34	▒		129	10	red brown, dense, fine to medium grained sand, very moist
			■	7,17,24	▒				brown, medium dense, moist, slightly micaceous
15			■	11,21,25	▒		128	10	
20			■	6,15,17	▒		129	10	
25			■	11,17,24	░	SP	124	12	SAND: brown, medium dense, wet, fine to medium grained sand
	▼				░				groundwater
30			■	9,21,32	▒	SM	118	14	SILTY SAND: brown, dense, wet, fine to coarse grained sand

Graphic Trend
Blow Count Dry Density

Depth (Ft.): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

Boring completed at 31-1/2 feet
Backfilled with cuttings, sealed with bentonite
Groundwater encountered at 28 feet

Boring No. B-12

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,305 feet (MSL)

Drilling Date: December 10, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: S. Clanton

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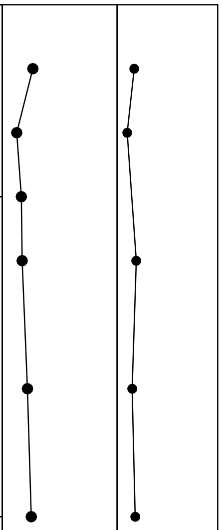
Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type Bulk	Sample Type SPT	Sample Type MOD Calif.	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0					▨	SM			SILTY SAND: brown, dense, damp, fine to medium grained sand, trace clay, Alluvium
			■	29,23,17	▨		117	7	slightly moist
5			■	7,8,11	▨		110	6	
			■	8,10,15	▨	SM			SILTY SAND: olive brown, medium dense, moist, fine to medium grained sand
10			■	8,10,16	▨		119	13	trace clay
15			■	7,15,18	▨		115	10	gray brown
20			■	12,14,24	▨	SM	118	14	SILTY SAND WITH CLAY: reddish brown, medium dense, moist, fine to medium grained sand

Graphic Trend
Blow Count Dry Density



Boring completed at 21-1/2 feet
Backfilled with cuttings
No groundwater encountered

Boring No. B-13

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,305 feet (MSL)

Drilling Date: December 10, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: S. Clanton

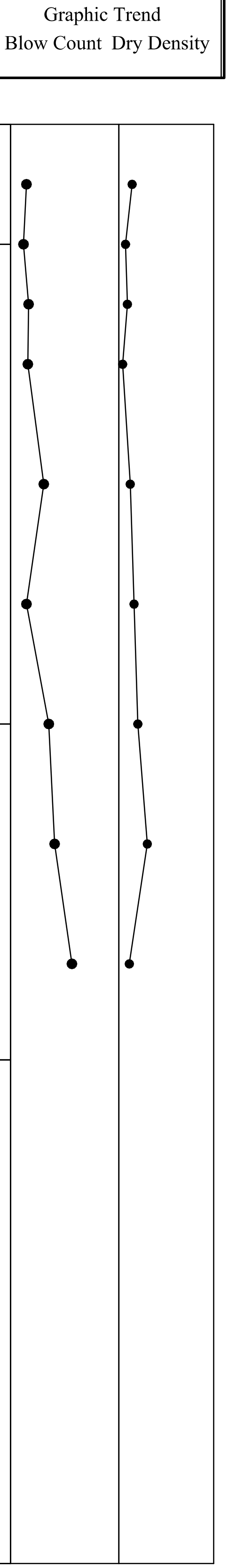
Page 1 of 1

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type (Bulk / SPT / MOD Calif.)	Penetration Resistance (Blows/6")	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0			SM			SITLY SAND: brown, medium dense, damp, fine to medium grained sand, fill
	MOD Calif. ■	11,11,11		114	3	
5	MOD Calif. ■	6,8,10	SM	107	4	SILTY SAND: light brown, medium dense, dry, fine to coarse grained sand, Alluvium
	MOD Calif. ■	6,12,13		109	6	
10	MOD Calif. ■	10,11,13		104	9	
15	MOD Calif. ■	9,21,25		112	6	reddish brown, dense, fine to coarse grained sand, dense older alluvium
20	MOD Calif. ■	2,8,14		116	15	dark gray brown, medium dense, moist
25	MOD Calif. ■	11,19,34	SM	120	13	SILTY SAND: brown, wet, dense fine to coarse grained sand
	▼					groundwater
30	MOD Calif. ■	15,26,35		130	12	
35	MOD Calif. ■	21,35,50		111	11	very dense, with clay
40						
45						
50						
55						
60						

Boring refusal at 39 feet
Backfilled with cuttings, sealed with bentonite
Groundwater encountered at 28 feet



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Phone (951) 928-9799

Boring No. B-14

Project Name: Bamiyan Marketplace
Project Number 302169-002
Boring Location: See Plate 2, Approximate Elevation 1,302 feet (MSL)

Drilling Date: December 10, 2018
Drilling Method: Mobile B-61 w/autohammer
Drill Type: 6" HSA
Logged By: S. Clanton

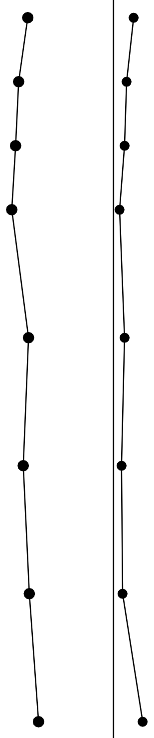
Page 1 of 1

Description of Units

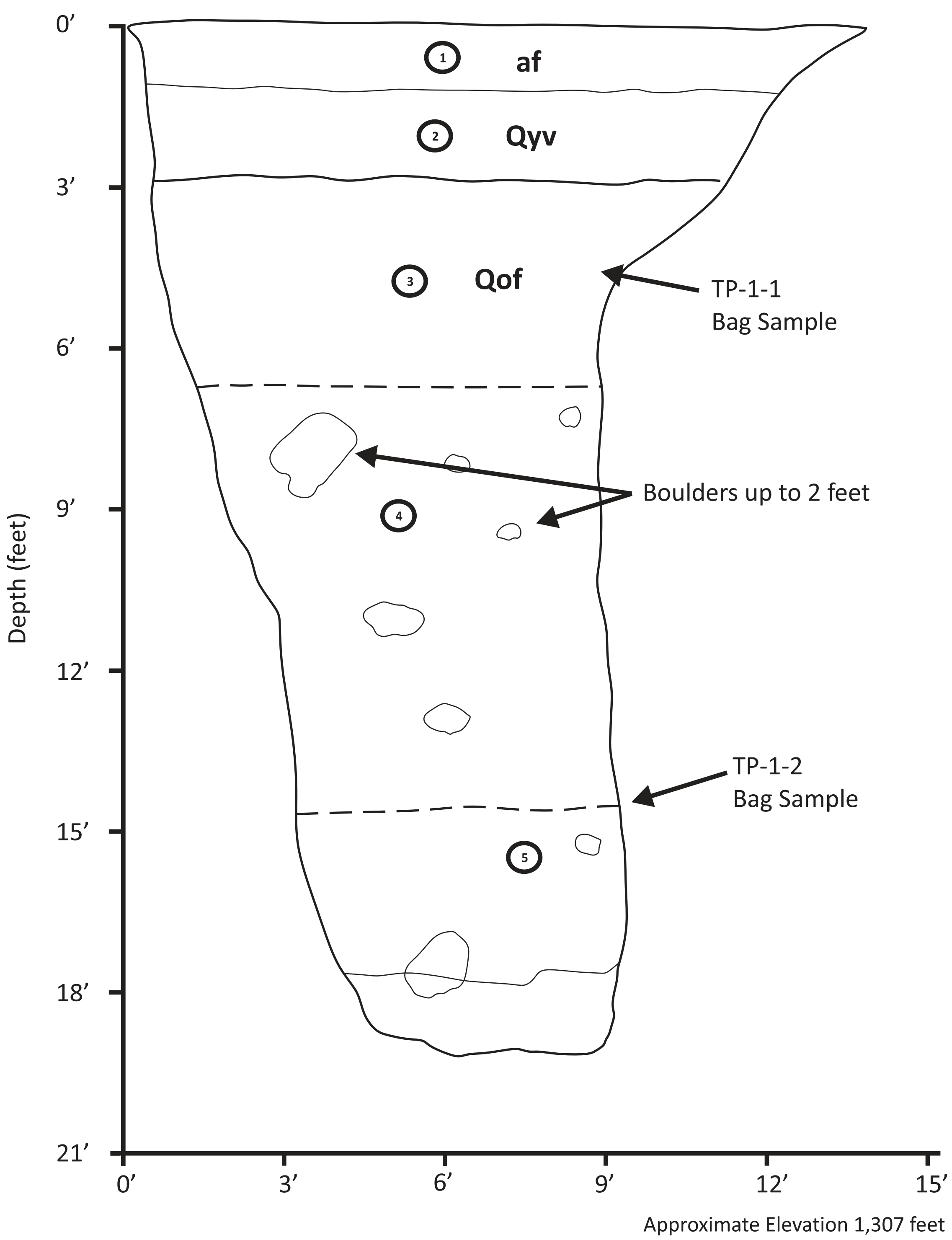
Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type: Bulk	Sample Type: SPT	Sample Type: MOD Calif.	Penetration Resistance (Blows/6")	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0					SM			SITLY SAND: reddish brown, medium dense, damp, fine to medium grained sand, fill
			■	7,16,22		120	5	
5			■	10,12,14	SM	113	5	SILTY SAND: brown, medium dense, slightly moist, fine to medium grained sand, Alluvium
			■	6,9,13		111	4	light brown, fine to coarse grained sand
10			■	8,5,12		106	4	
15			■	11,17,22	SM	111	8	SILTY SAND: reddish brown, medium dense, moist, fine to coarse grained sand, Older Alluvium
20			■	14,14,18		108	6	
25			■	12,17,23		109	10	some gravel
30			■	10,20,32	SM	129	12	SILTY SAND: brown, dense, moist, fine to coarse grained sand

Graphic Trend
Blow Count Dry Density



Boring completed at 31-1/2 feet
Backfilled with cuttings
No groundwater encountered



Approximate Elevation 1,307 feet

TP-1

Descriptions

① af, Fill, medium dense (SM)
f-c silty sand, trace gravel, dry,
dark yellowish brown (10yr 3/4).

② Qyv, Young alluvial fan deposits (SM)
medium dense, silty f-c sand, trace
gravel, dry, dark reddish brown
(5yr 3/4). Abundant pinholes.

③ Qof, Old alluvial fan deposits (SM), Qa,
medium dense, f-c sand with silt,
moist, dark reddish brown,
(2.5yr 3/3). Some pinholes.

④ Qof, Old alluvial fan deposits (SM)
medium dense, silty f-c sand with
boulders subrounded up to 2 feet
long.

⑤ Qof, Old alluvial fan deposits (SC)
medium dense, f-c sand trace silt,
with boulders subrounded up to 18”,
moist grayish brown (2.5y 5/2).

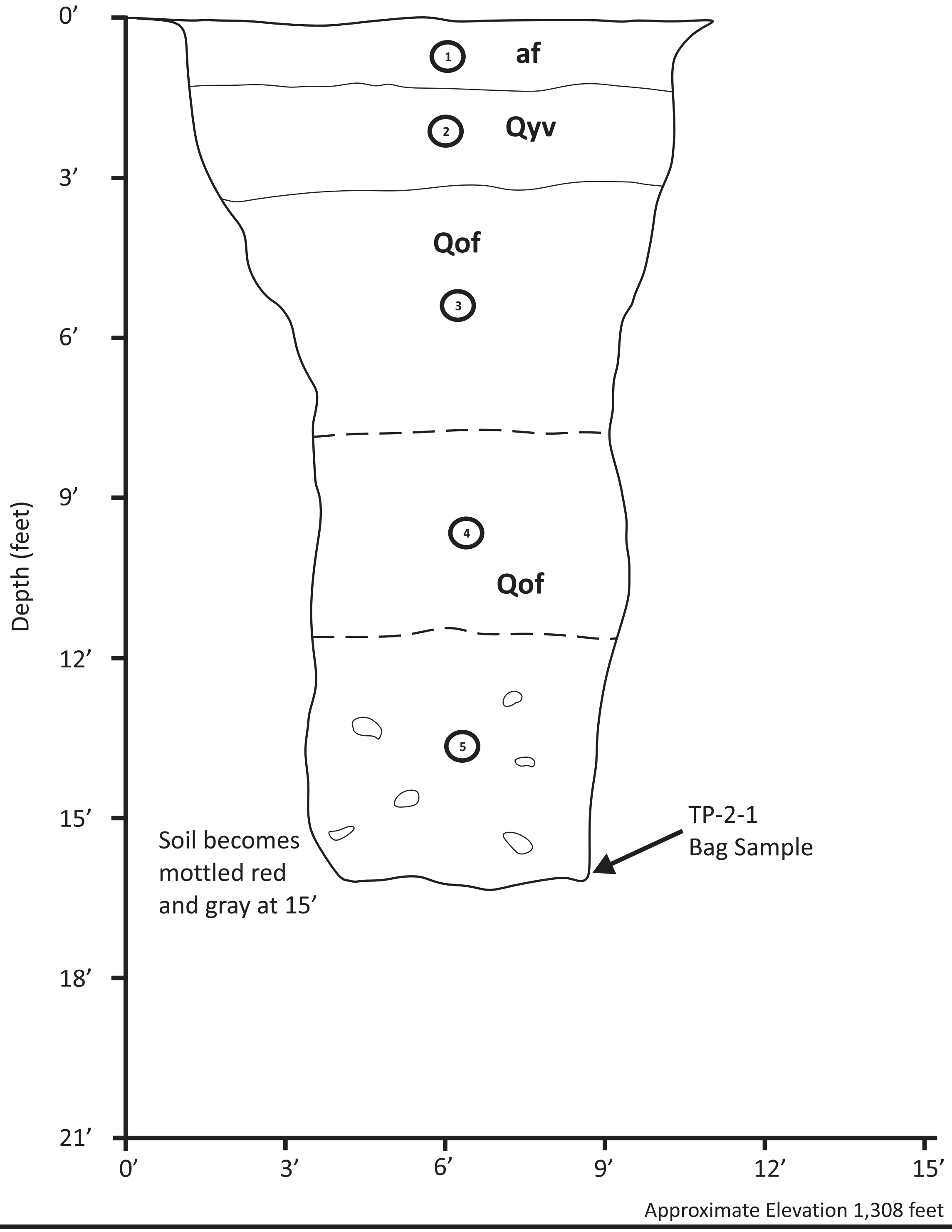
Test Pit Logs

Proposed Bamiyan Marketplace
15749 Grand Avenue, Lake Elsinore
Riverside County, CA

Earth Systems

1/17/2019
302169-001

TP-2



Descriptions

① af, Fill, medium dense (SM) silty f-c sand, trace gravel, dry, brown (7.5yr 4/4). Some pinholes.

② Qyv, Young alluvial fan deposits (SM) medium dense, silty f-c sand, some gravel, dry, reddish brown (5yr 4/4). Some pinholes.

③ Qof, Old alluvial fan deposits (SM) medium dense, f-c sand with silt, trace gravel, moist, reddish brown, (5yr 4/3).

④ Qof, Old alluvial fan deposits, (SM) Qa, medium dense, silty f-m sand, moist, dark reddish brown (2.5yr 3/3). Few pinholes.

⑤ Qof, Old alluvial fan deposits (SC) medium dense, f-c sand trace silt, dry to moist, dusty red (2.5yr 3/2). Some subround cobbles up to 8".

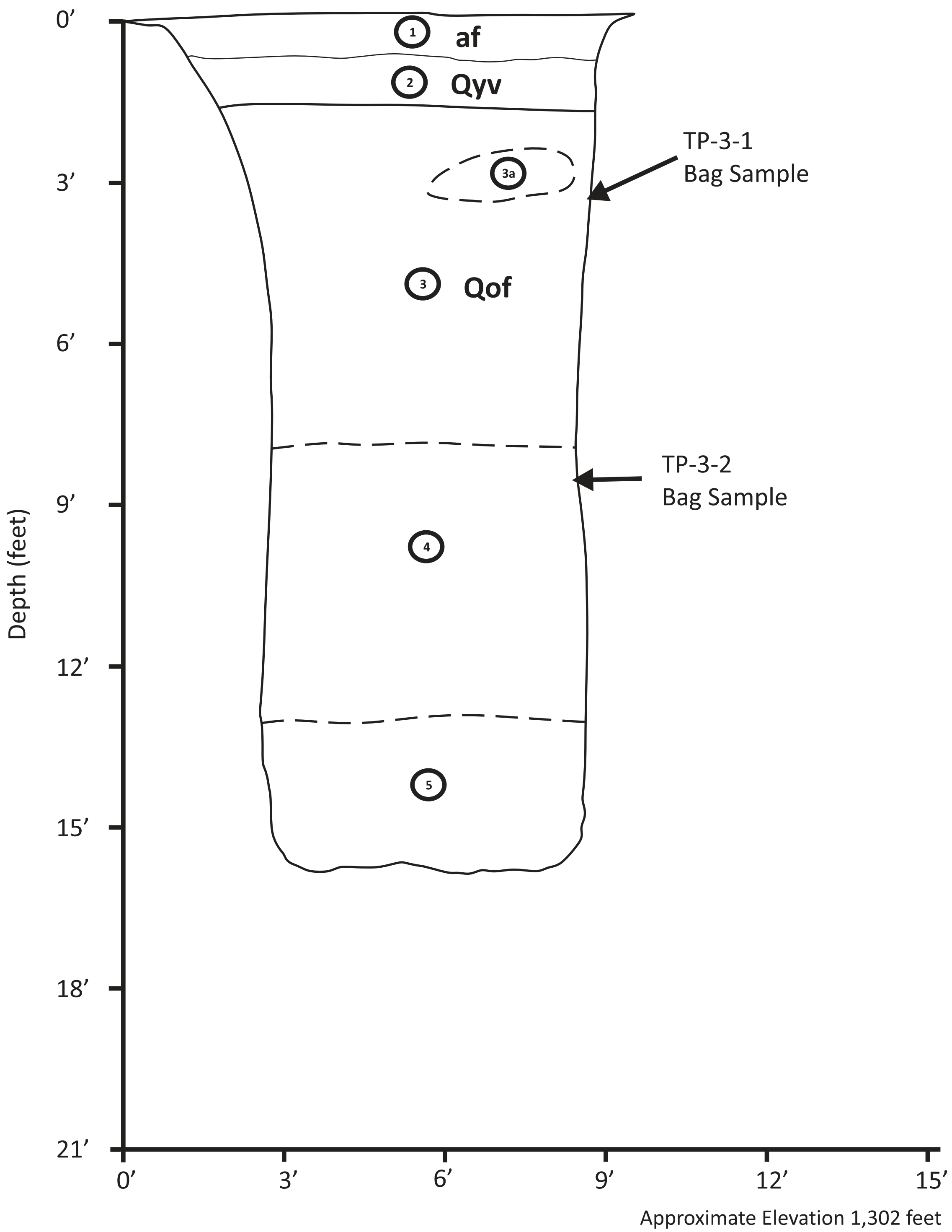
Test Pit Logs

Proposed Bamiyan Marketplace
15749 Grand Avenue, Lake Elsinore
Riverside County, CA

Earth Systems

1/17/2019 302169-001

TP-3



Descriptions

① af, Fill, medium dense (SM)
silty f-c sand, some gravel, dry,
brown (7.5yr 4/3).

② Qyv, Young alluvial fan deposits (SM)
medium dense, silty f-c sand, trace
gravel, dry, brown (7.5yr 4/2).

③ Qof, Old alluvial fan deposits (SC)
medium dense, f-c sand, trace gravel,
moist, mottled 5 to 8, yellowish red 5yr 4/6
to dark reddish brown (5yr 3/3).

(3a) Qof, Old alluvial fan deposits
Dense f-c sand, moist, dark gray
(2.5y 4/1)

④ Qof, Old alluvial fan deposits (CL to SC)
medium dense to firm, sandy clay to
Oayey f-c sand, very moist, mottled
dark gray (5y 4/1) to olive yellow
(2.5y 6/6).

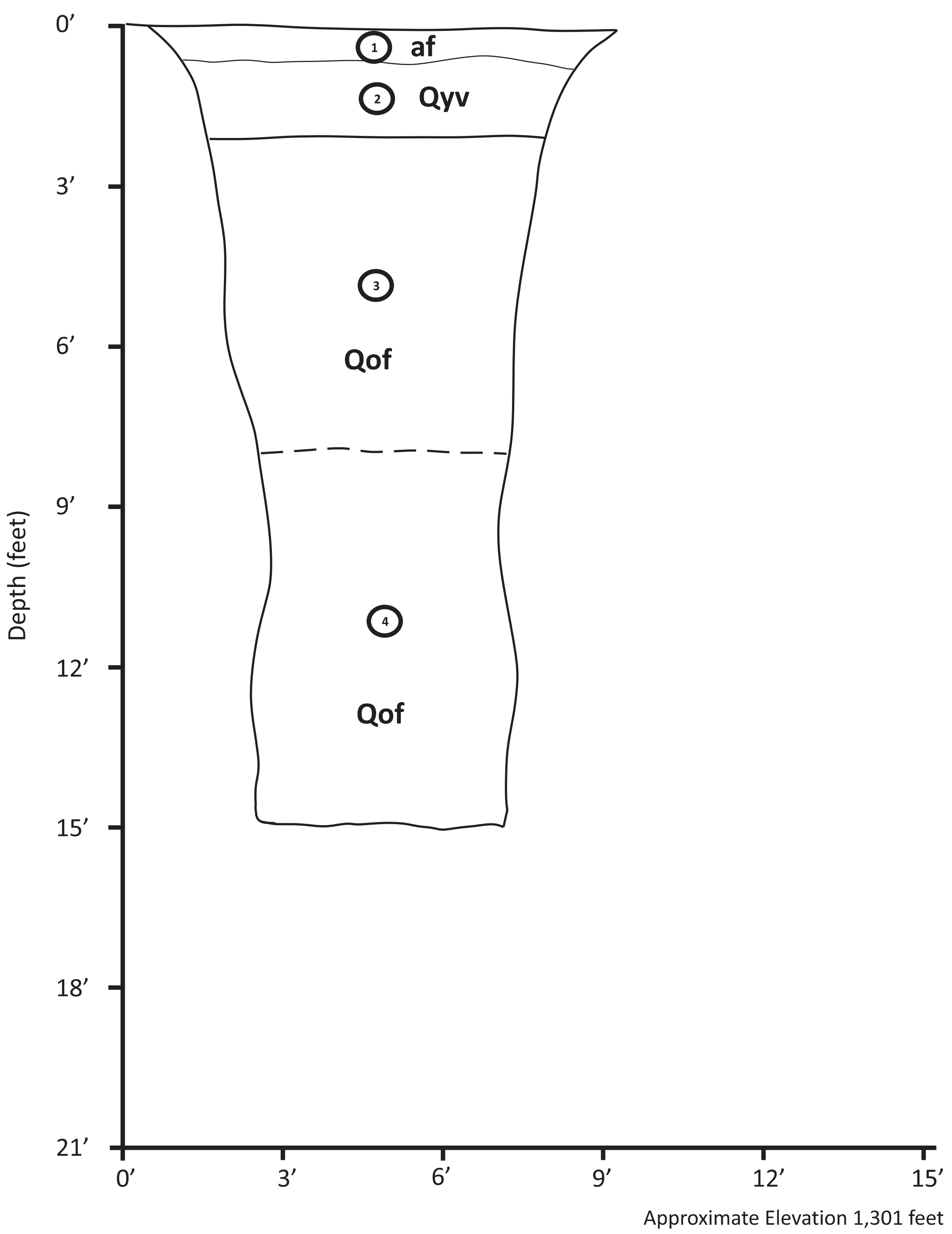
⑤ Qof, Old alluvial fan deposits (SC)
medium dense, f-c sand trace silt,
very moist, gray (2.5y 5/1).
Some mottled dark reddish brown
(2.5yr 5/4).

Test Pit Logs

Proposed Bamiyan Marketplace
15749 Grand Avenue, Lake Elsinore
Riverside County, CA

Earth Systems

1/17/2019
302169-001



TP-4

Descriptions

① af, Fill, medium dense (SM)
silty f-c sand, dry, brown (10y 4/3).
Some pinholes.

② Qyv, Young alluvial fan deposits (SM)
medium dense, silty f-c sand, trace
gravel, dry, brown (7.5yr 4/4).

③ Qof, Old alluvial fan deposits (SM)
medium dense, f-c sand with silt,
damp, reddish brown,(5yr 4/4).

④ Qof, Old alluvial fan deposits (SC)
medium dense, silty f-c sand,
trace gravel, moist, mottled dark
grayish brown 2.5y 4/2 to olive yellow
2.5y 6/6. Few pinholes.

Test Pit Logs

Proposed Bamiyan Marketplace
15749 Grand Avenue, Lake Elsinore
Riverside County, CA

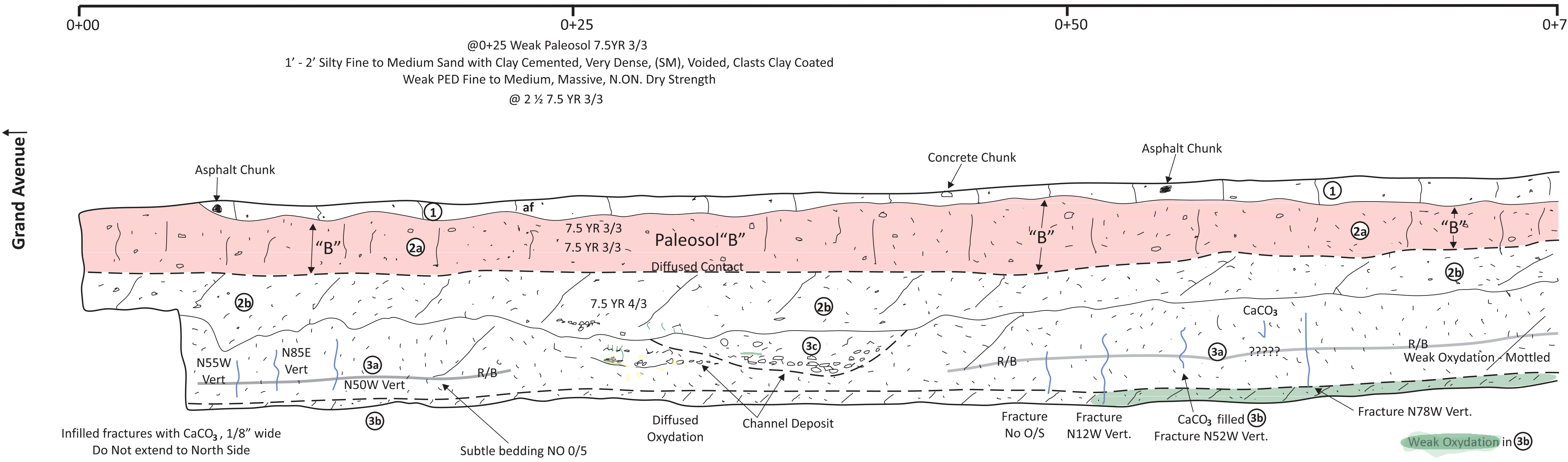
Earth Systems

1/17/2019 302169-001

Scale: 1" = 5'

T-1

Trench Orientation
N48E
South Side



① Fill, Fine to Coarse Sand with Clay (SC), Dry, Loose to Medium Dense, Some Gravel, Trace Cobble, Very Dark Grayish Brown (10 yr 3/2).

2a Alluvium, Fine to Coarse Sand with Clay (SC), Visible Voids, High Dry/Strength, Dry, Medium Dense, Trace Gravel, Trace Cobble, Dark Brown (7.5 yr 3/2), Weakly Cemented, Weak Blocky Structure, Weak B-Horizon, Massive.

2b Alluvium, Fine to Coarse Sand with Gravel, with Silt (SM), Visibly Voided, Dry, Medium Dense, Brown (7.5 yr 4/3), Gradational Change from 2a to 2b, Massive.

3a Older Alluvium, Fine to Coarse Sand with Gravel, Trace Silt (SP - SM), Dry, Medium Dense, Mottled Brown (10 yr 5/3) to Reddish Yellow (7.5 yr 6/8), from Sta 2+25 West Becomes Silty Sand, Massive.

3b Older Alluvium, Silty Fine to Coarse Sand (SM), Moist, Medium Dense, Mottled Yellowish Brown (10 yr 5/6) to Reddish Yellow (7.5 yr 6/8), Massive.

3c Older Alluvium (Channel Deposit), It Appears During the Deposition of 3a and Prior to 2b, Numerous Channels Cut Into 3a and Deposited Coarser Grained Materials, These Channel Deposits Vary from Clean Fine to Coarse Sand (SP) to Gravelly Fine to Coarse Sand with Cobble and Small Lenses of Fine Sandy Silt, Dry, Loose to Medium Dense, Typically the Channel Deposits on the Upper Portion Will Grade Into 3a. One Channel Deposit Sta 0+35 to 0+40 is Overlain by 2b.

R/B - Subtle Relic Bedding

LEGEND

🟥 Bt - Horizon
🟨 Weak B - Horizon
— — Lithologic Contact
～ Geologic Contact

Approximate Scale: 1" = 5'
0 5 Feet 10 Feet

Plate 5
T-1 Trench Log

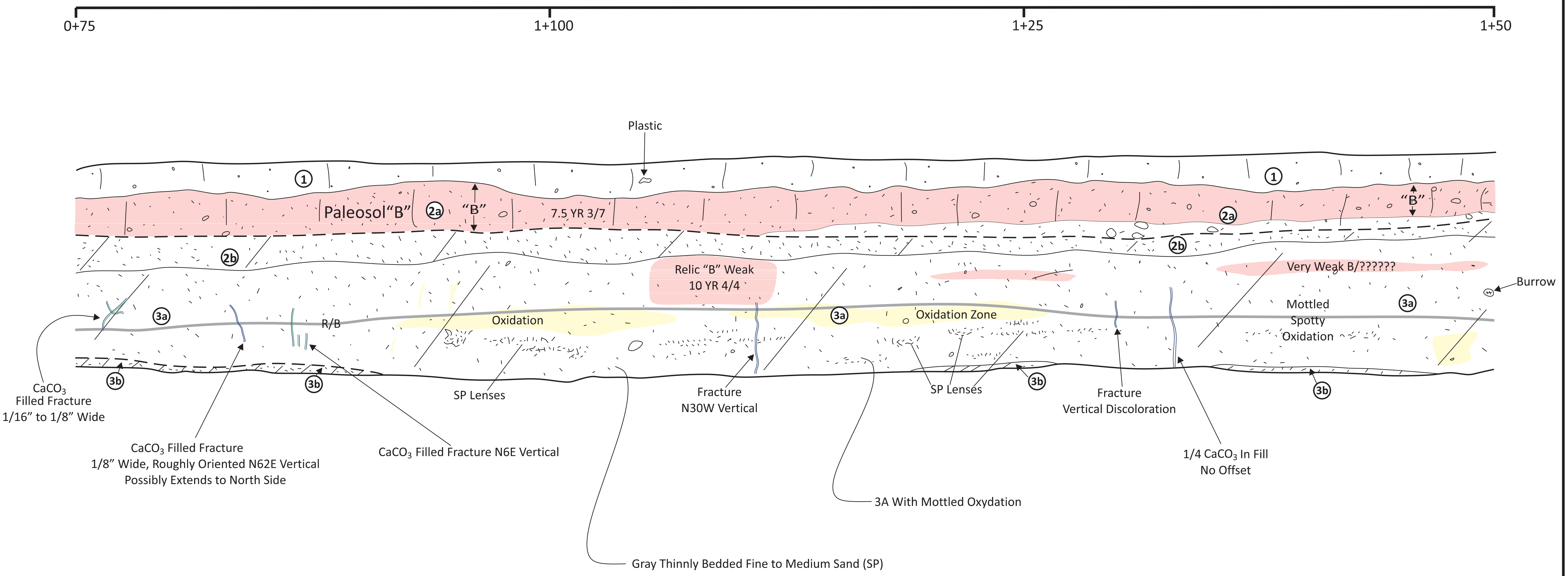
Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Earth Systems

1/17/2019	File No.: 302169-001

T-1

Trench Orientation
N48E



Relic Palrosol 1+10'
Silty Fine to Medium Sand 10 YR 4/4
Weakly Cemented
Medium Dry Strength
Mottled With Weak Oxydation

LEGEND

🟥	Bt - Horizon	╌	Lithologic Contact
🟨	Weak B - Horizon	∼	Geologic Contact

Approximate Scale: 1" = 5'
0 5 Feet 10 Feet

Plate 6
T-1 Trench Log

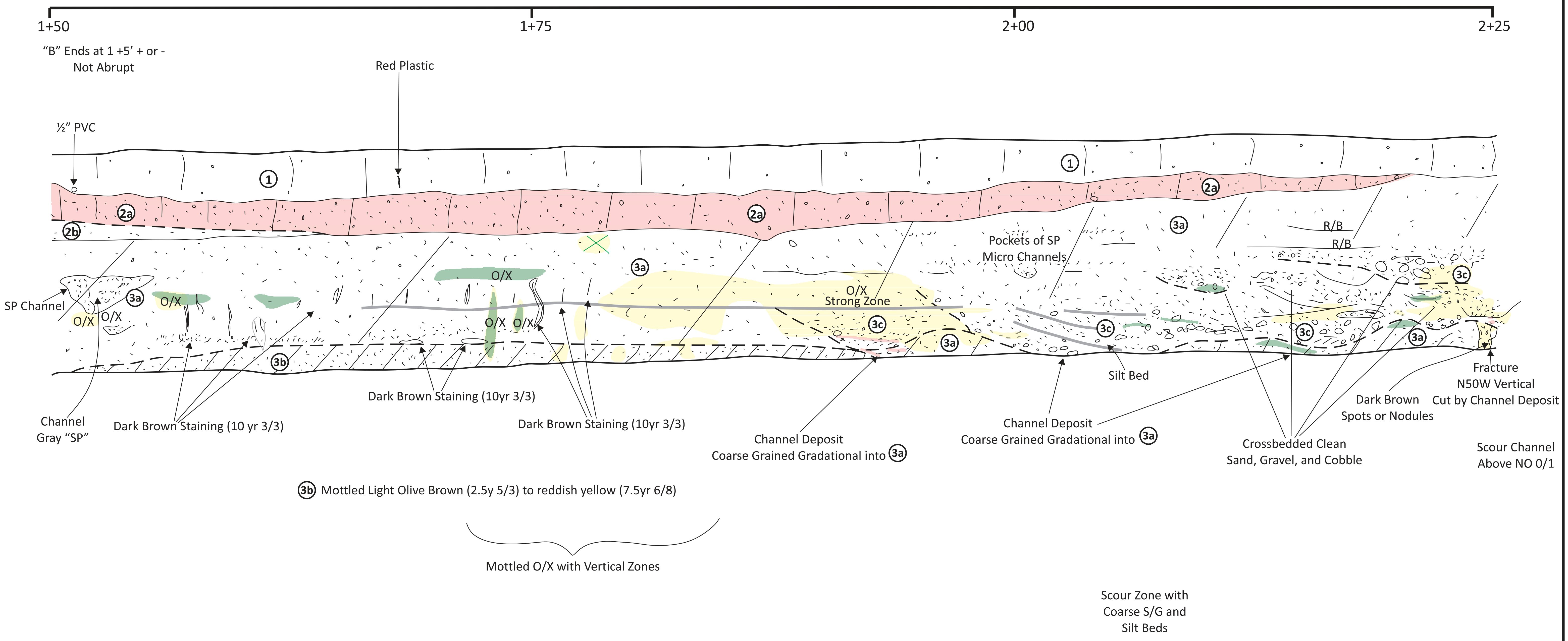
Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Earth Systems

1/17/2019
File No.: 302169-001

T-1

Trench Orientation
N48E



LEGEND

🟥 Bt - Horizon
🟨 Weak B - Horizon
⁓ ⁓ Lithologic Contact
〜 Geologic Contact

Approximate Scale: 1" = 5'
0 5 Feet 10 Feet

Plate 7
T-1 Trench Log

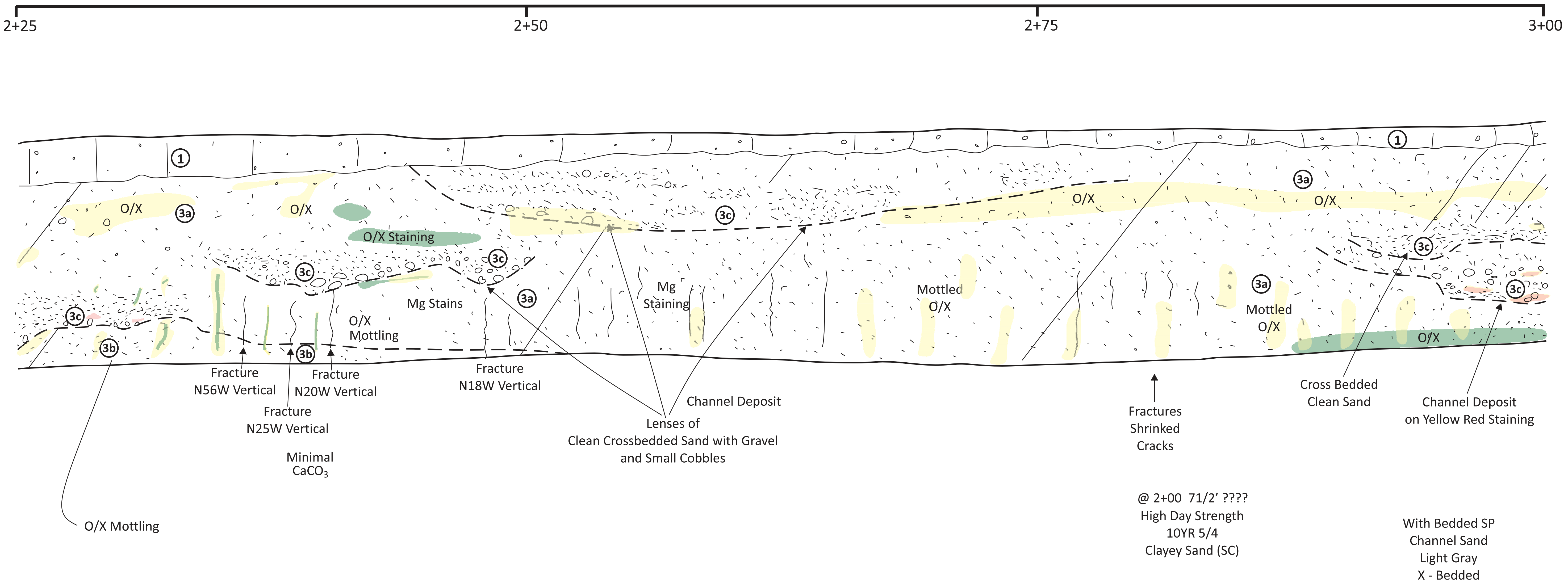
Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Earth Systems

1/17/2019
File No.: 302169-001

T-1

Trench Orientation
N48E



LEGEND

🟥 Bt - Horizon
🟨 Weak B - Horizon
Lithologic Contact
Geologic Contact

Approximate Scale: 1" = 5'

0 5 Feet 10 Feet

Plate 8
T-1 Trench Log

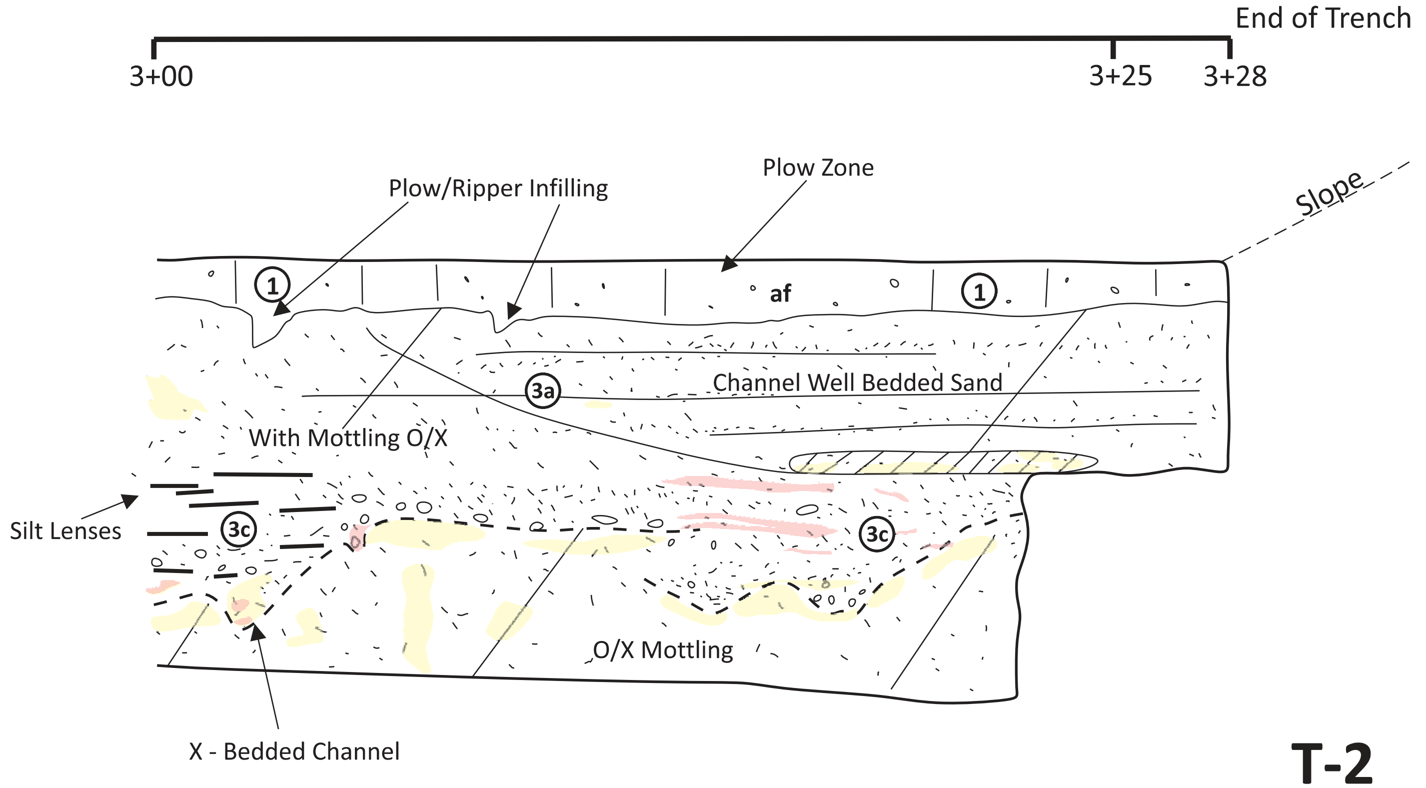
Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Earth Systems

1/17/2019
File No.: 302169-001

T-1

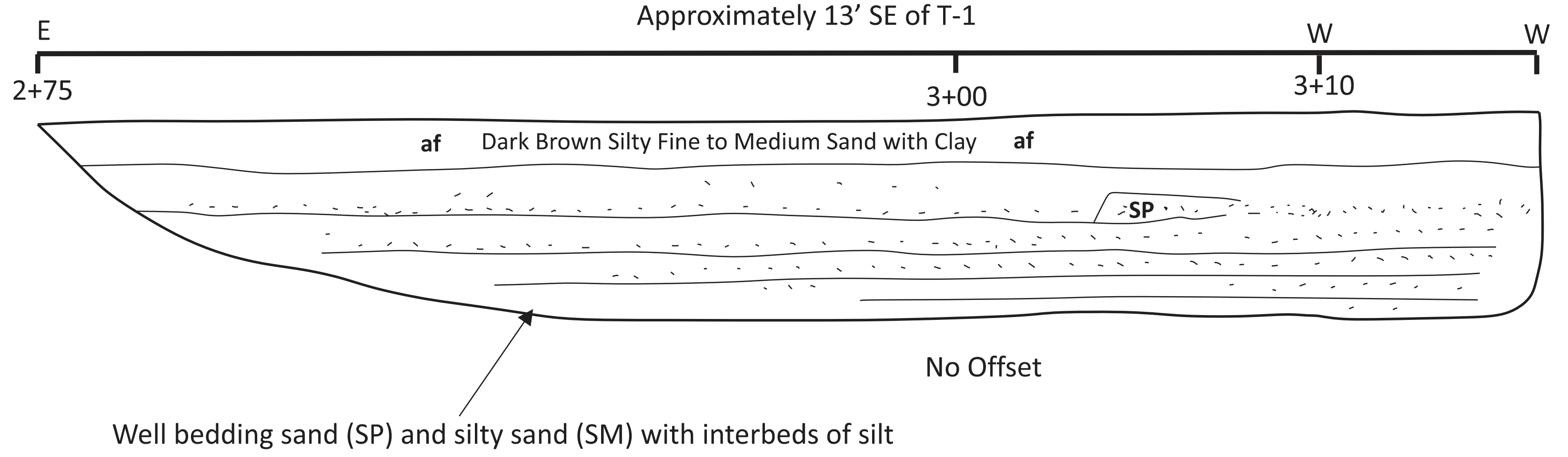
Trench Orientation
N48E



T-2

Trench Orientation
N52E

Approximately 13' SE of T-1



No O/S
O/X within silt and SM beds

LEGEND

🟥 Bt - Horizon
🟨 Weak B - Horizon
Lithologic Contact
Geologic Contact

Approximate Scale: 1" = 5'
0 5 Feet 10 Feet

Plate 9
T-1 & T-2 Trench Logs

Proposed Bamiyan Marketplace
15749 Grand Avenue
Lake Elsinore, Riverside County, California

Earth Systems

1/17/2019
File No.: 302169-001

LIQUEFY-v 2.3.XLS - A SPREADSHEET FOR EMPIRICAL ANALYSIS OF LIQUEFACTION POTENTIAL AND INDUCED GROUND SUBSIDENCE

Coryright & Developed 2007 by Shelton L. Stringer, PE, GE, PG , EG - Earth Systems Southwest

Project: Bamiyan Marketplace
Job No: 302169-002
Date: 1/17/2019
Boring: B-2 Data Set: 1

Methods: **Liquefaction Analysis using 1996 & 1998 NCEER workshop method (Youd & Idriss, editors)**
Journal of Geotechnical and Enviromental Engineering (JGEE), October 2001, Vol 127, No. 10, ASCE
Settlement Analysis from Tokimatsu and Seed (1987), JGEE,Vol 113, No.8, ASCE
Modified by Pradel, JGEE, Vol 124, No. 4, ASCE

EARTHQUAKE INFORMATION:
Magnitude: 7.7 7.5
PGA, g: 0.91 0.97
MSF: 0.93
GWT: 5.0 feet
Calc GWT: 5.0 feet
Remediate to: 5.0 feet

SPT N VALUE CORRECTIONS:
Energy Correction to N60 (C_E): 1.20
Drive Rod Corr. (C_R): 1 Default
Rod Length above ground (feet): 3.0
Borehole Dia. Corr. (C_B): 1.00
Sampler Liner Correction for SPT?: 1 Yes
Cal Mod/ SPT Ratio: 0.63

Threshold Acceler., g: 0.31

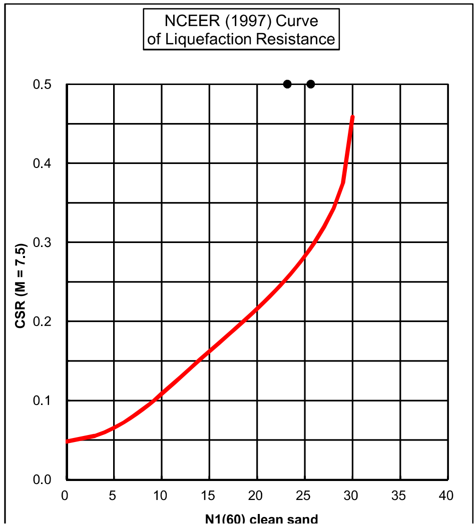
Required SF: 1.50
Minimum Calculated SF: 0.34

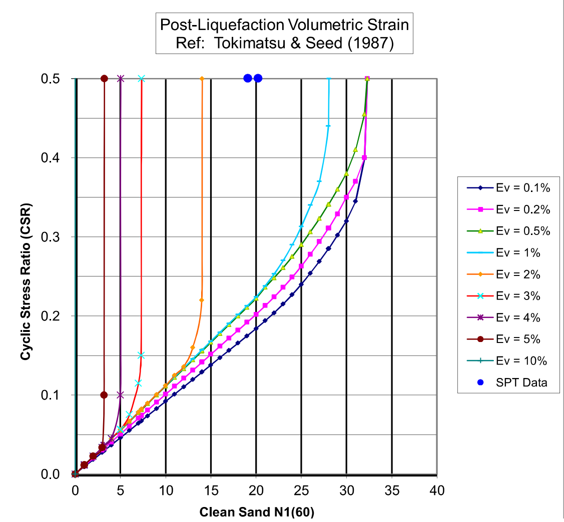
Total (in.) Induced Subsidence
1.0
upper 50 ft

SETTLEMENT (SUBSIDENCE) OF DRY SANDS

Nc = 17.1

Base Depth (feet)	Cal Mod N	SPT N	Liquef. Suscept. (0 or 1)	Total Unit Wt. (pcf)	Fines Content (%)	Depth of SPT (feet)	Rod Length (feet)	Tot.Stress at SPT po (tsf)	Eff.Stress at SPT p'o (tsf)	rd	C_N	C_R	C_S	$N_{1(60)}$	Rel. Dens. Dr (%)	Trigger FC Adj. $\Delta N_{1(60)}$	Equiv. Sand $N_{1(60)CS}$	Kσ	M = 7.5 Available CRR	M =7.5 Induced CSR*	Liquefac. Safety Factor	Post FC Adj. $\Delta N_{1(60)}$	$N_{1(60)CS}$	Volumetric Strain (%)	Induced Subsidence (in.)	p (tsf)	G_{max} (tsf)	τ_{av} (tsf)	Shear Strain γ	Strain E_{15}	Strain Enc	Dry Sand Subsidence (in.)
								0.000																								
5.0	36	50	1	122	24	2.5	5.5	0.153	0.153	1.00	1.70	0.75	1.00	76.5	###	10.0	86.5	1.00	1.200	0.631	Non-Liq.	10.0	86.5	0.03	0.02	0.102	632	0.090	7.0E-04	1.2E-04	1.3E-04	0.02
7.5	14	9	1	117	24	5.0	8.0	0.305	0.305	0.99	1.70	0.75	1.00	13.5	44	5.6	19.1	1.00	0.206	0.627	Non-Liq.	5.6	19.1	0.00	0.00	0.204	540	0.179	9.6E-03			
10.0	18	11	1	122	24	7.5	10.5	0.451	0.373	0.98	1.68	0.75	1.00	17.2	50	6.0	23.2	1.00	0.256	0.753	0.34	1.9	19.1	1.65	0.49	0.302	701	0.263	6.5E-03			
12.5	20	13	1	113	33	10.0	13.0	0.604	0.448	0.98	1.54	0.76	1.00	17.6	50	8.0	25.7	1.00	0.294	0.836	0.35	2.6	20.2	1.57	0.47	0.405	838	0.350	5.4E-03			
14.5	63	40	1	106	10	12.5	15.5	0.745	0.511	0.97	1.44	0.82	1.00	56.0	89	2.1	58.1	1.00	1.200	0.899	1.34	2.1	58.1	0.00	0.00	0.499	1,223	0.429	1.6E-03			
20.0	57	36	1	146	10	15.0	18.0	0.888	0.576	0.97	1.36	0.86	1.00	50.5	85	2.0	52.4	1.00	1.200	0.945	1.27	2.0	52.4	0.00	0.00	0.595	1,290	0.508	1.9E-03			
25.0	41	26	1	126	40	20.0	23.0	1.253	0.785	0.96	1.16	0.93	1.00	33.6	69	10.0	43.6	1.00	1.200	0.967	1.24	10.0	43.6	0.00	0.00	0.839	1,441	0.709	2.6E-03			
30.0	83	52	1	140	40	25.0	28.0	1.568	0.944	0.94	1.06	0.98	1.00	65.3	97	10.0	75.3	1.00	1.200	0.990	1.21	10.0	75.3	0.00	0.00	1.050	1,935	0.873	1.4E-03			
35.0	66	42	1	146	40	30.0	33.0	1.918	1.138	0.92	0.96	1.00	1.00	48.1	83	10.0	58.1	0.97	1.200	1.011	1.19	10.0	58.1	0.00	0.00	1.285	1,963	1.044	1.9E-03			
40.0	57	36	1	142	40	35.0	38.0	2.283	1.347	0.89	0.89	1.00	1.00	38.2	74	10.0	48.2	0.91	1.200	1.052	1.14	10.0	48.2	0.00	0.00	1.529	2,012	1.202	2.3E-03			
45.0	49	31	1	145	40	40.0	43.0	2.638	1.546	0.85	0.83	1.00	1.00	30.6	66	10.0	40.6	0.89	1.200	1.030	1.17	10.0	40.6	0.00	0.00	1.767	2,043	1.328	2.6E-03			
50.0	88	55	1	143	40	45.0	48.0	3.000	1.752	0.80	0.78	1.00	1.00	51.7	86	10.0	61.7	0.82	1.200	1.066	1.13	10.0	61.7	0.00	0.00	2.010	2,504	1.426	1.5E-03			
50.5	100	63	1	143	40	50.0	53.0	3.358	1.954	0.75	0.74	1.00	1.00	55.6	89	10.0	65.6	0.78	1.200	1.046	1.15	10.0	65.6	0.00	0.00	2.250	2,704	1.495	1.3E-03			


NCEER (1997) Curve of Liquefaction Resistance


Post-Liquefaction Volumetric Strain
Ref: Tokimatsu & Seed (1987)

$N_{1(60)}$ = C_N*C_E*C_B*C_R*C_S*N
C_R = 0.75 for Rod lengths < 3m, 1.0 for > 10m
= min(1,max(0.75,1.4666-2.556/(z(ft))$^{0.5}$))
C_N = (1 atm/p'o)$^{0.5}$, max 1.7
C_S = max(1.1,min(1.3,1+$N_{1(60)}$/100)) for SPT without liners
MSF = $10^{2.24}/M^{2.56}$
z = Depth (m)
pa = 1 atm = 101 KPa = 1.058 tsf

rd = (1-0.4113*z^0.5+0.04052*z+0.001753*z^1.5)/(1-0.4177*z^0.5+0.05729*z-0.006205*z^1.5+0.00121*z^2))
$\Delta N_{1(60)}$ = min(10,IF(FC<35,exp(1.76-(190/FC^2)),5)+IF(FC<=5,1,IF(FC<35,0.99+(FC^1.5/1000),1.2))*N1(60) - N1(60)
$N_{1(60)CS}$ = $N_{1(60)CS}$ + $\Delta N_{1(60)}$
Kσ = min of 1.0 or (p'o/1.058)$^{(IF(Dr>0.7,0.6,IF(Dr<0.5,0.8,0.7))-1)}$
Dr = $(N_{1(60)}/70)^{0.5}$
CSReq = 0.65*PGA*(po/p'o)*rd
CSR* = CSReq/MSF/Kσ
$CRR_{7.5}$ = (0.048-0.004721*N+0.0006136*N^2-0.00001673*N^3)/(1-0.1248*N+0.009578*N^2-0.0003285*N^3+0.000003714*N^4))
N = $N_{1(60)CS}$

SF = $CRR_{7.5,1atm}$/CSR*

p = 0.67*po
τ_{av} = 0.65*PGA*po*rd
G_{max} = 447*$N_{1(60)CS}^{(1/3)}$*$p^{0.5}$
a = 0.0389*(p/1)+0.124
b = 6400*(p/1)$^{(-0.6)}$
γ = [1+a*EXP(b*τ_{av}/G_{max})]/[(1+a)*τ_{av}/G_{max}]
E_{15} = γ*($N_{1(60)CS}$/20)$^{-1.2}$
E_{nc} = (Nc/15)$^{0.45}$*E15

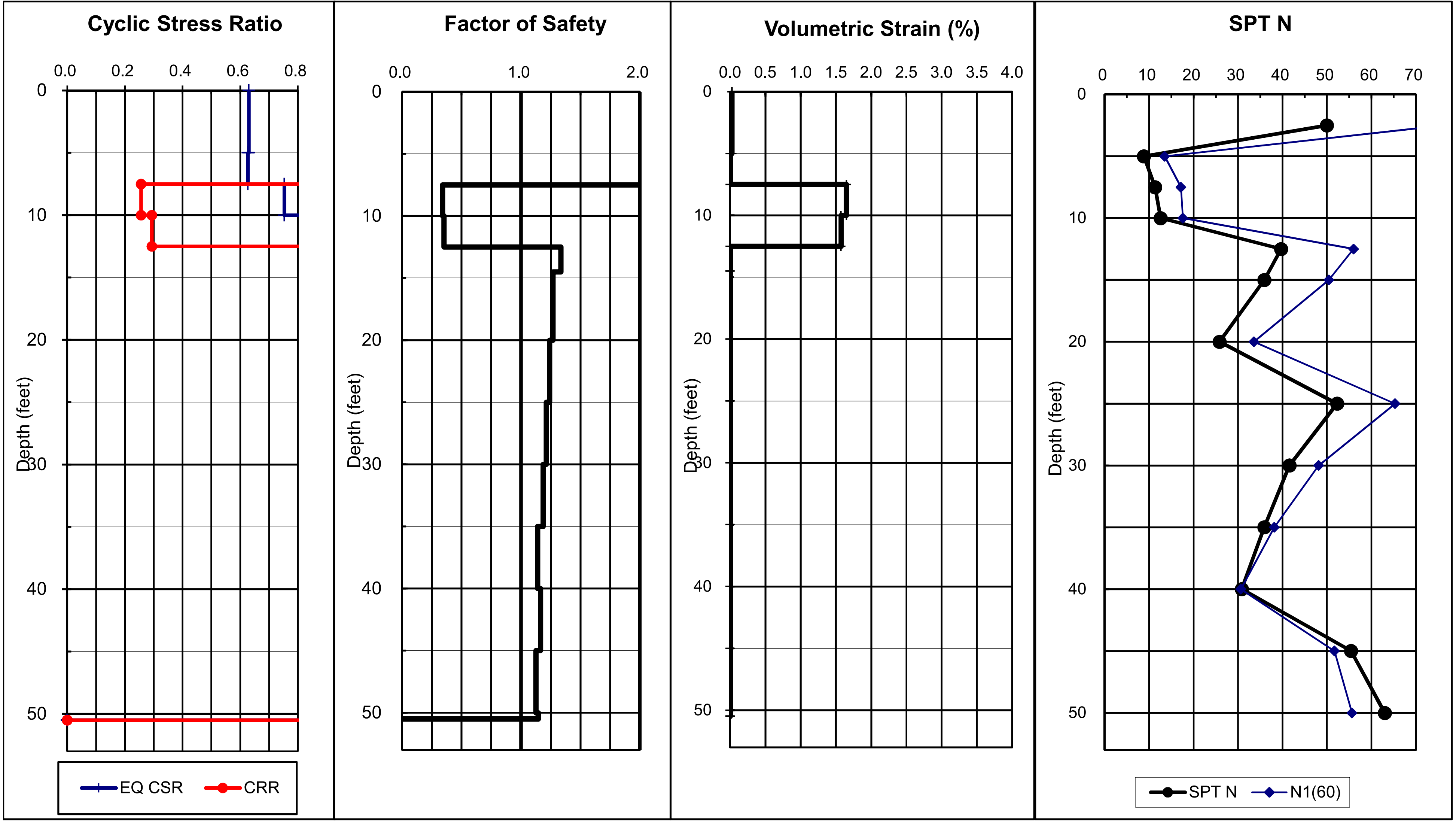
Nc = (MAG-4)$^{2.17}$
S = 2*H*E_{nc}

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Bamiyan Marketplace **Project No: 302169-002**

1996/1998 NCEER Method
Ground Compaction Remediated to 5 foot depth

Boring: B-2 **Earthquake Magnitude: 7.7** **PGA, g: 0.91** **Calc GWT (feet): 5**



Total Thickness of Liquefiable Layers: 0.0 feet **Estimated Total Ground Subsidence: 1.0 inches**

LIQUEFY-v 2.3.XLS - A SPREADSHEET FOR EMPIRICAL ANALYSIS OF LIQUEFACTION POTENTIAL AND INDUCED GROUND SUBSIDENCE

Project: Bamiyan Marketplace
Job No: 302169-002
Date: 1/17/2019
Boring: B-13 Data Set: 5

Methods: Liquefaction Analysis using 1996 & 1998 NCEER workshop method (Youd & Idriss, editors)
Journal of Geotechnical and Enviromental Engineering (JGEE), October 2001, Vol 127, No. 10, ASCE
Settlement Analysis from Tokimatsu and Seed (1987), JGEE,Vol 113, No.8, ASCE
Modified by Pradel, JGEE, Vol 124, No. 4, ASCE

EARTHQUAKE INFORMATION:
Magnitude: 7.7 7.5
PGA, g: 0.91 0.97
MSF: 0.93
GWT: 5.0 feet
Calc GWT: 5.0 feet
emediate to: 5.0 feet

SPT N VALUE CORRECTIONS:
Energy Correction to N60 (C_E): 1.20
Drive Rod Corr. (C_R): 1 Default
Rod Length above ground (feet): 3.0
Borehole Dia. Corr. (C_B): 1.00
Sampler Liner Correction for SPT?: 1 Yes
Cal Mod/ SPT Ratio: 0.63

Threshold Acceler., g: 0.31

Required SF: 1.50
Minimum Calculated SF: 0.34

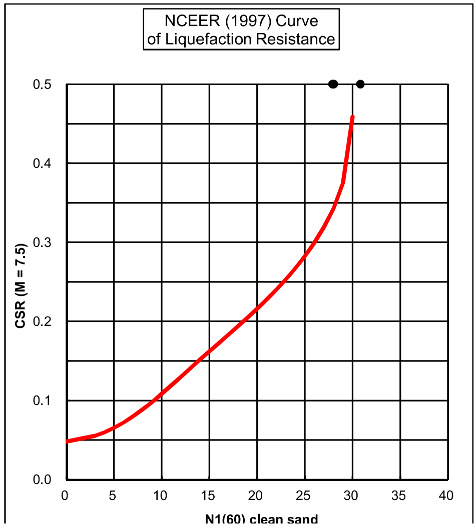
Total (in.) Induced Subsidence
1.9
upper 50 ft

SETTLEMENT (SUBSIDENCE) OF DRY SANDS

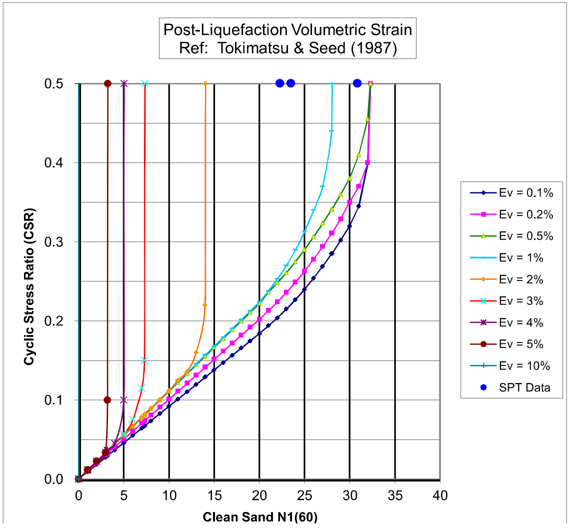
Nc = 17.1

Base Depth (feet)	Cal Mod N	SPT N	Liquef. Suscept. (0 or 1)	Total Unit Wt. (pcf)	Fines Content (%)	Depth of SPT (feet)	Rod Length (feet)	Tot.Stress at SPT po (tsf)	Eff.Stress at SPT p'o (tsf)	rd	C_N	C_R	C_S	$N_{1(60)}$	Rel. Dens. Dr (%)	Trigger FC Adj. $\Delta N_{1(60)}$	Equiv. Sand $N_{1(60)CS}$	Kσ	M = 7.5 Available CRR	M =7.5 Induced CSR*	Liquefac. Safety Factor	Post FC Adj. $\Delta N_{1(60)}$	$N_{1(60)CS}$	Volumetric Strain (%)	Induced Subsidence (in.)	p (tsf)	G_{max} (tsf)	τ_{av} (tsf)	Shear Strain γ	Strain E_{15}	Strain Enc	Dry Sand Subsidence (in.)
								0.000																								
5.0	22	50	1	118	24	2.5	5.5	0.148	0.148	1.00	1.70	0.75	1.00	76.5	###	10.0	86.5	1.00	1.200	0.631	Non-Liq.	10.0	86.5	0.03	0.02	0.099	621	0.087	7.0E-04	1.2E-04	1.3E-04	0.02
7.5	18	11	1	117	24	5.0	8.0	0.295	0.295	0.99	1.70	0.75	1.00	17.4	50	6.0	23.4	1.00	0.259	0.627	Non-Liq.	6.0	23.4	0.00	0.00	0.198	568	0.173	6.3E-03			
9.5	25	16	1	116	24	7.5	10.5	0.441	0.363	0.98	1.70	0.75	1.00	24.1	59	6.8	30.9	1.00	1.200	0.757	1.59	6.8	30.9	0.68	0.16	0.296	762	0.257	3.9E-03			
15.0	24	15	1	113	24	10.0	13.0	0.586	0.430	0.98	1.57	0.76	1.00	21.6	56	6.5	28.1	1.00	0.345	0.845	0.41	1.9	23.5	1.34	0.88	0.392	851	0.339	4.6E-03			
20.0	46	29	1	119	20	15.0	18.0	0.868	0.556	0.97	1.38	0.86	1.00	41.4	77	6.9	48.4	1.00	1.200	0.957	1.25	6.9	48.4	0.00	0.00	0.582	1,242	0.497	2.1E-03			
25.0	22	14	1	134	40	20.0	23.0	1.166	0.698	0.96	1.23	0.93	1.00	19.1	52	8.8	27.9	1.00	0.342	1.012	0.34	3.2	22.3	1.43	0.86	0.781	1,199	0.660	4.9E-03			
30.0	53	33	1	136	40	25.0	28.0	1.501	0.877	0.94	1.10	0.98	1.00	43.3	79	10.0	53.3	1.00	1.200	1.021	1.18	10.0	53.3	0.00	0.00	1.005	1,687	0.836	2.1E-03			
35.0	61	38	1	146	40	30.0	33.0	1.841	1.061	0.92	1.00	1.00	1.00	46.1	81	10.0	56.1	1.00	1.200	1.012	1.19	10.0	56.1	0.00	0.00	1.233	1,900	1.002	2.0E-03			
39.0	85	54	1	123	40	35.0	38.0	2.206	1.270	0.89	0.91	1.00	1.00	58.7	92	10.0	68.7	0.93	1.200	1.053	1.14	10.0	68.7	0.00	0.00	1.478	2,225	1.162	1.6E-03			

NCEER (1997) Curve of Liquefaction Resistance



Post-Liquefaction Volumetric Strain
Ref: Tokimatsu & Seed (1987)



$N_{1(60)}$ = C_N*C_E*C_B*C_R*C_S*N
C_R = 0.75 for Rod lengths < 3m, 1.0 for > 10m
= min(1,max(0.75,1.4666-2.556/(z(ft))$^{0.5}$))
C_N = (1 atm/p'o)$^{0.5}$, max 1.7
C_S = max(1.1,min(1.3,1+$N_{1(60)}$/100)) for SPT without liners
MSF = $10^{2.24}$/$M^{2.56}$
z = Depth (m)
pa = 1 atm = 101 KPa = 1.058 tsf

rd = (1-0.4113*z^0.5+0.04052*z+0.001753*z^1.5)/(1-0.4177*z^0.5+0.05729*z-0.006205*z^1.5+0.00121*z^2))
$\Delta N_{1(60)}$ = min(10,IF(FC<35,exp(1.76-(190/FC^2)),5)+IF(FC<=5,1,IF(FC<35,0.99+(FC^1.5/1000),1.2))*N1(60) - N1(60)
$N_{1(60)CS}$ = $N_{1(60)CS}$ + $\Delta N_{1(60)}$
Kσ = min of 1.0 or (p'o/1.058)$^{(IF(Dr>0.7,0.6,IF(Dr<0.5,0.8,0.7))-1)}$
Dr = ($N_{1(60)}$/70)$^{0.5}$
CSReq = 0.65*PGA*(po/p'o)*rd
CSR* = CSReq/MSF/Kσ
$CRR_{7.5}$ = (0.048-0.004721*N+0.0006136*N^2-0.00001673*N^3)/(1-0.1248*N+0.009578*N^2-0.0003285*N^3+0.000003714*N^4))
N = $N_{1(60)CS}$

SF = $CRR_{7.5,1atm}$/CSR*

p = 0.67*po
τ_{av} = 0.65*PGA*po*rd
G_{max} = 447*$N_{1(60)CS}^{(1/3)}$*$p^{0.5}$
a = 0.0389*(p/1)+0.124
b = 6400*(p/1)$^{(-0.6)}$
γ = [1+a*EXP(b*τ_{av}/G_{max})]/[(1+a)*τ_{av}/G_{max}]
E_{15} = γ*($N_{1(60)CS}$/20)$^{-1.2}$
E_{nc} = (Nc/15)$^{0.45}$*E15

Nc = (MAG-4)$^{2.17}$

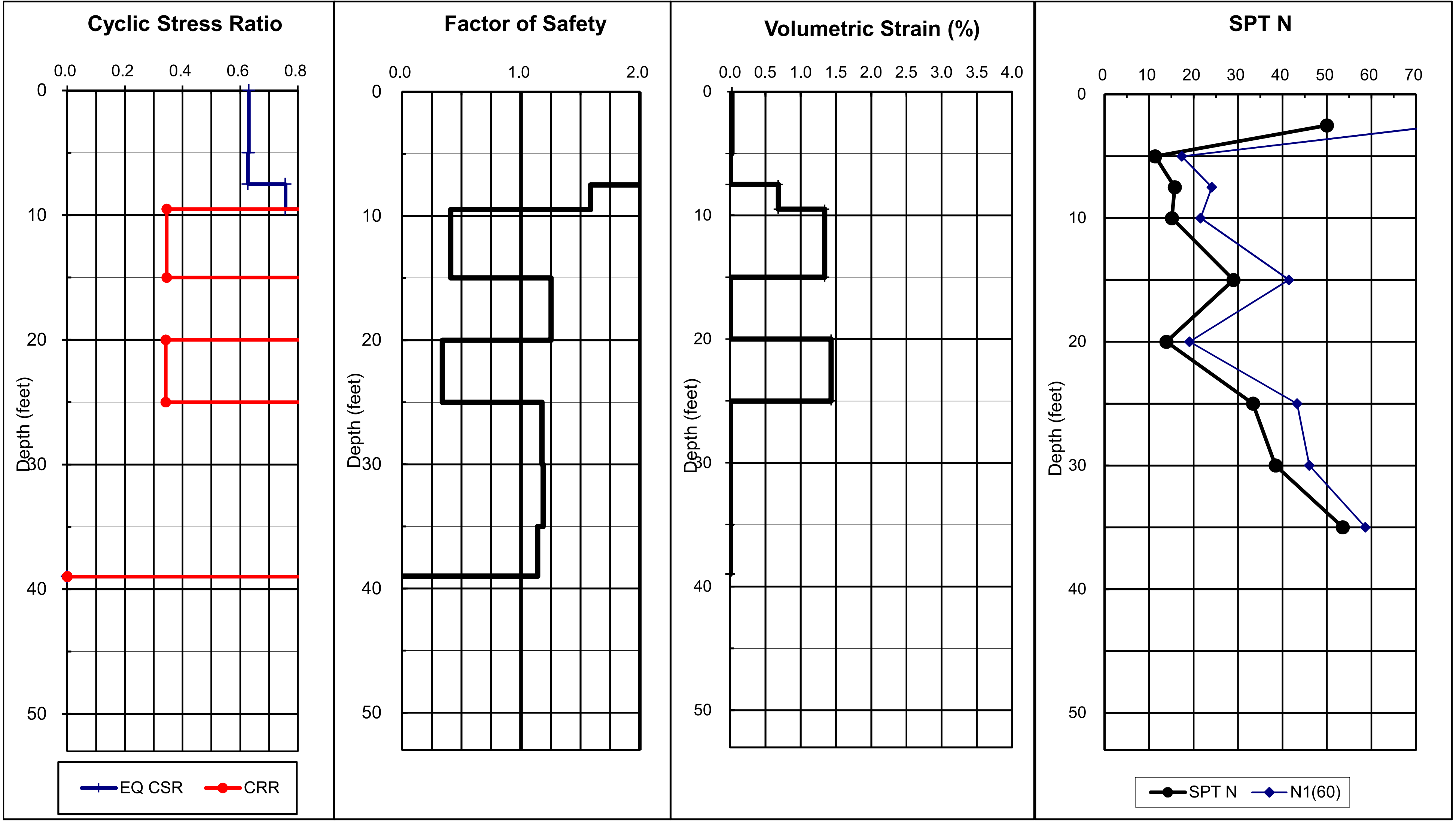
S = 2*H*E_{nc}

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Bamiyan Marketplace **Project No: 302169-002**

1996/1998 NCEER Method
Ground Compaction Remediated to 5 foot depth

Boring: B-13 **Earthquake Magnitude: 7.7** **PGA, g: 0.91** **Calc GWT (feet): 5**



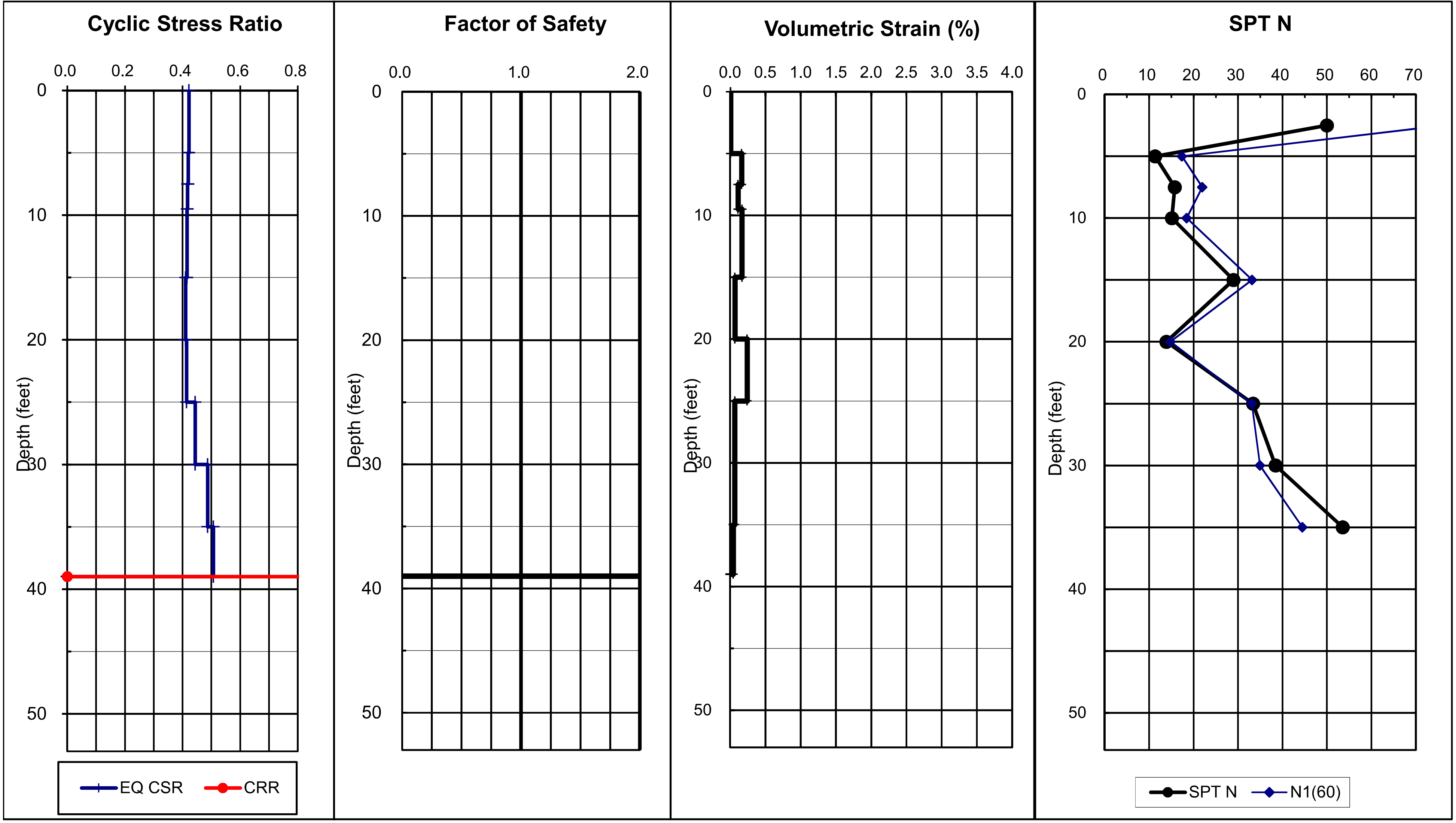
Total Thickness of Liquefiable Layers: 0.0 feet **Estimated Total Ground Subsidence: 1.9 inches**

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Bamiyan Marketplace **Project No: 302169-002** 1996/1998 NCEER Method

Ground Compaction Remediated to 5 foot depth

Boring: B-13 **Earthquake Magnitude: 7.7** **PGA, g: 0.61** **Calc GWT (feet): 50**



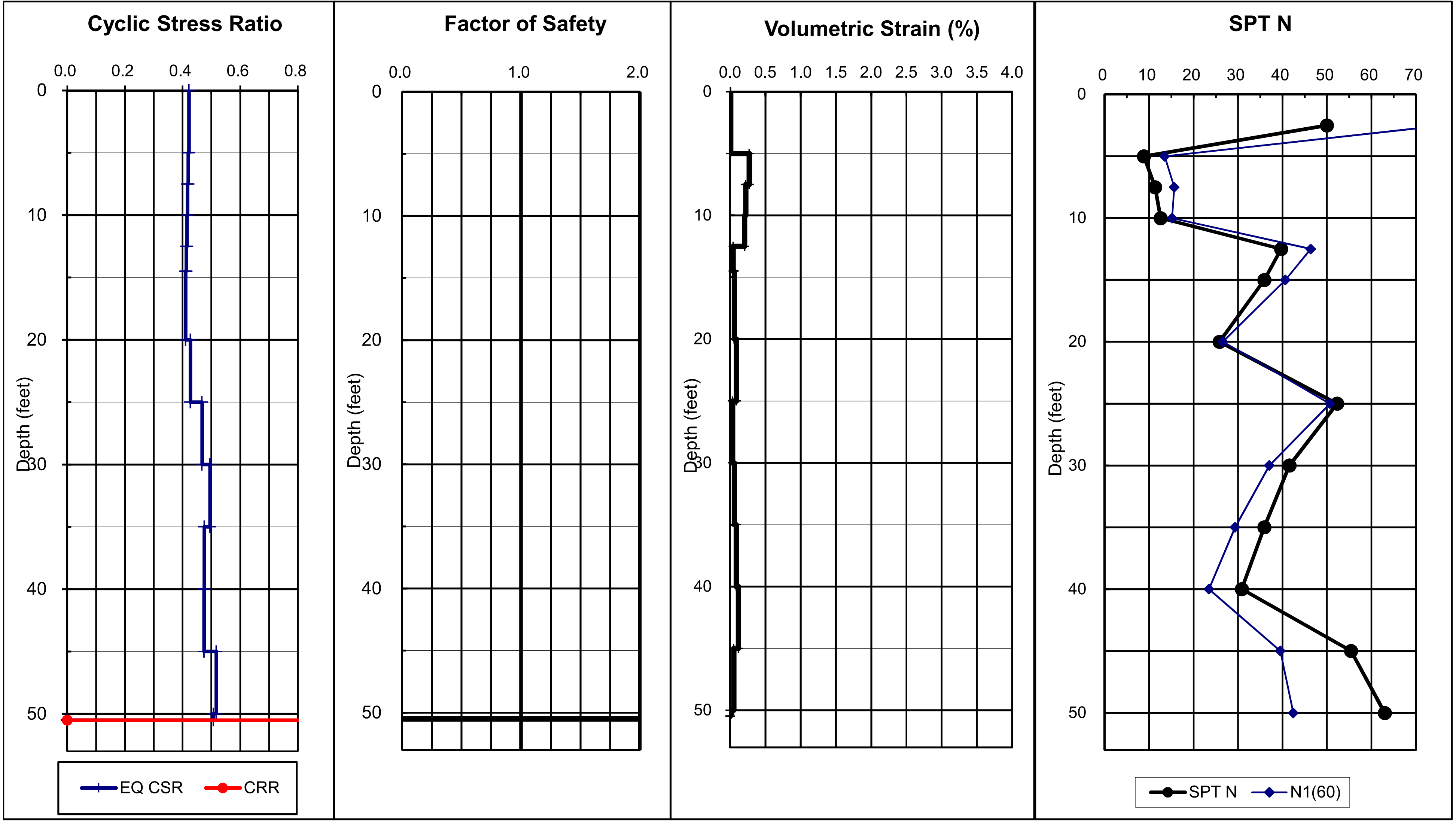
Total Thickness of Liquefiable Layers: 0.0 feet **Estimated Total Ground Subsidence: 0.5 inches**

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Bamiyan Marketplace **Project No: 302169-002**

1996/1998 NCEER Method
Ground Compaction Remediated to 5 foot depth

Boring: B-2 **Earthquake Magnitude: 7.7** **PGA, g: 0.61** **Calc GWT (feet): 50**



Total Thickness of Liquefiable Layers: 0.0 feet

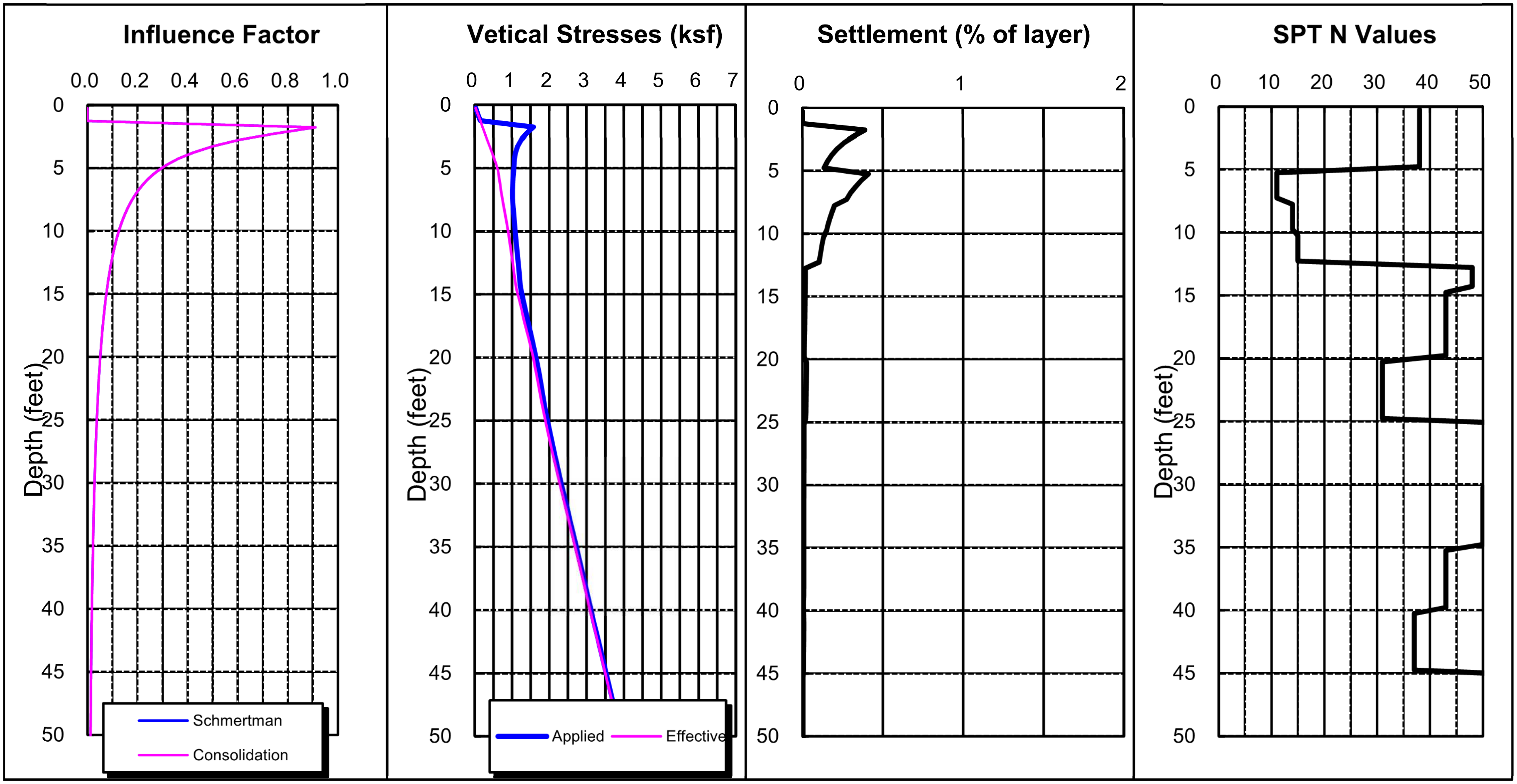
Estimated Total Ground Subsidence: 0.5 inches

EARTH SYSTEMS SOUTHWEST - SETTLEMENT ANALYSES

Bamiyan Marketplace

302169-002

Width, ft: 2.5 Length, ft: 40.0 Net pressure, ksf: 1.50 **Settlement, inches: 0.34**



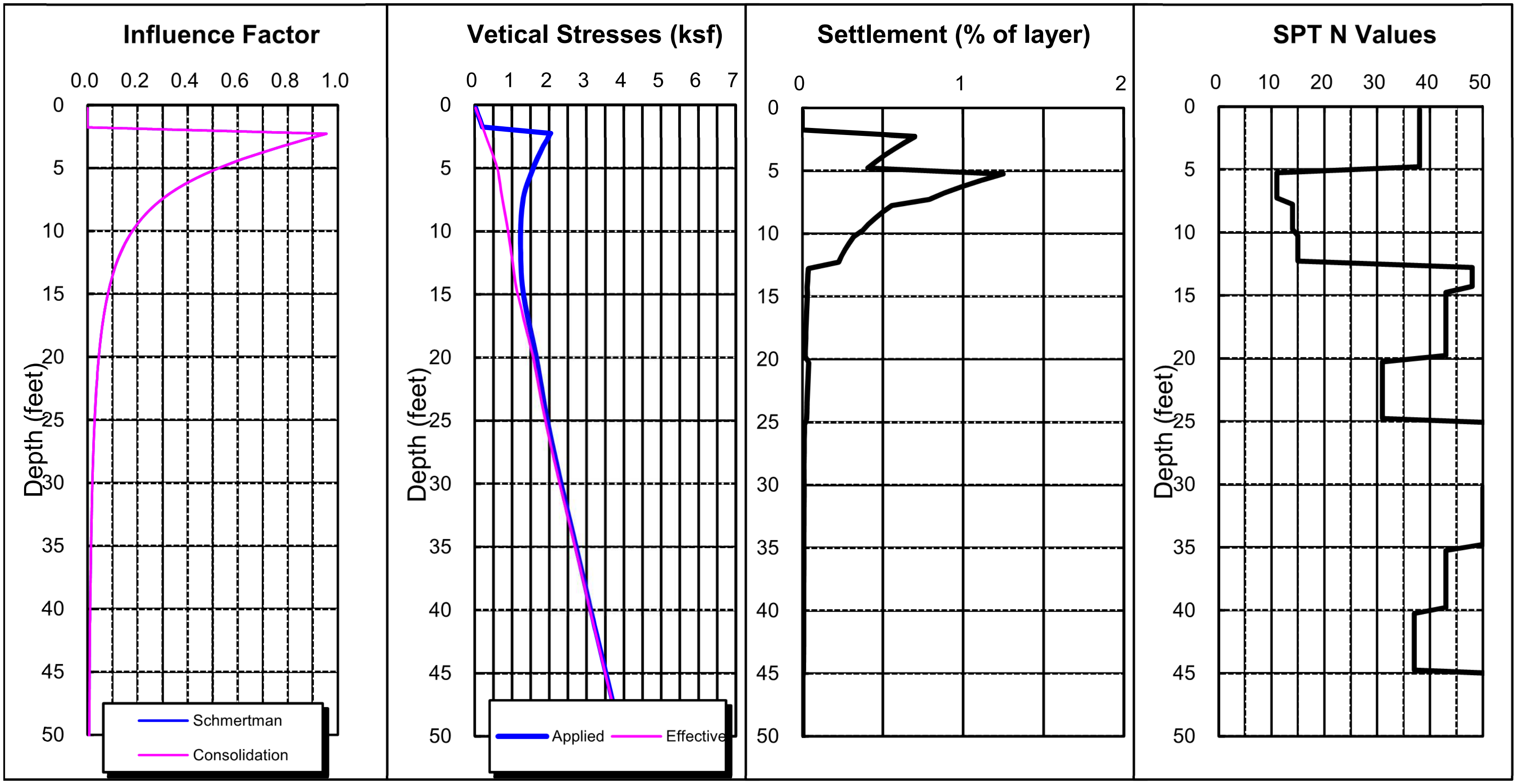
Load, Q: 4 kpf Embedment, feet: 1.5 **Boring: B-2**

EARTH SYSTEMS SOUTHWEST - SETTLEMENT ANALYSES

Bamiyan Marketplace

302169-002

Width, ft: 7.0 Length, ft: 7.0 Net pressure, ksf: 1.85 **Settlement, inches: 0.79**



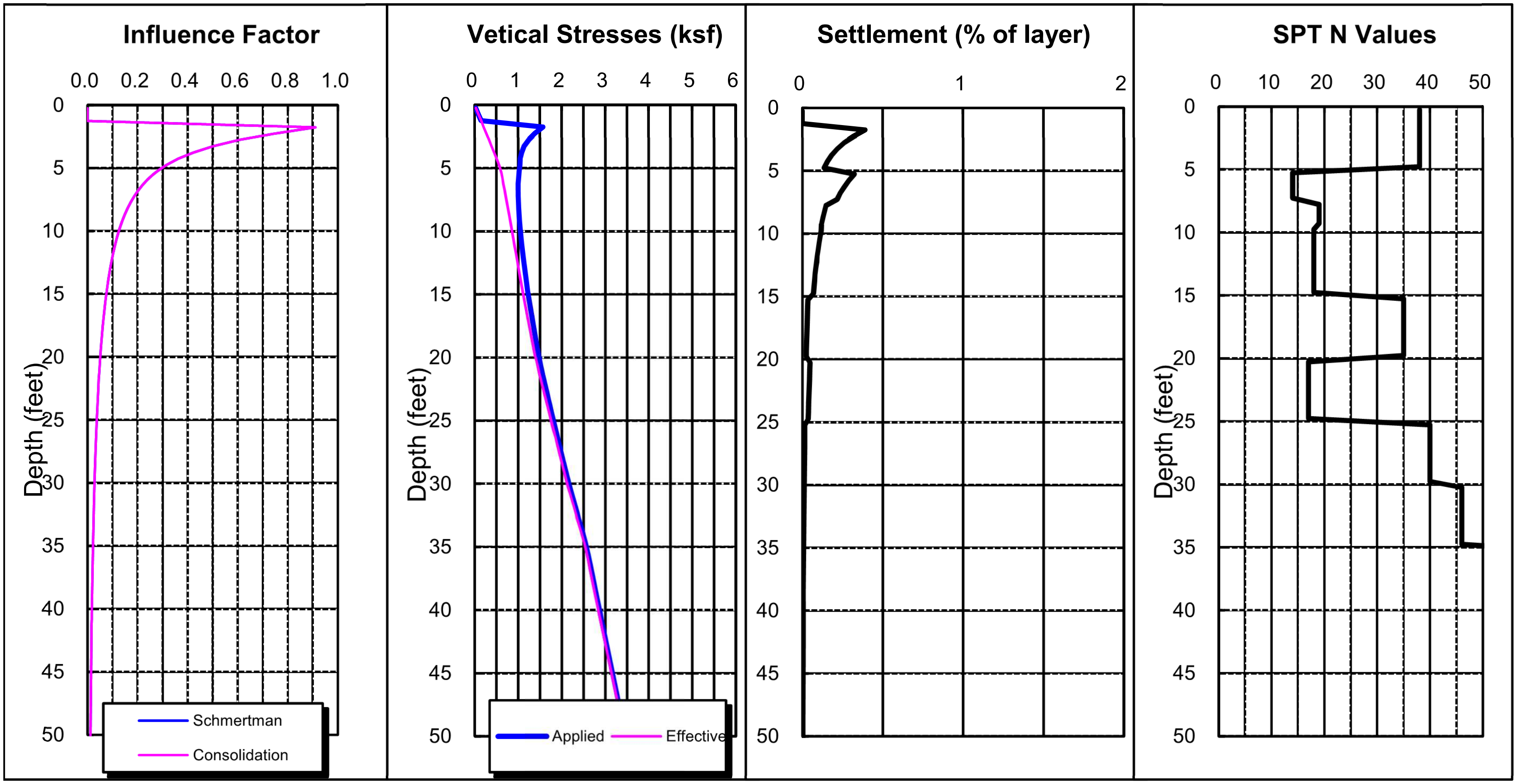
Load, Q: 91 kips Embedment, feet: 2.0 **Boring: B-2**

EARTH SYSTEMS SOUTHWEST - SETTLEMENT ANALYSES

Bamiyan Marketplace

302169-002

Width, ft: 2.5 Length, ft: 40.0 Net pressure, ksf: 1.50 **Settlement, inches: 0.34**



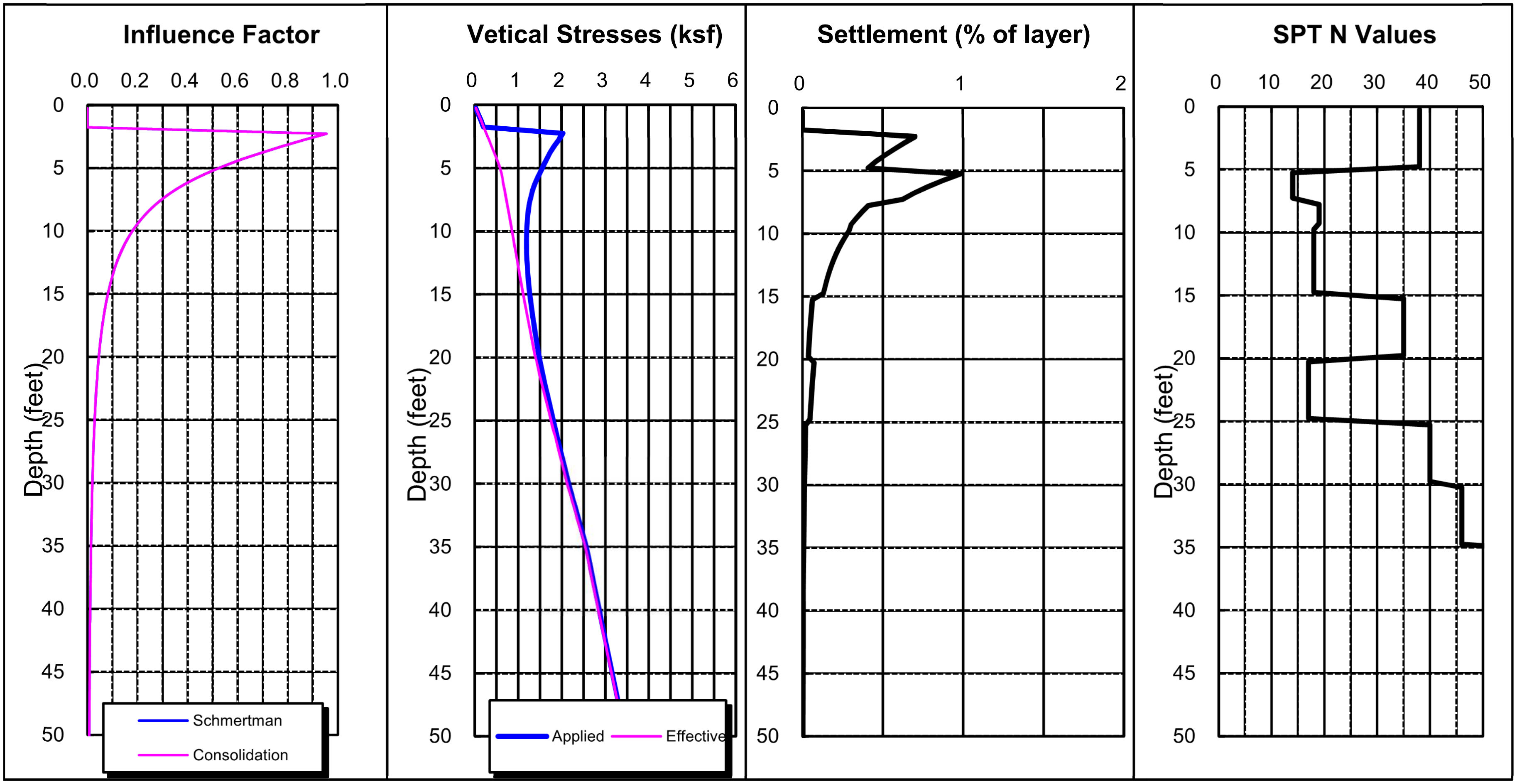
Load, Q: 4 kpf Embedment, feet: 1.5 **Boring: B-13**

EARTH SYSTEMS SOUTHWEST - SETTLEMENT ANALYSES

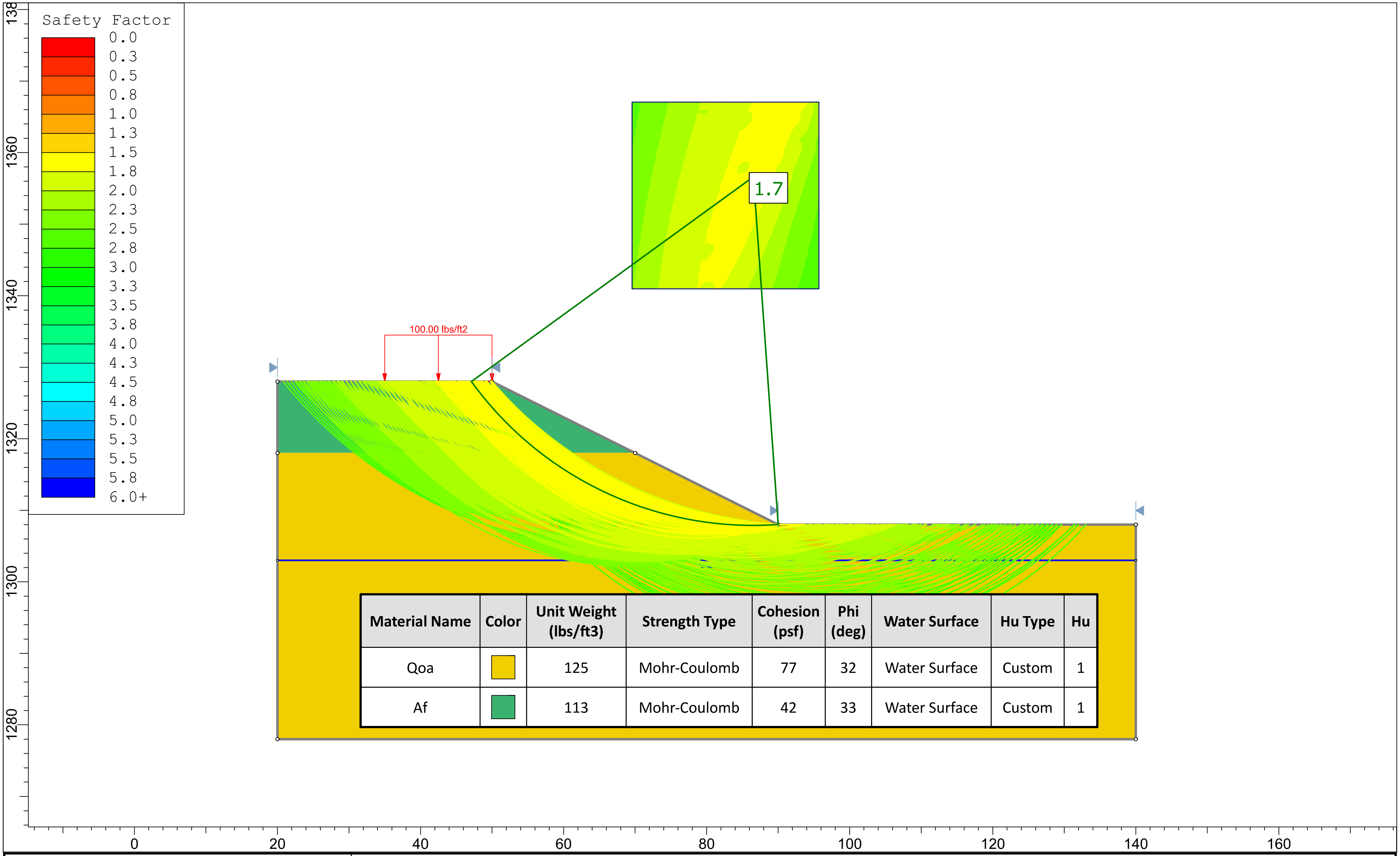
Bamiyan Marketplace

302169-002

Width, ft: 7.0 Length, ft: 7.0 Net pressure, ksf: 1.85 **Settlement, inches: 0.74**



Load, Q: 91 kips Embedment, feet: 2.0 **Boring: B-13**



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Qoa	🟨	125	Mohr-Coulomb	77	32	Water Surface	Custom	1
Af	🟩	113	Mohr-Coulomb	42	33	Water Surface	Custom	1

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SLIDEINTERPRET 8.020

Project
Bamiyan Marketplace

Analysis Description
Current Condition - Static

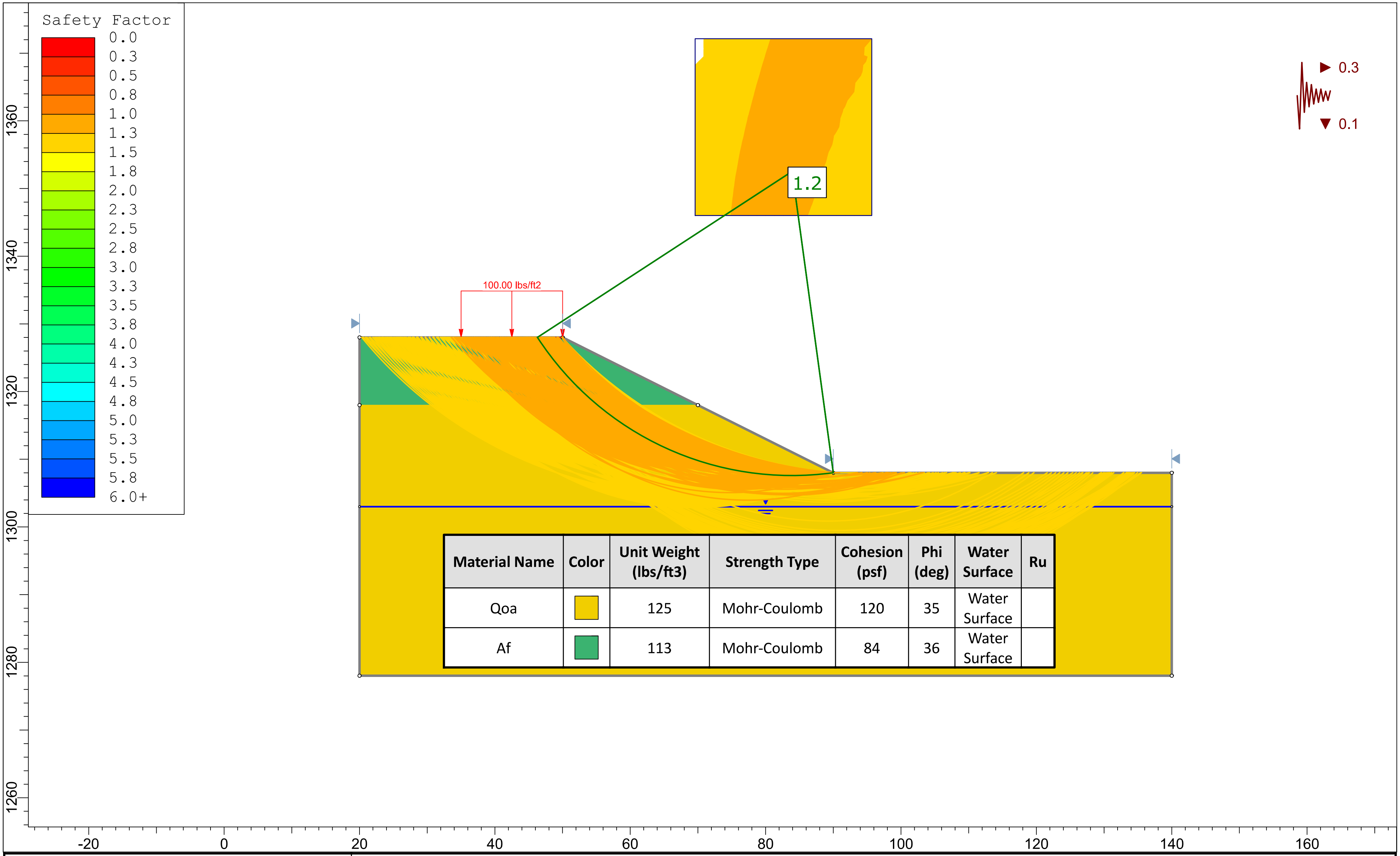
Drawn By

Scale 1:223

Company Earth Systems

Date 1/9/2019, 12:22:48 PM

File Name 302169-002_Bamiyan Marketplace.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Qoa	🟨	125	Mohr-Coulomb	120	35	Water Surface	
Af	🟩	113	Mohr-Coulomb	84	36	Water Surface	

rocscience

SLIDEINTERPRET 8.020

Project
Bamiyan Marketplace

Analysis Description
Current Condition - Seismic

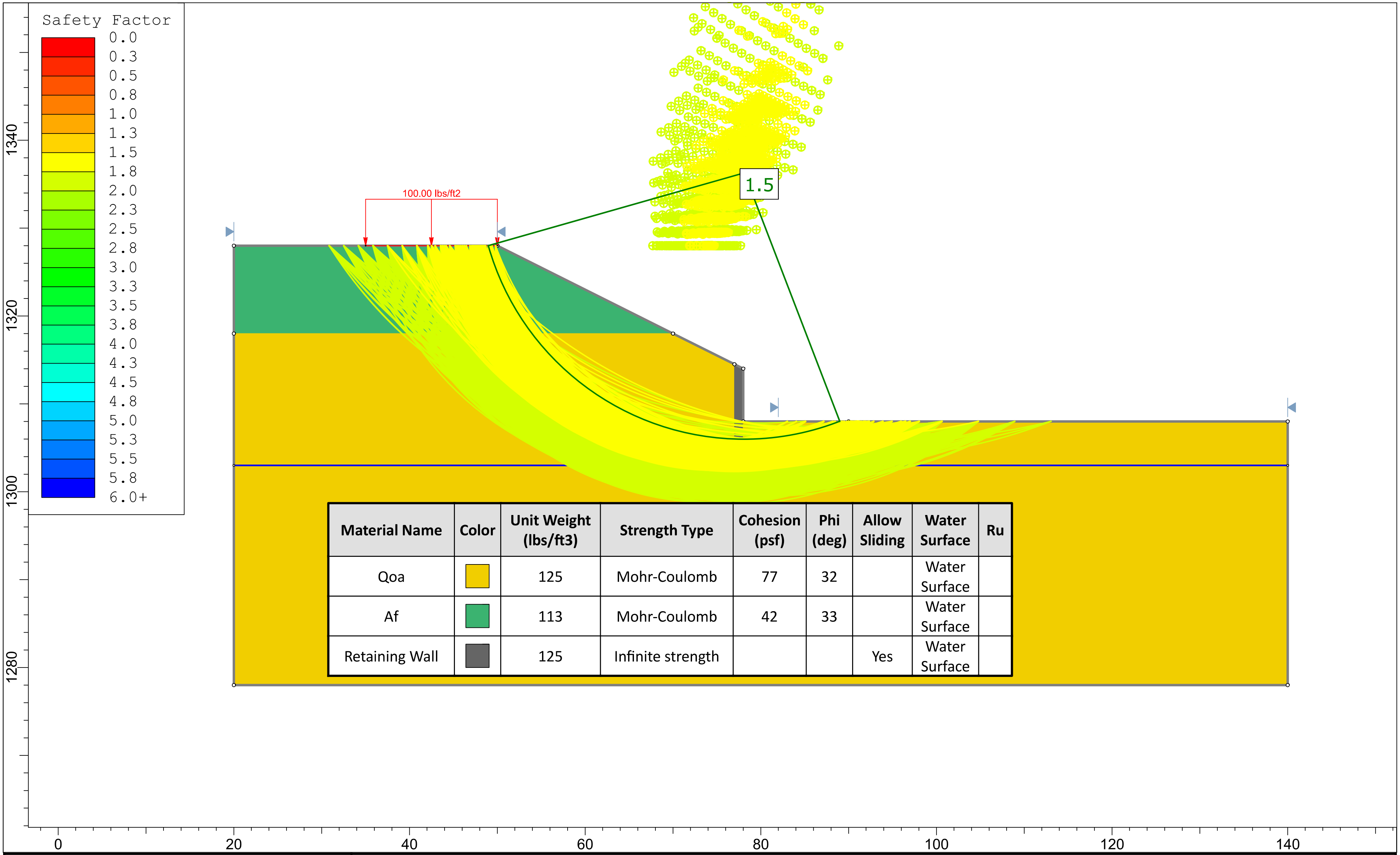
Drawn By

Scale
1:235

Company
Earth Systems

Date
1/9/2019, 12:22:48 PM

File Name
302169-002_Bamiyan Marketplace.slmd

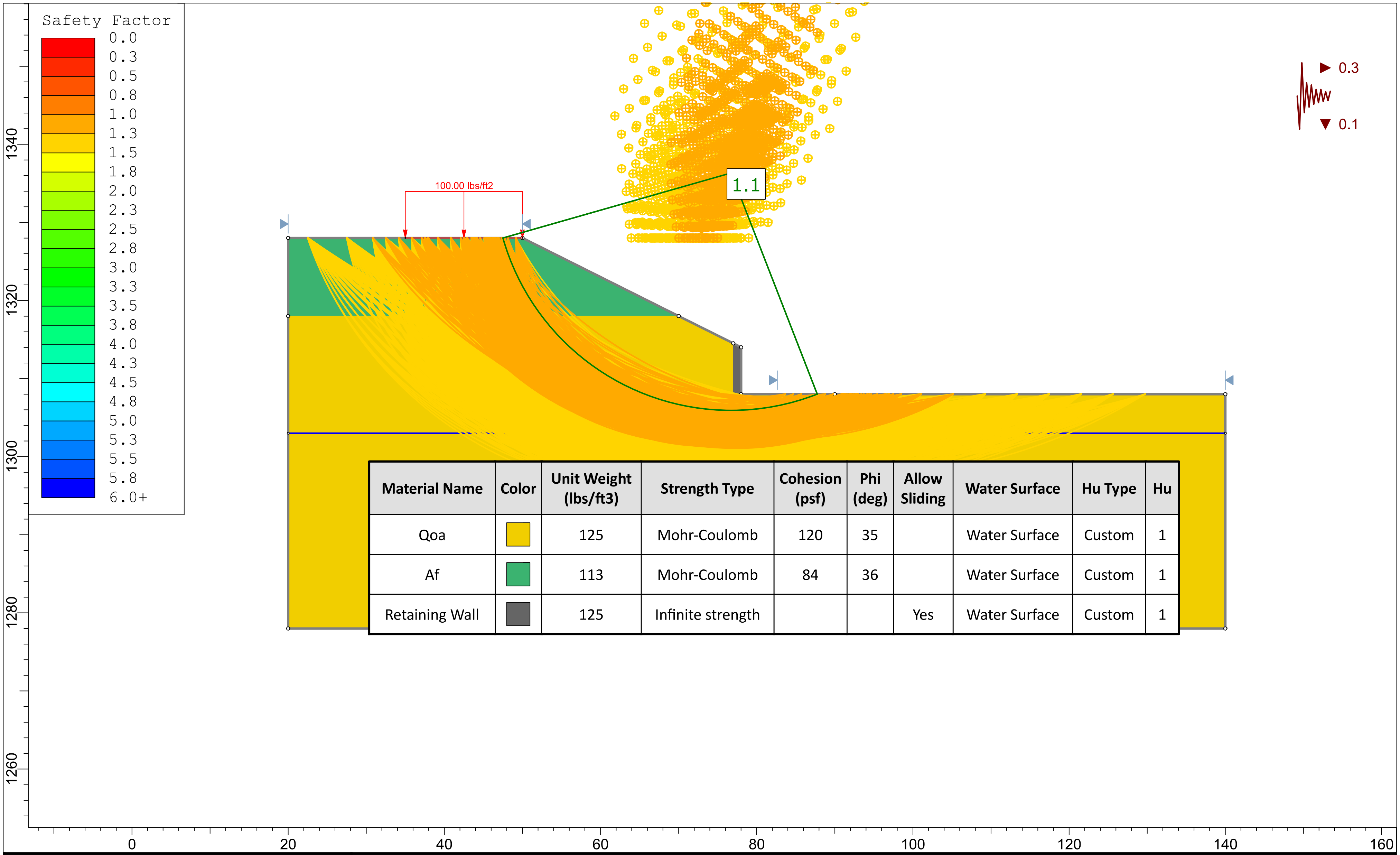


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	Water Surface	Ru
Qoa	🟨	125	Mohr-Coulomb	77	32		Water Surface	
Af	🟩	113	Mohr-Coulomb	42	33		Water Surface	
Retaining Wall	⬛	125	Infinite strength			Yes	Water Surface	

rocscience

SLIDEINTERPRET 8.020

Project	Bamiyan Marketplace
Analysis Description	Proposed Retaining Wall
Drawn By	
Scale	1:181
Company	Earth Systems
Date	1/9/2019, 12:22:48 PM
File Name	302169-002_Bamiyan Marketplace.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	Water Surface	Hu Type	Hu
Qoa	🟨	125	Mohr-Coulomb	120	35		Water Surface	Custom	1
Af	🟩	113	Mohr-Coulomb	84	36		Water Surface	Custom	1
Retaining Wall	⬛	125	Infinite strength			Yes	Water Surface	Custom	1

rocscience

SLIDEINTERPRET 8.020

Project Bamiyan Marketplace

Analysis Description Proposed Retaining Wall - Seismic

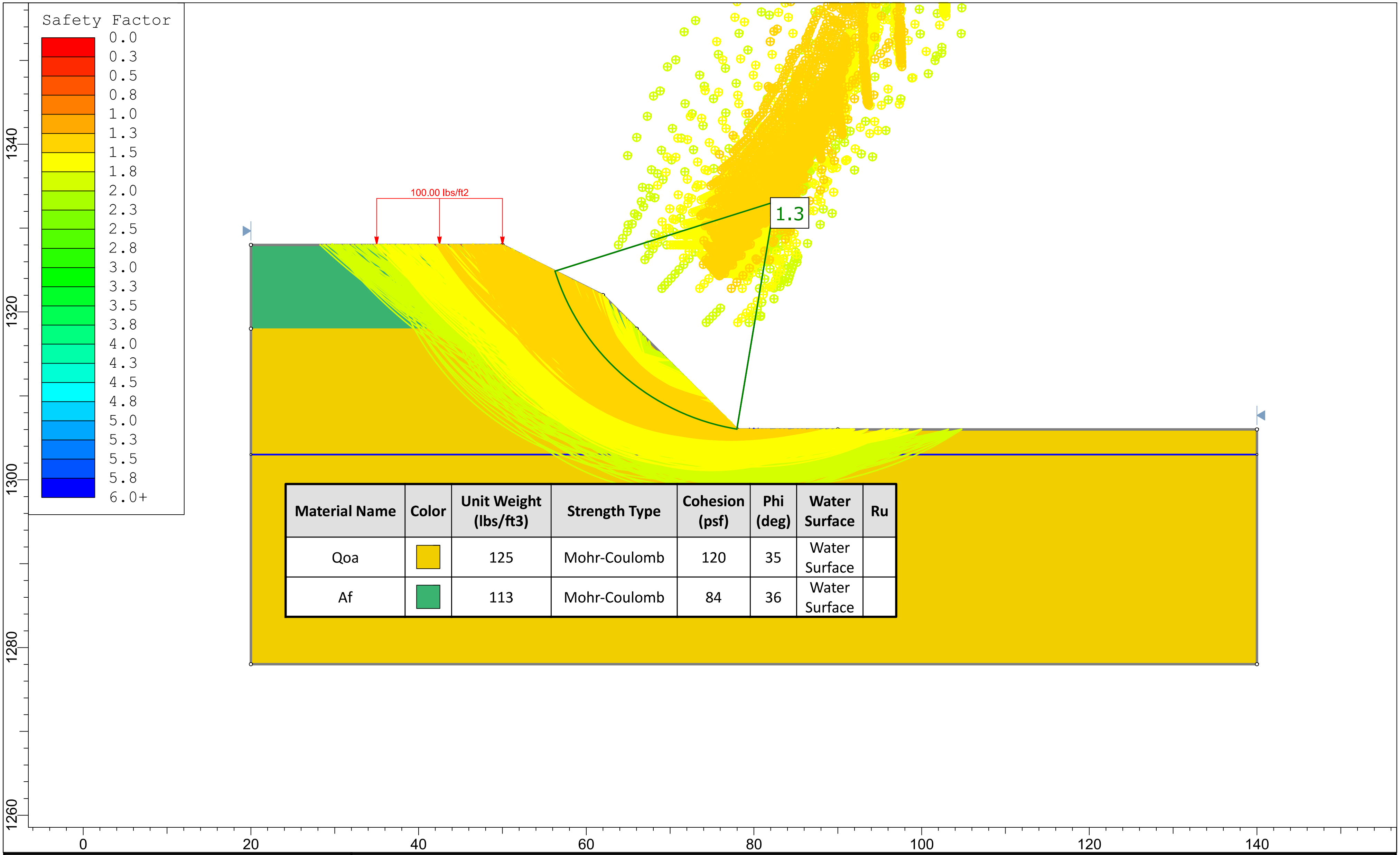
Drawn By

Scale 1:204

Company Earth Systems

Date 1/9/2019, 12:22:48 PM

File Name 302169-002_Bamiyan Marketplace.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Qoa	🟨	125	Mohr-Coulomb	120	35	Water Surface	
Af	🟩	113	Mohr-Coulomb	84	36	Water Surface	

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SLIDEINTERPRET 8.020

Project	Bamiyan Marketplace
Analysis Description	Temporary Construction
Drawn By	
Scale	1:190
Company	Earth Systems
Date	1/9/2019, 12:22:48 PM
File Name	302169-002_Bamiyan Marketplace.slmd

APPENDIX B

Laboratory Test Results

File No.: 302169-002 January 17, 2019

Lab No.: 18-178

UNIT DENSITIES AND MOISTURE CONTENT ASTM D2937 & D2216

Job Name: Bamiyan Marketplace

Sample Location	Depth (feet)	Unit Dry Density (pcf)	Moisture Content (%)	USCS Group Symbol
B1	2.5	111	5	SM
B1	5	112	6	SM
B1	7.5	111	4	SM
B1	10	112	4	SM
B1	12.5	110	7	SM
B1	15	114	7	SM
B1	20	131	4	SP
B2	2.5	115	5	SM
B2	5	112	5	SM
B2	7.5	116	5	SM
B2	10	108	4	SM
B2	12.5	101	5	SP
B2	15	--	3	SP
B2	20	119	6	SM
B2	25	123	14	SM
B2	30	141	4	SM
B2	35	130	9	SM
B2	40	132	9	SM
B2	45	129	11	SM
B3	5	115	4	SM
B3	7.5	114	7	SM
B3	10	128	5	SM

File No.: 302169-002 January 17, 2019

Lab No.: 18-178

UNIT DENSITIES AND MOISTURE CONTENT ASTM D2937 & D2216

Job Name: Bamiyan Marketplace

Sample Location	Depth (feet)	Unit Dry Density (pcf)	Moisture Content (%)	USCS Group Symbol
B4	2.5	123	2	SM
B4	15	128	6	SP-SM
B4	20	127	10	SM
B5	2.5	114	5	SM
B5	5	104	11	SM
B5	7.5	116	8	SM
B5	10	106	7	SM
B5	12.5	112	5	SM
B5	15	134	6	SM
B5	20	127	10	SM
B5	25	125	10	SM
B5	30	130	9	SP
B6	2.5	117	7	SM
B6	5	113	10	SM
B6	7.5	132	10	SM
B6	10	124	8	SP-SM
B7	5	108	7	SM
B7	7.5	105	6	SP-SM
B7	10	116	18	CL
B7	12.5	121	13	SC
B7	15	122	13	SC
B7	20	128	11	SM
B7	25	119	15	SM
B7	30	128	9	SP

UNIT DENSITIES AND MOISTURE CONTENT

ASTM D2937 & D2216

Job Name: Bamiyan Marketplace

Sample Location	Depth (feet)	Unit Dry Density (pcf)	Moisture Content (%)	USCS Group Symbol
B8	2.5	124	4	SM
B8	5	116	5	SM
B8	7.5	114	9	SM
B8	10	126	12	SM
B9	2.5	121	10	SM
B9	5	127	9	SM
B9	7.5	114	12	SM
B9	10	119	14	SC
B9	15	122	13	SM
B9	20	122	12	SM
B9	25	117	12	SM
B10	2.5	120	7	SM
B10	5	124	9	SM
B10	7.5	113	16	SM
B10	10	120	14	SM
B11	5	121	8	SM
B11	7.5	127	9	SM
B11	10	129	10	SM
B11	15	128	10	SM
B11	20	129	10	SM
B11	25	124	12	SP
B11	30	118	14	SM

File No.: 302169-002 January 17, 2019

Lab No.: 18-178

UNIT DENSITIES AND MOISTURE CONTENT ASTM D2937 & D2216

Job Name: Bamiyan Marketplace

Sample Location	Depth (feet)	Unit Dry Density (pcf)	Moisture Content (%)	USCS Group Symbol
B12	2.5	117	7	SM
B12	5	110	6	SM
B12	10	119	13	SM
B12	15	115	10	SM
B12	20	118	14	SM
B13	2.5	114	3	SM
B13	5	107	4	SM
B13	7.5	109	6	SM
B13	10	104	9	SM
B13	15	112	6	SM
B13	20	116	15	SM
B13	25	120	13	SM
B13	30	130	12	SM
B13	35	111	11	SM
B14	2.5	120	5	SM
B14	5	113	5	SM
B14	7.5	111	4	SM
B14	10	106	4	SM
B14	15	111	8	SM
B14	20	108	6	SM
B14	25	109	10	SM
B14	30	129	12	SM

File No.: 302169-002 January 17, 2019
Lab No.: 18-178

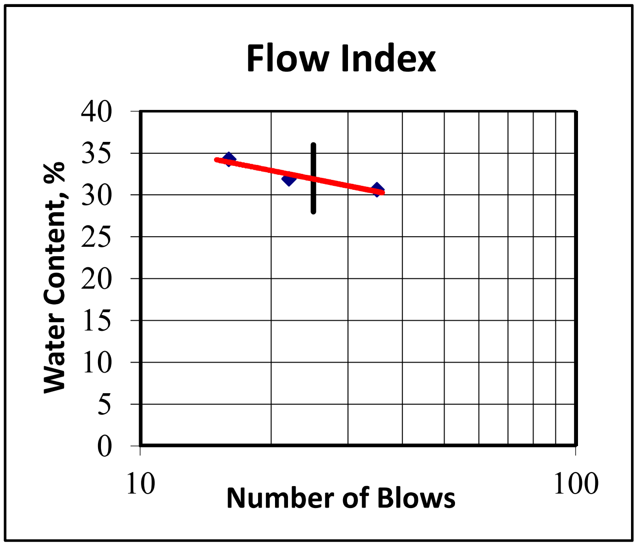
PLASTICITY INDEX

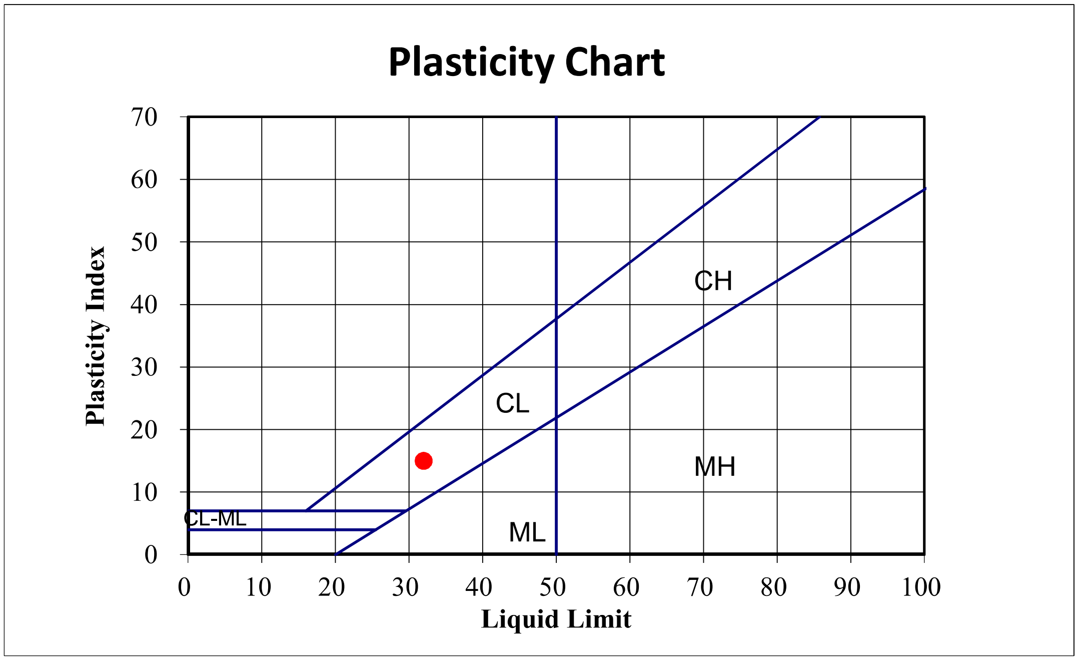
ASTM D 4318

Job Name: Bamiyan Marketplace
Sample ID: B7 @ 10 feet
Soil Description: Silty Sandy Clay (CL)

DATA SUMMARY			
Number of Blows:	16	22	35
Water Content, %	34.2	31.9	30.6

TEST RESULTS	
LIQUID LIMIT	**32**
PLASTIC LIMIT	**17**
PLASTICITY INDEX	**15**



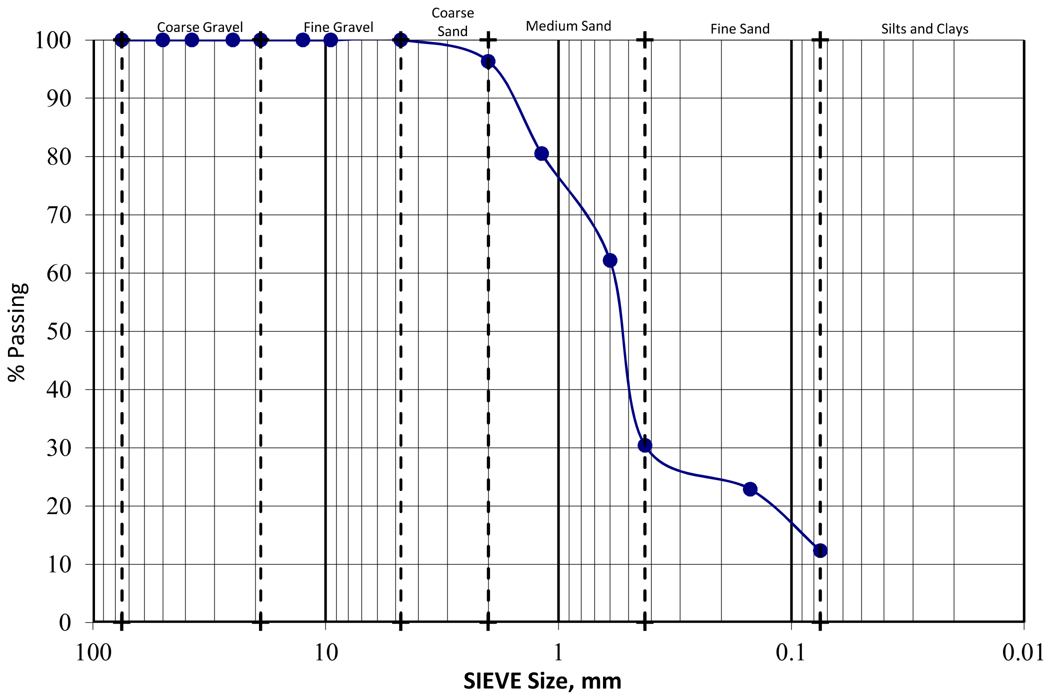


File No.: 302169-002 1/17/2019
Lab No.: 18-178

SIEVE ANALYSIS ASTM D6913

Job Name: Bamiyan Marketplace
Sample ID: B1 @ 7 1/2 feet
Description: Silty Sand (SM)

Sieve Size	% Passing	
3"	100	-
2"	100	-
1-1/2"	100	-
1"	100	-
3/4"	100	-
1/2"	100	-
3/8"	100	-
#4	100	-
#10	96	-
#16	81	-
#30	62	-
#40	30	-
#100	23	-
#200	12.3	-



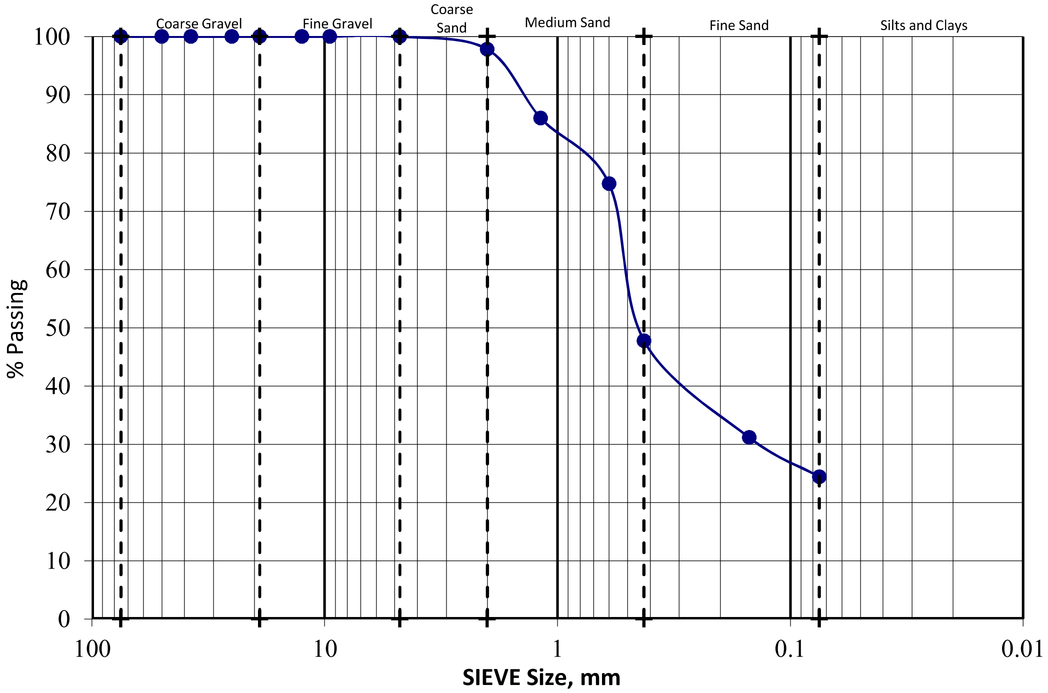
% Coarse Gravel:	0	% Coarse Sand:	4			
% Fine Gravel:	0	% Medium Sand:	66	Cu:	NA	
		% Fine Sand:	18	Cc:	NA	Gradation
% Total Gravel	0	% Total Sand	88	% Fines:	12.3	NA

File No.: 302169-002 1/17/2019
Lab No.: 18-178

SIEVE ANALYSIS ASTM D6913

Job Name: Bamiyan Marketplace
Sample ID: B2 @5 feet
Description: Silty Sand (SM)

Sieve Size	% Passing	
3"	100	-
2"	100	-
1-1/2"	100	-
1"	100	-
3/4"	100	-
1/2"	100	-
3/8"	100	-
#4	100	-
#10	98	-
#16	86	-
#30	75	-
#40	48	-
#100	31	-
#200	24.4	-



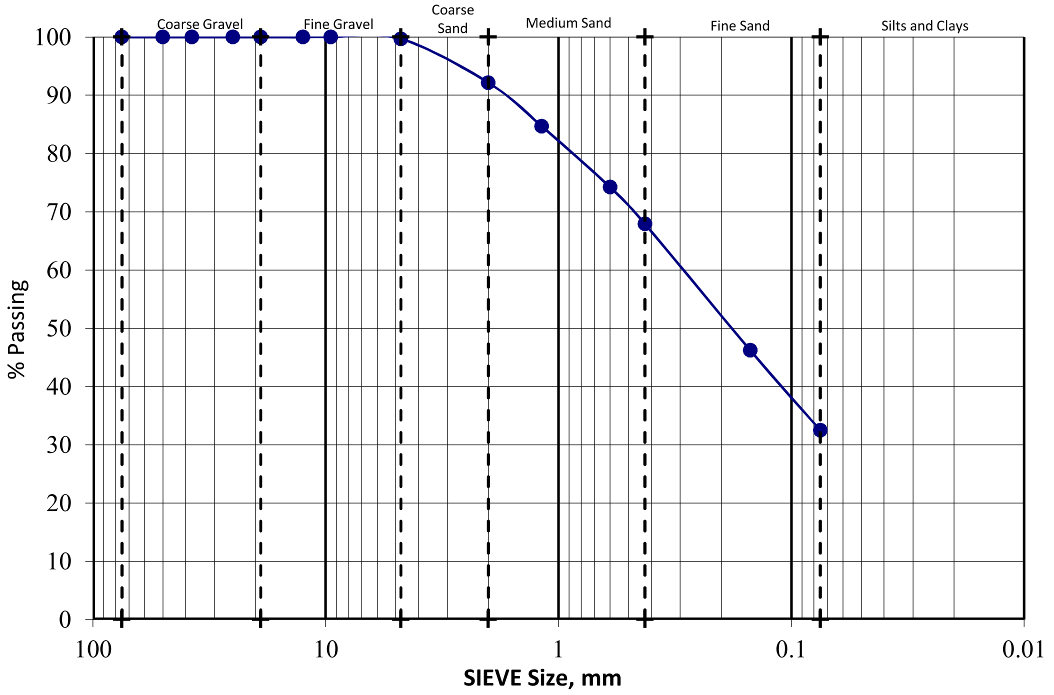
% Coarse Gravel:	0	% Coarse Sand:	2			
% Fine Gravel:	0	% Medium Sand:	50	Cu:	NA	
		% Fine Sand:	23	Cc:	NA	Gradation
% Total Gravel	0	% Total Sand	76	% Fines:	24.4	NA

File No.: 302169-002 1/17/2019
Lab No.: 18-178

SIEVE ANALYSIS ASTM D6913

Job Name: Bamiyan Marketplace
Sample ID: B2 @ 10 feet
Description: Silty Sand (SM)

Sieve Size	% Passing	
3"	100	-
2"	100	-
1-1/2"	100	-
1"	100	-
3/4"	100	-
1/2"	100	-
3/8"	100	-
#4	100	-
#10	92	-
#16	85	-
#30	74	-
#40	68	-
#100	46	-
#200	32.5	-



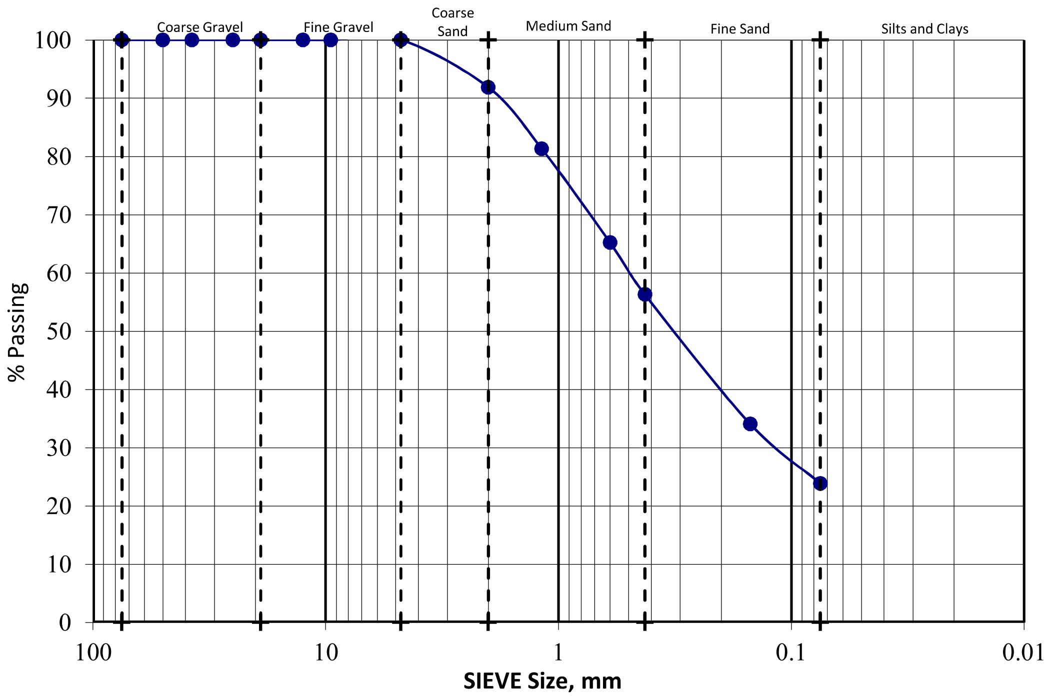
% Coarse Gravel:	0	% Coarse Sand:	8			
% Fine Gravel:	0	% Medium Sand:	24	Cu:	NA	
		% Fine Sand:	35	Cc:	NA	Gradation
% Total Gravel	0	% Total Sand	67	% Fines:	32.5	NA

File No.: 302169-002 1/17/2019
Lab No.: 18-178

SIEVE ANALYSIS ASTM D6913

Job Name: Bamiyan Marketplace
Sample ID: B13 @ 5 feet
Description: Silty Sand (SM)

Sieve Size	% Passing	
3"	100	-
2"	100	-
1-1/2"	100	-
1"	100	-
3/4"	100	-
1/2"	100	-
3/8"	100	-
#4	100	-
#10	92	-
#16	81	-
#30	65	-
#40	56	-
#100	34	-
#200	23.9	-



% Coarse Gravel:	0	% Coarse Sand:	8			
% Fine Gravel:	0	% Medium Sand:	36	Cu:	NA	
		% Fine Sand:	32	Cc:	NA	Gradation
% Total Gravel	0	% Total Sand	76	% Fines:	23.9	NA

File No.: 302169-002 1/17/2019

Lab No.: 18-178

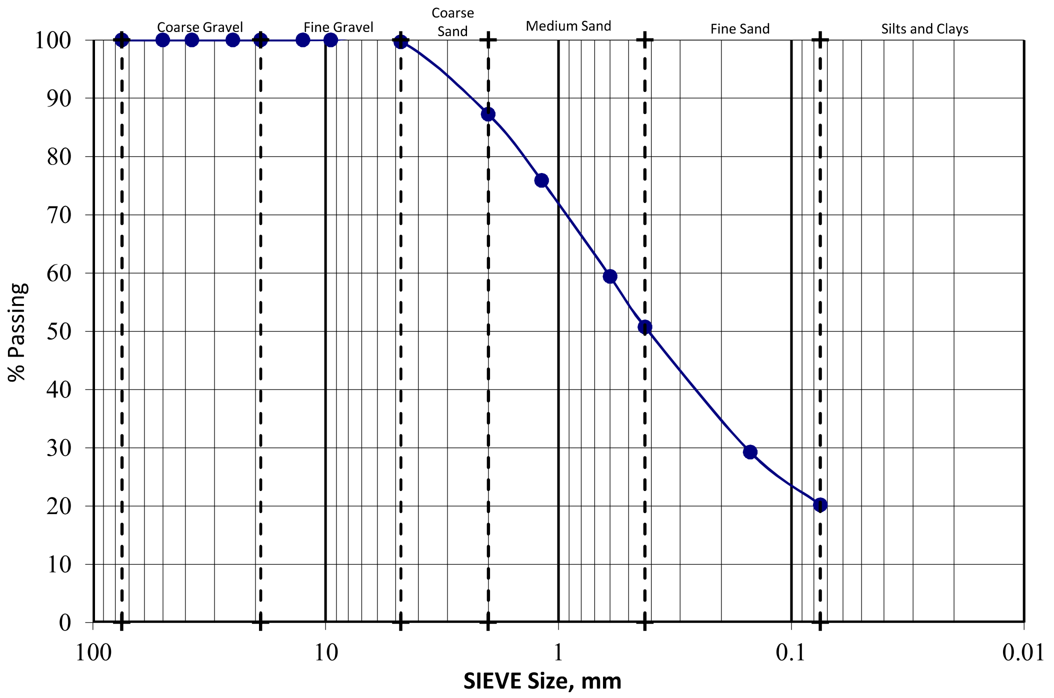
SIEVE ANALYSIS ASTM D6913

Job Name: Bamiyan Marketplace

Sample ID: B13 @ 15 feet

Description: Silty Sand (SM)

Sieve Size	% Passing	
3"	100	-
2"	100	-
1-1/2"	100	-
1"	100	-
3/4"	100	-
1/2"	100	-
3/8"	100	-
#4	100	-
#10	87	-
#16	76	-
#30	59	-
#40	51	-
#100	29	-
#200	20.2	-



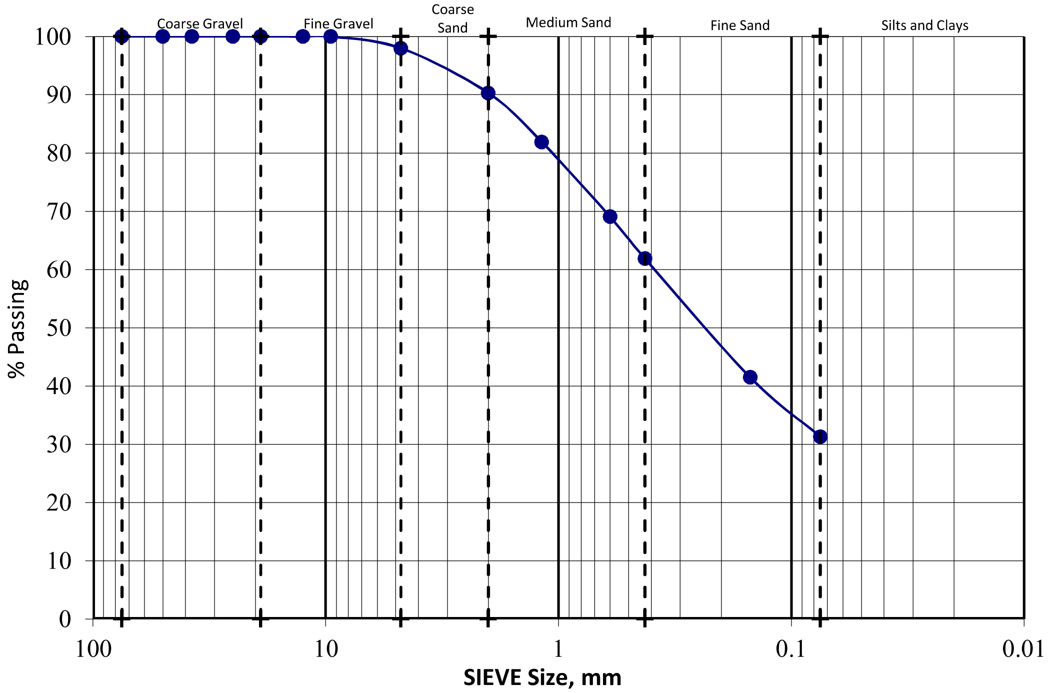
% Coarse Gravel:	0	% Coarse Sand:	12			
% Fine Gravel:	0	% Medium Sand:	36	Cu:	NA	
		% Fine Sand:	31	Cc:	NA	Gradation
% Total Gravel	0	% Total Sand	79	% Fines:	20.2	NA

File No.: 302169-002 1/17/2019
Lab No.: 18-178

SIEVE ANALYSIS ASTM D6913

Job Name: Bamiyan Marketplace
Sample ID: P2 @ 4.5-5.0 feet
Description: Silty Sand (SM)

Sieve Size	% Passing	
3"	100	-
2"	100	-
1-1/2"	100	-
1"	100	-
3/4"	100	-
1/2"	100	-
3/8"	100	-
#4	98	-
#10	90	-
#16	82	-
#30	69	-
#40	62	-
#100	41	-
#200	31.3	-



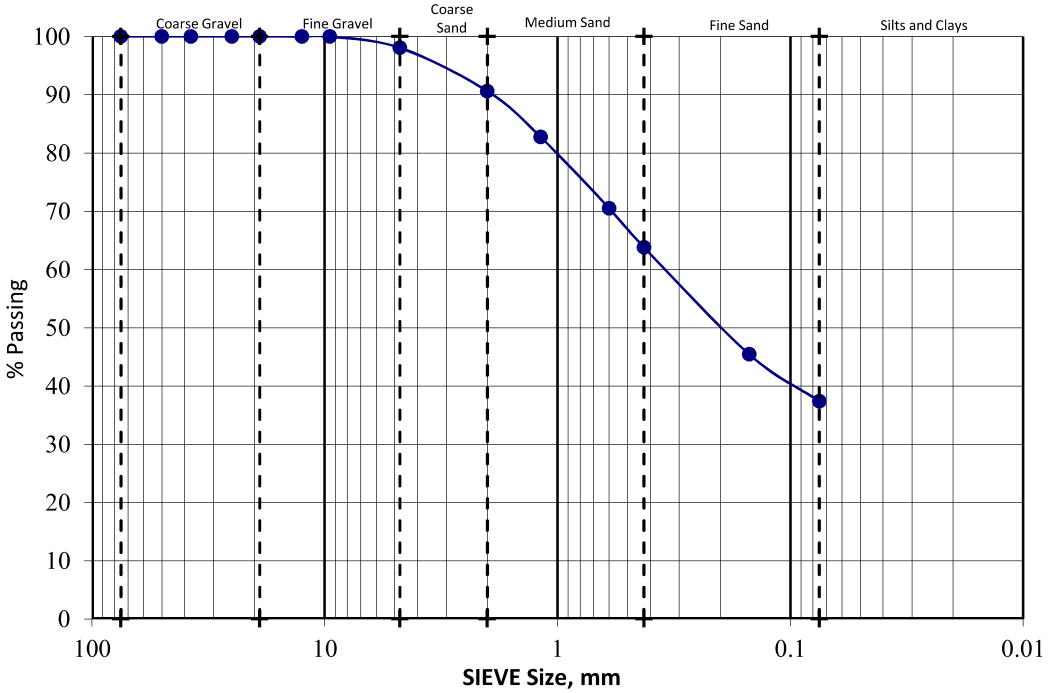
% Coarse Gravel:	0	% Coarse Sand:	8			
% Fine Gravel:	2	% Medium Sand:	28	Cu:	NA	
		% Fine Sand:	31	Cc:	NA	Gradation
% Total Gravel	2	% Total Sand	67	% Fines:	31.3	NA

File No.: 302169-002 1/17/2019
Lab No.: 18-178

SIEVE ANALYSIS ASTM D6913

Job Name: Bamiyan Marketplace
Sample ID: P4 @ 4.5-5.0 feet
Description: Silty Sand (SM)

Sieve Size	% Passing	
3"	100	-
2"	100	-
1-1/2"	100	-
1"	100	-
3/4"	100	-
1/2"	100	-
3/8"	100	-
#4	98	-
#10	91	-
#16	83	-
#30	71	-
#40	64	-
#100	45	-
#200	37.4	-



% Coarse Gravel:	0	% Coarse Sand:	7				
% Fine Gravel:	2	% Medium Sand:	27	Cu:	NA		
		% Fine Sand:	26	Cc:	NA	Gradation	
% Total Gravel	2	% Total Sand	61	% Fines:	37.4	NA	

File No.: 302169-002
Job Name: Bamiyan Marketplace
Lab Number: 18-178

January 17, 2019

AMOUNT PASSING NO. 200 SIEVE

ASTM D 1140

Sample Location	Depth (feet)	Fines Content (%)	USCS Group Symbol
B5	5	39.7	SM
B9	10	42.9	SC
B12	20	39.8	SM

File No.: 302169-002
Lab No.: 18-178

January 17, 2019

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Bamiyan Marketplace
B2 @ 5 feet

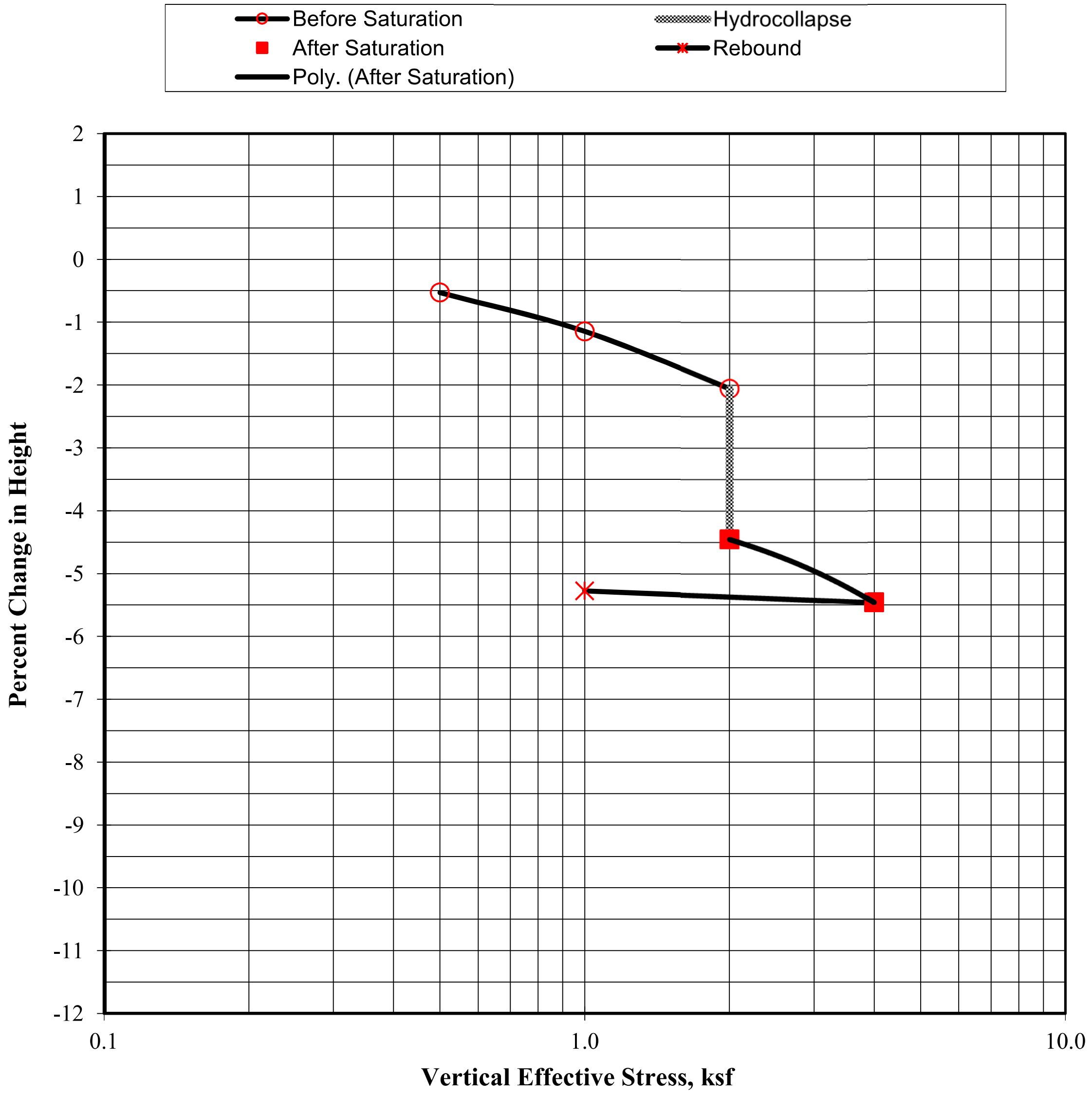
Silty Sand (SM)

Ring Sample

Initial Dry Density: 106.7 pcf
Initial Moisture: 5.3%
Specific Gravity: 2.67
Initial Void Ratio: 0.563

Hydrocollapse: 2.4% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 302169-002
Lab No.: 18-178

January 17, 2019

CONSOLIDATION TEST

ASTM D 2435 & D 5333

Bamiyan Marketplace
B2 @ 10 feet

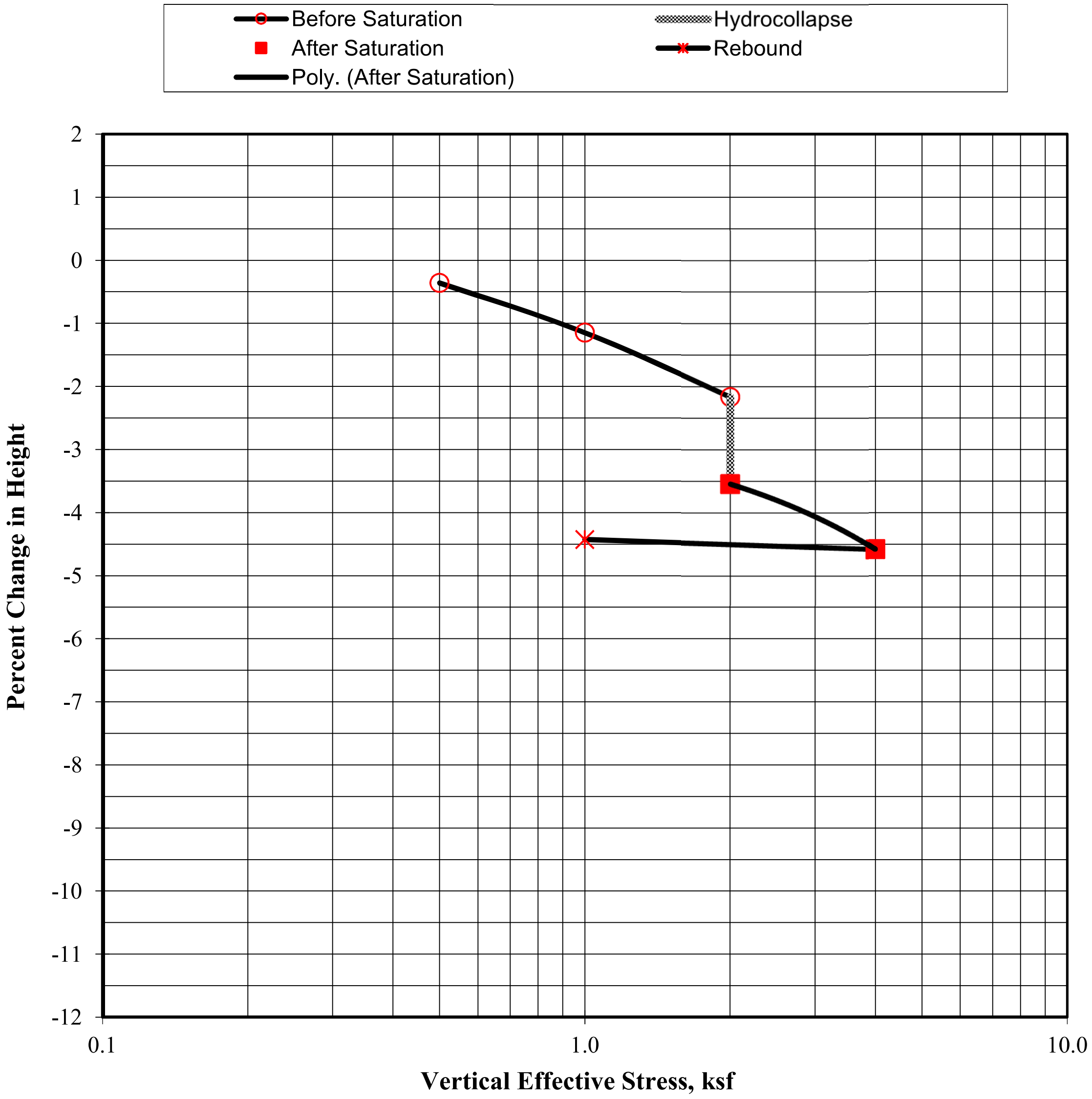
Silty Sand (SM)

Ring Sample

Initial Dry Density: 101.6 pcf
Initial Moisture: 5.1%
Specific Gravity: 2.67
Initial Void Ratio: 0.640

Hydrocollapse: 1.4% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 302169-002
Lab No.: 18-178

January 17, 2019

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Bamiyan Marketplace
B2 @ 15 feet

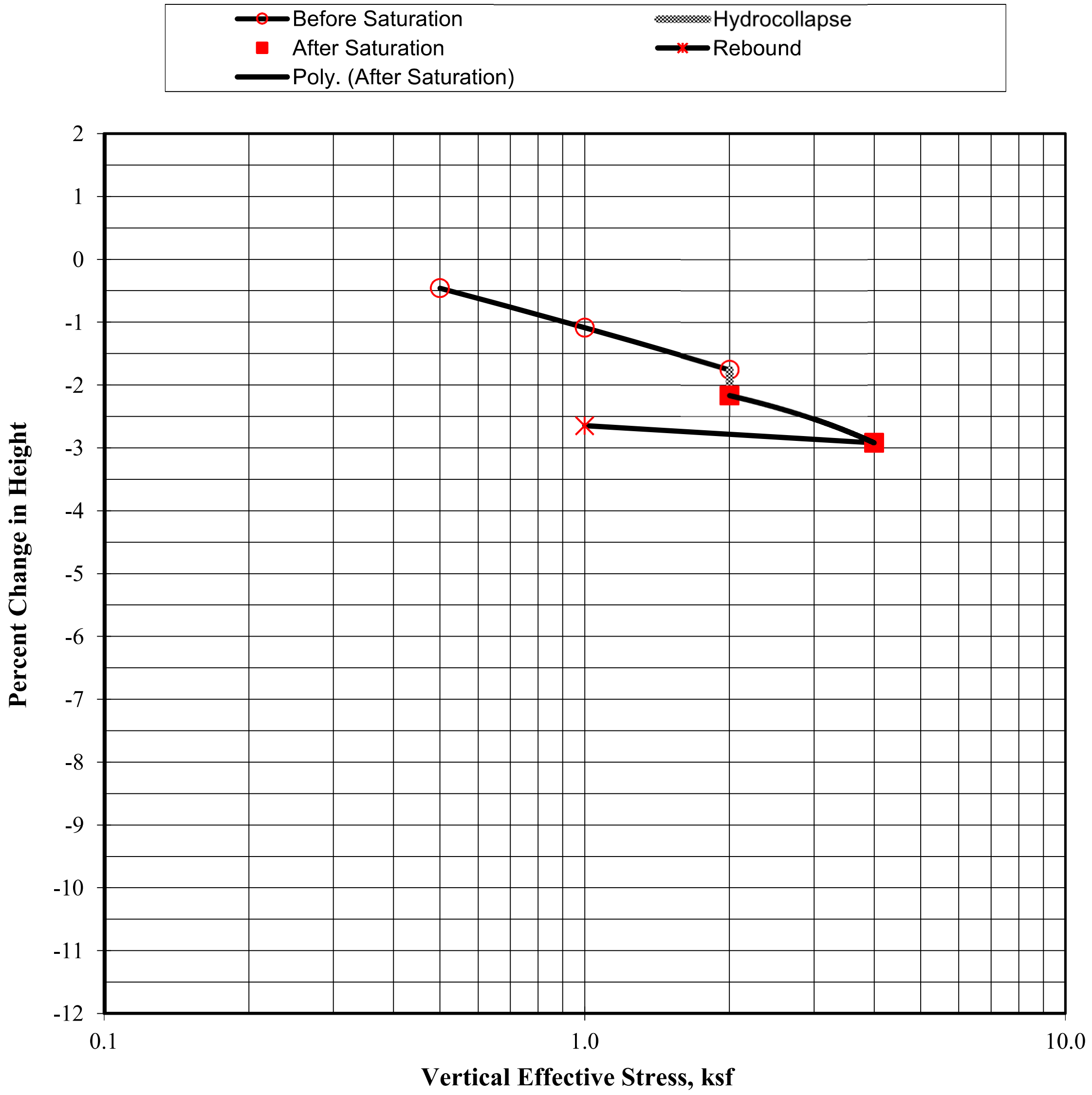
Silty Sand w/Trace Clay (SM)

Ring Sample

Initial Dry Density: 124.9 pcf
Initial Moisture: 3.1%
Specific Gravity: 2.67
Initial Void Ratio: 0.151

Hydrocollapse: 0.4% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 302169-002 January 17, 2019
Lab No.: 18-178

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Bamiyan Marketplace
B7 @ 10 feet

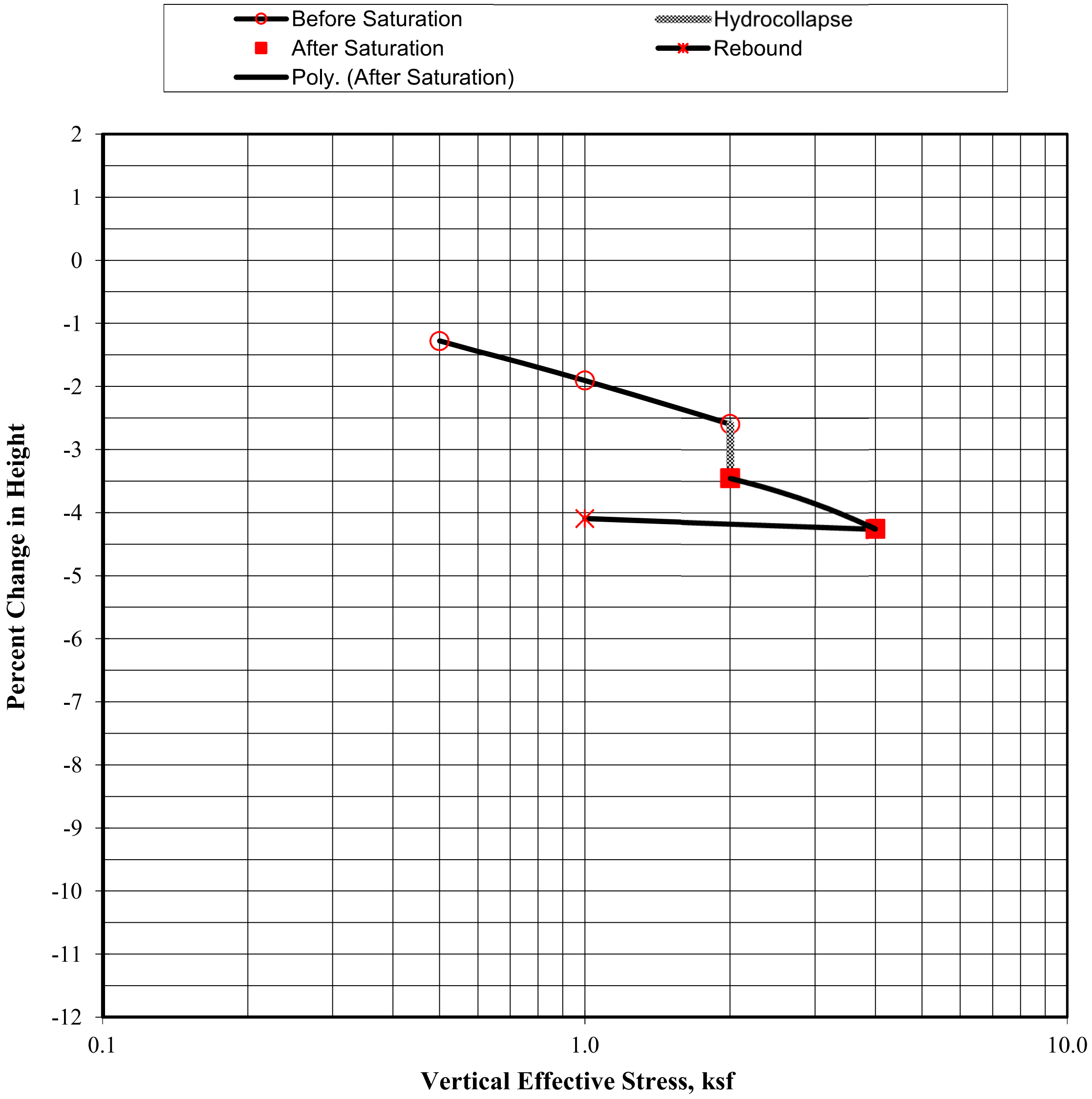
Silty Sandy Clay (CL)

Ring Sample

Initial Dry Density: 119.0 pcf
Initial Moisture: 9.0%
Specific Gravity: 2.67
Initial Void Ratio: 0.401

Hydrocollapse: 0.9% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 302169-002
Lab No.: 18-178

January 17, 2019

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Bamiyan Marketplace
B13 @ 5 feet

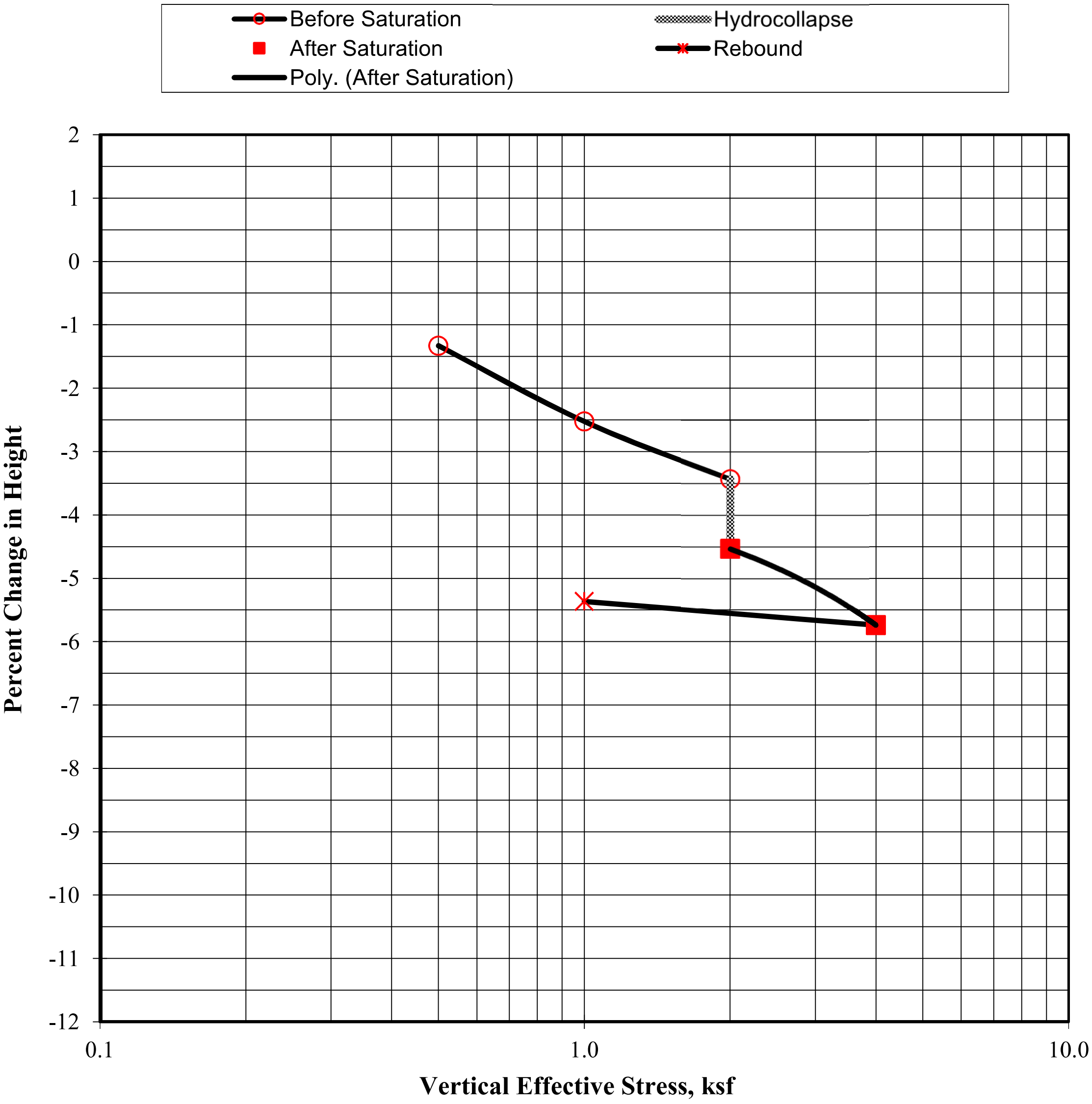
Silty Sand (SM)

Ring Sample

Initial Dry Density: 119.2 pcf
Initial Moisture: 12.6%
Specific Gravity: 2.67
Initial Void Ratio: 0.399

Hydrocollapse: 1.1% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 302169-002
Lab No.: 18-178

January 17, 2019

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Bamiyan Marketplace
B13 @ 10 feet

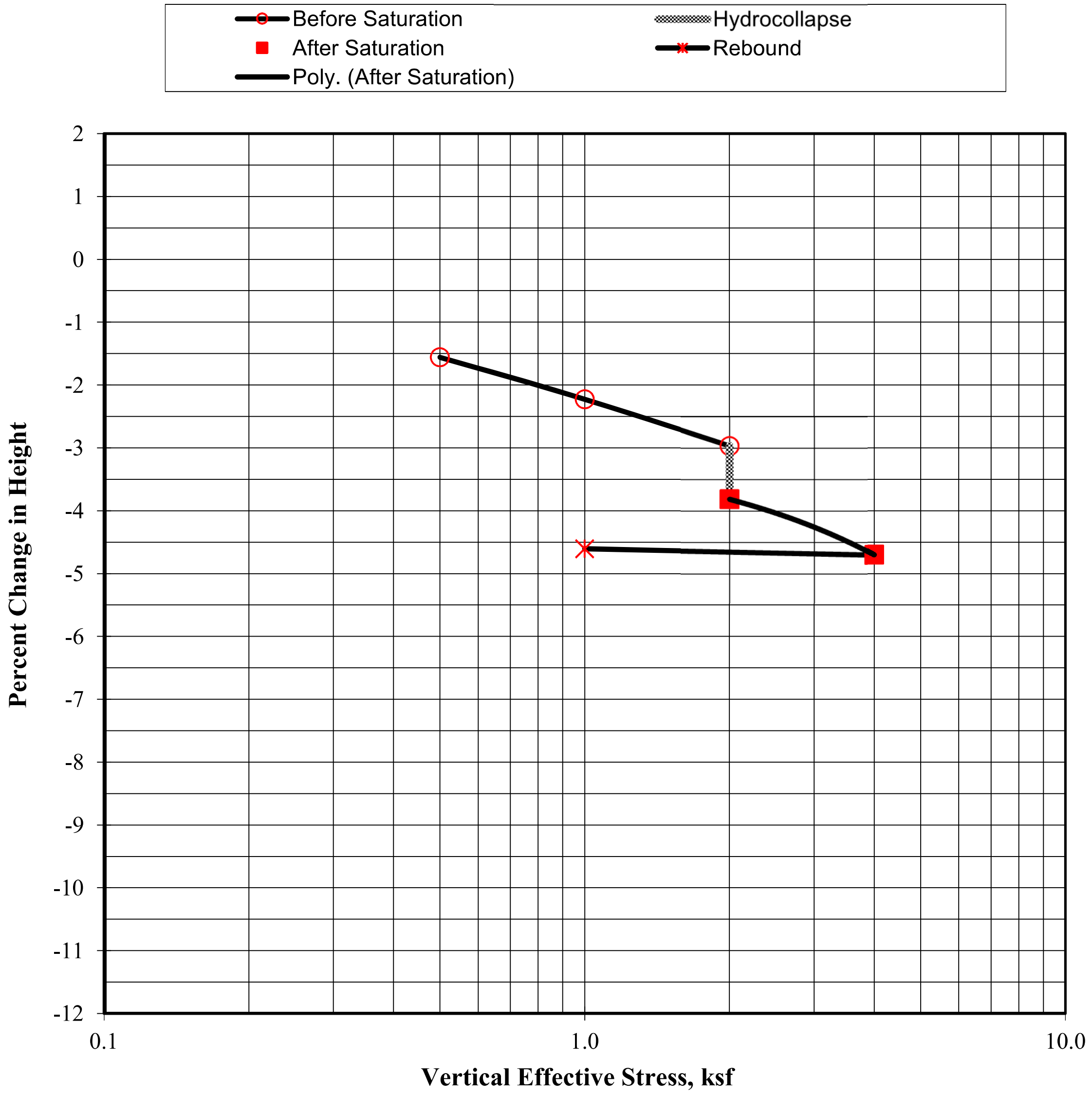
Silty Sand w/Gravel (SM)

Ring Sample

Initial Dry Density:	119.1 pcf
Initial Moisture:	9.7%
Specific Gravity:	2.67
Initial Void Ratio:	0.400

Hydrocollapse: 0.9% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 302169-002
Lab No.: 18-178

January 17, 2019

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Bamiyan Marketplace
B13 @ 15 feet

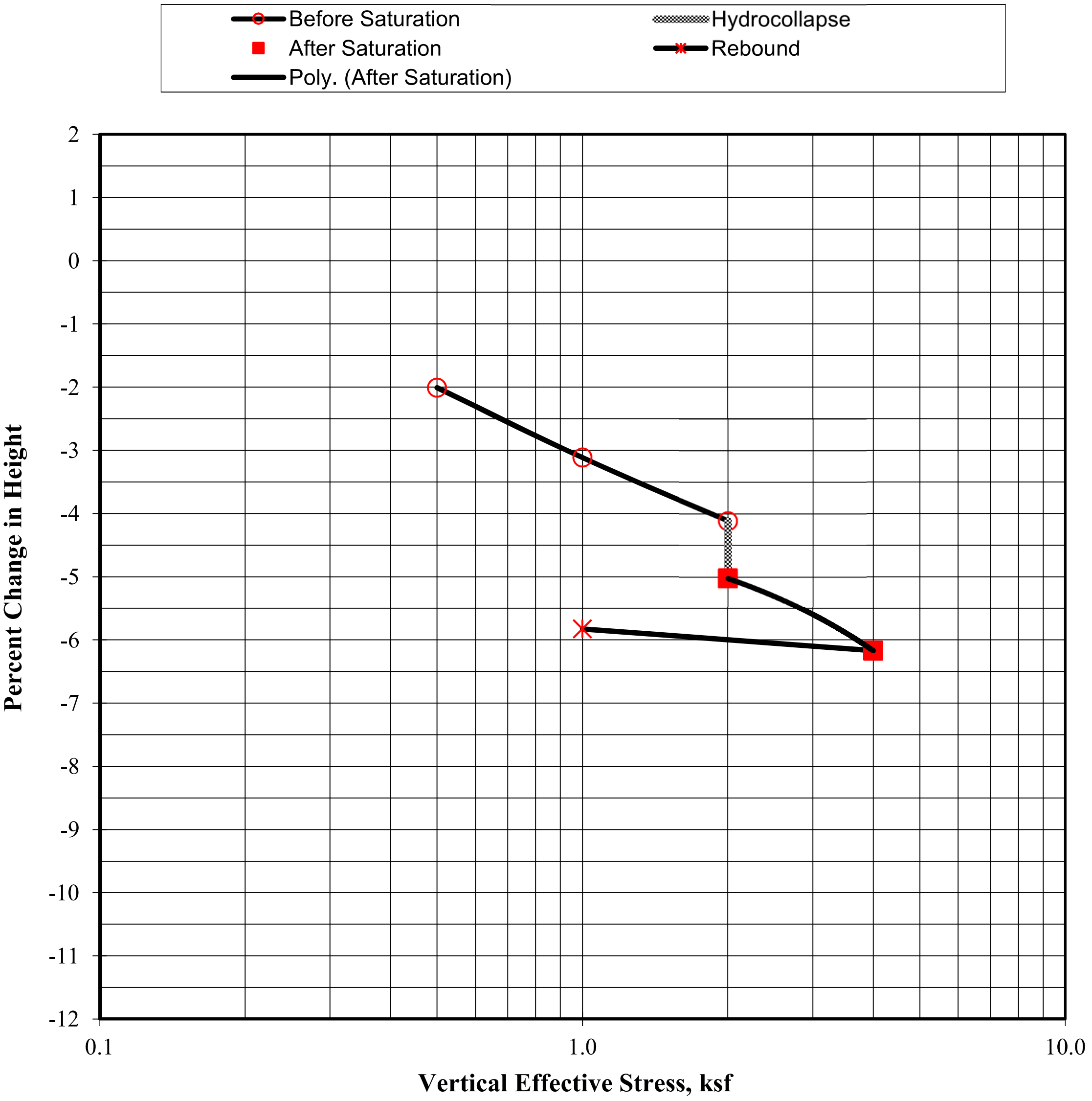
Silty Sand (SM)

Ring Sample

Initial Dry Density: 121.2 pcf
Initial Moisture: 9.7%
Specific Gravity: 2.67
Initial Void Ratio: 0.376

Hydrocollapse: 0.9% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 302169-002
Lab No.: 18-178

January 17, 2019

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Bamiyan Marketplace
B13 @ 20 feet

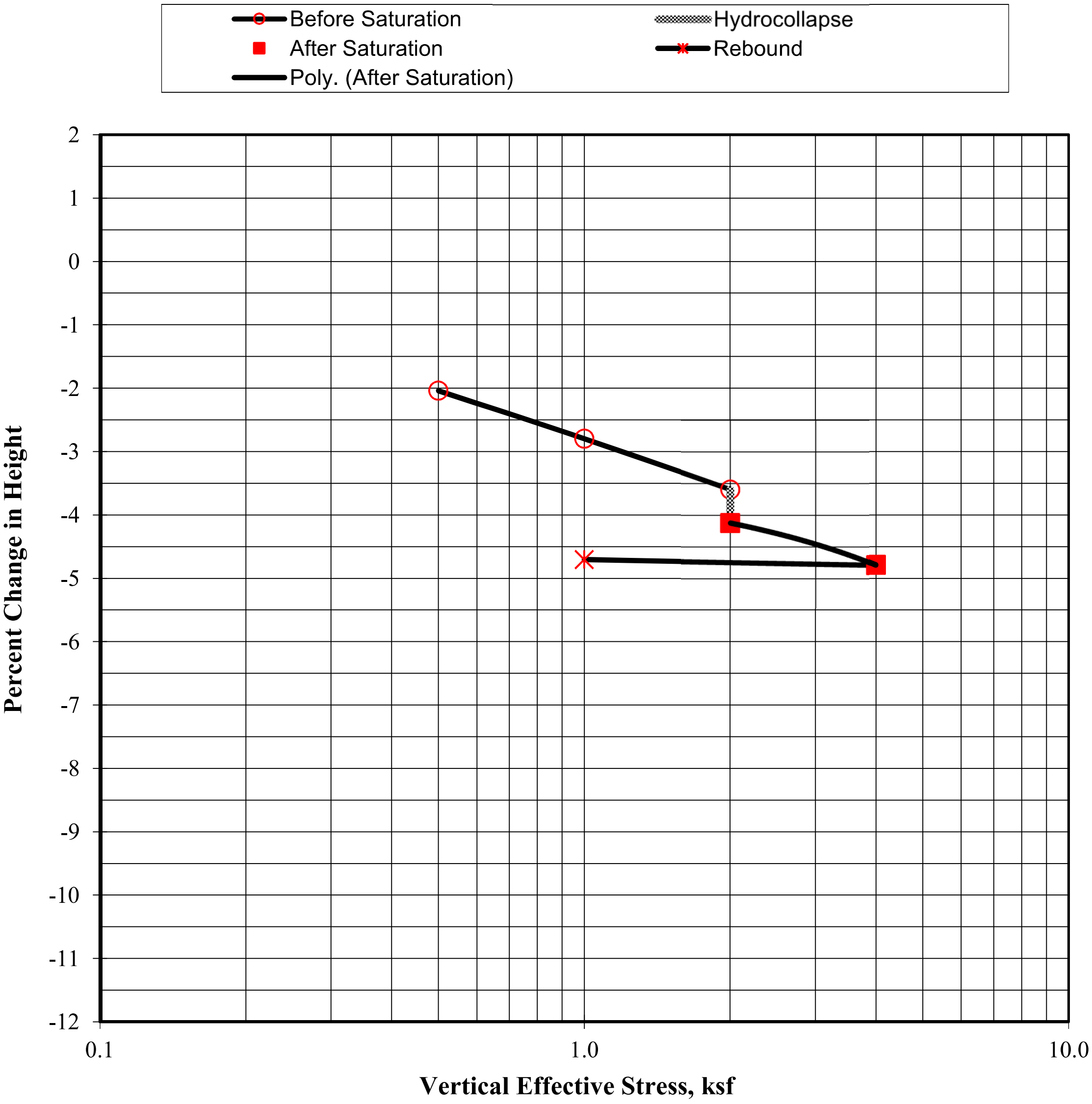
Silty Sand (SM)

Ring Sample

Initial Dry Density:	124.8 pcf
Initial Moisture:	9.8%
Specific Gravity:	2.67
Initial Void Ratio:	0.336

Hydrocollapse: 0.5% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 302169-002
Lab No.: 18-178

January 17, 2019

EXPANSION INDEX **ASTM D-4829**

Job Name: Bamiyan Marketplace
Sample ID: B2 @ 2.5 feet
Soil Description: Silty Sand w/Trace Clay (SM)

Initial Moisture, %:	8.4
Initial Compacted Dry Density, pcf:	116.3
Initial Saturation, %:	51
Final Moisture, %:	17.1
Volumetric Swell, %:	0.3

Expansion Index, EI: 3 Very Low

EI	ASTM Classification
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

File No.: 302169-002 January 17, 2019

Lab No.: 18-178

MAXIMUM DRY DENSITY / OPTIMUM MOISTURE

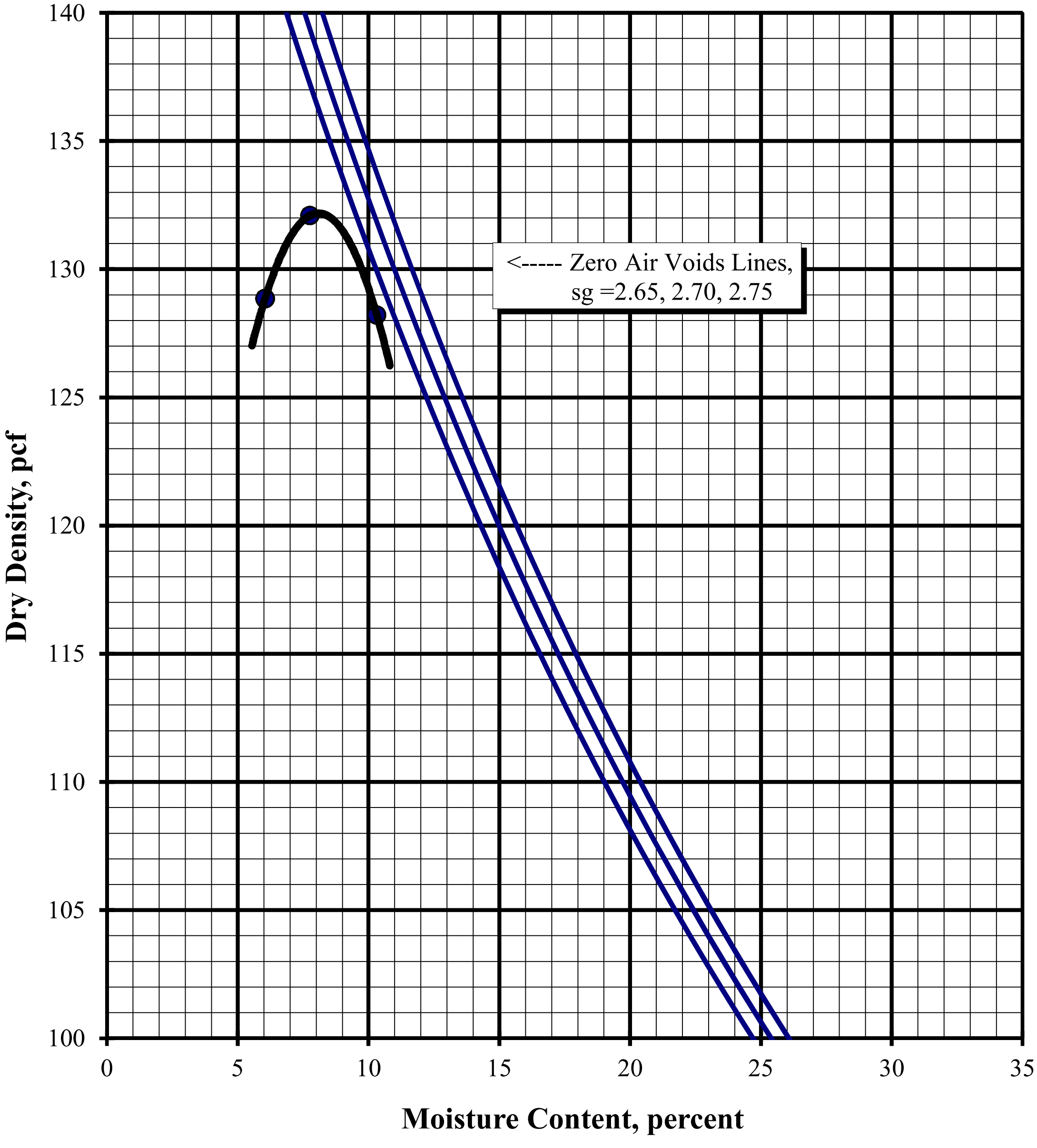
ASTM D 1557 (Modified)

Job Name: Bamiyan Marketplace
Sample ID: 1
Location: B13 @ 0-5 feet
Description: Brown Silty F - M Sand (SM)

Procedure Used: A
Preparation Method: Moist
Rammer Type: Mechanical
Lab Number: 18-178

Maximum Dry Density: **132.3 pcf**
Optimum Moisture: **8.3%**

Sieve Size	% Retained (Cumulative)
3/4"	0.0
3/8"	0.3
#4	1.0



File No.: 302169-002 1/17/2019

Lab No.: 18-178

SOIL CHEMICAL ANALYSES

Job Name: Bamiyan Marketplace

Job No.: 302169-002

Sample ID:	B3	B13
Sample Location:	2.5 feet	0-5 feet
Resistivity (Units)		
as-received (ohm-cm)	36,400	52,000
saturated (ohm-cm)	17,200	13,200
pH	7.3	7.2
Electrical Conductivity (mS/cm)	0.02	0.04
Chemical Analyses		
Cations		
calcium Ca^{2+} (mg/kg)	6	12
magnesium Mg^{2+} (mg/kg)	1.4	1.9
sodium Na^{1+} (mg/kg)	27	31
potassium K^{1+} (mg/kg)	1.7	22
Anions		
carbonate CO_3^{2-} (mg/kg)	ND	ND
bicarbonate HCO_3^{1-}(mg/kg)	43	76
fluoride F^{1-} (mg/kg)	0.7	ND
chloride Cl^{1-} (mg/kg)	2.9	6.4
sulfate SO_4^{2-} (mg/kg)	2.7	16
phosphate PO_4^{3-} (mg/kg)	2	17
Other Tests		
ammonium NH_4^{1+} (mg/kg)	ND	ND
nitrate NO_3^{1-} (mg/kg)	3.3	4.4
sulfide S^{2-} (qual)	na	na
Redox (mV)	na	na

Note: Tests performed by Subcontract Laboratory:
HDR Engineering, Inc.
431 West Baseline Road
Calremont, California 91711 Tel: (909) 962-5485

mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed
T.O.P. = top of pipe

Resistivity per ASTM G187, Cations per ASTM D6919, Anions per ASTM D4327, and Alkalinity per APHA 2320-B. Electrical conductivity in millisiemens/cm and chemical analyses were made on a 1:5 soil-to-water extract.

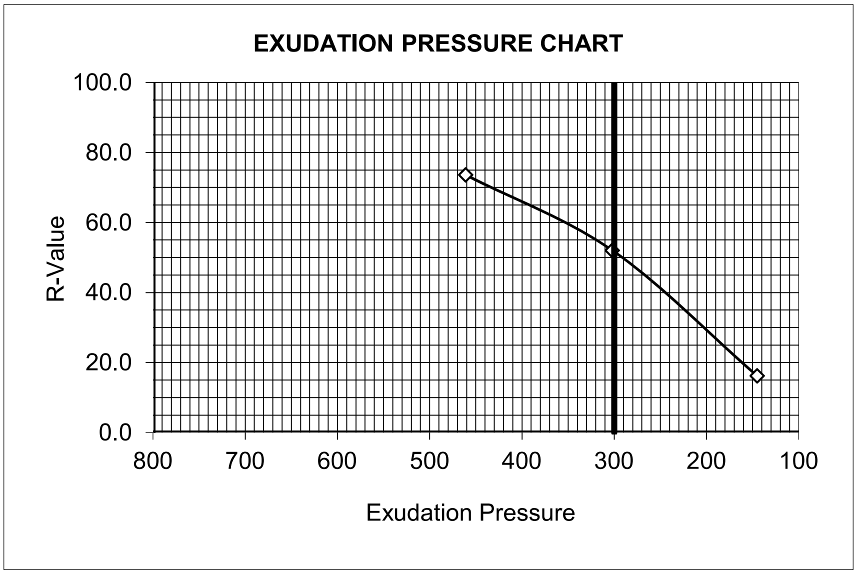
General Guidelines for Soil Corrosivity

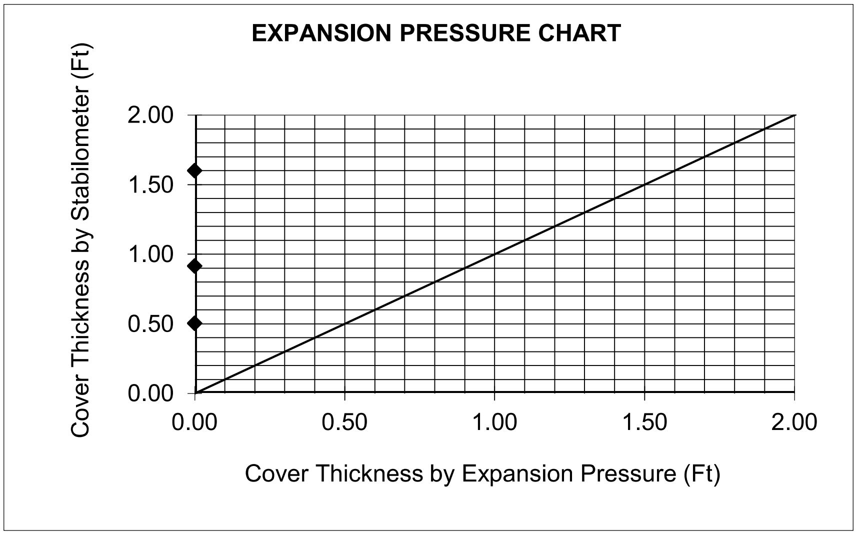
Chemical Agent	Amount in Soil	Degree of Corrosivity
Soluble Sulfates[1]	0 -1,000 mg/Kg (ppm) [0-.1%]	Low
	1,000 - 2,000 mg/Kg (ppm) [0.1-0.2%]	Moderate
	2,000 - 20,000 mg/Kg (ppm) [0.2-2.0%]	Severe
	> 20,000 mg/Kg (ppm) [>2.0%]	Very Severe
Resistivity[2] (Saturated)	0- 900 ohm-cm	Very Severely Corrosive
	900 to 2,300 ohm-cm	Severely Corrosive
	2,300 to 5,000 ohm-cm	Moderately Corrosive
	5,000-10,000 ohm-cm	Mildly Corrosive
	10,000+ ohm-cm	Progressively Less Corrosive

1 - General corrosivity to concrete elements. American Concrete Institute (ACI) Water Soluble Sulfate in Soil by Weight, ACI 318, Tables 4.2.2 - Exposure Conditions and Table 4.3.1 - Requirements for Concrete Exposed to Sulfate-Containing Solutions. ***It is recommended that concrete be proportioned in accordance with the requirements of the two ACI tables listed above (4.2.2 and 4.3.1). The current ACI should be referred to for further information.***

2 - General corrosivity to metallic elements (iron, steel, etc.). Although no standard has been developed and accepted by corrosion engineering organizations, it is generally agreed that the classification shown above, or other similar classifications, reflect soil corrosivity. Source: Corrosionsource.com. The classification presented is excerpted from ASTM STP 1013 titled "Effects of Soil Characteristics on Corrosion" (February, 1989)

3 - Earth Systems does not practice corrosion engineering. Results should be reviewed by an engineer competent in corrosion evaluation, especially in regard to nitrites and ammonium.



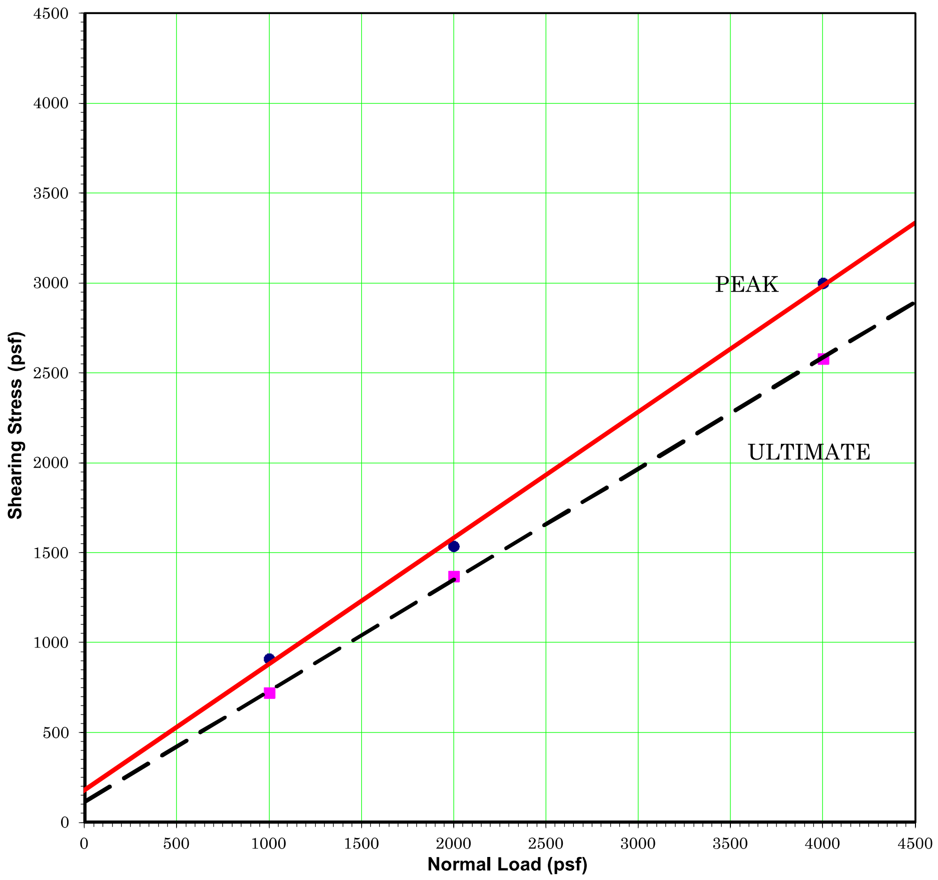


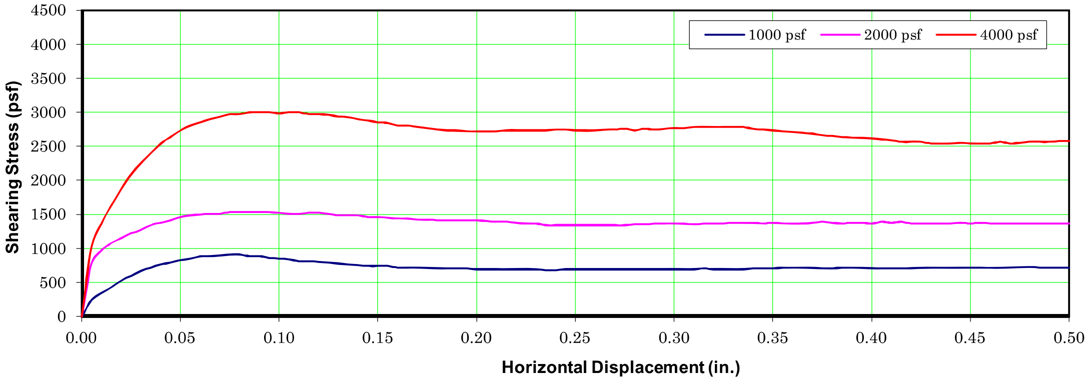
JOB NAME: Bamiyan Marketplace
SAMPLE I. D.: B-13@0-5'
SOIL DESCRIPTION: Silty Sand (MS)

SPECIMEN NUMBER	A	B	C
EXUDATION PRESSURE	461	302	145
RESISTANCE VALUE	73.6	52.0	16.2
EXPANSION DIAL(0.0001")	0	0	0
EXPANSION PRESSURE (PSF)	0.0	0.0	0.0
% MOISTURE AT TEST	8.7	9.8	11.0
DRY DENSITY AT TEST	126.6	126.9	125.2

R-VALUE @ 300 PSI EXUDATION	**52**
R-VALUE by Expansion Pressure*	**N/A**

**Based on Traffic Index = 8.00 & Gravel Factor = 1.34*





DIRECT SHEAR DATA*

Sample Location: B13 @ 0-5 feet

Material: Silty Sand (SM)

Dry Density (pcf): 119 (90% remolded

	Initial	Final
Moisture Content (%):	8.3	14.0
Saturation (%):	######	#VALUE!

	Peak	Ultimate
ϕ Angle of Friction (degrees):	35	32
c Cohesive Strength (psf):	180	110

Test Type: Peak and Ulitimate

Shear Rate (in/min): 0.007

* Test Method: ASTM D-3080

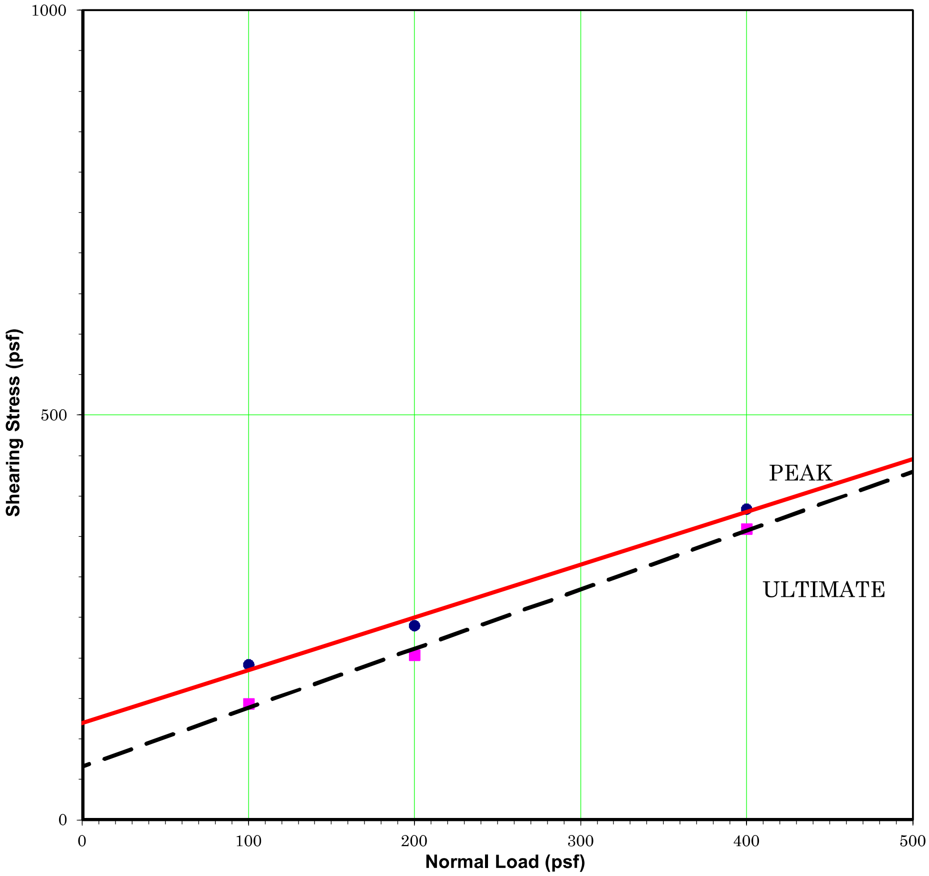
DIRECT SHEAR TEST

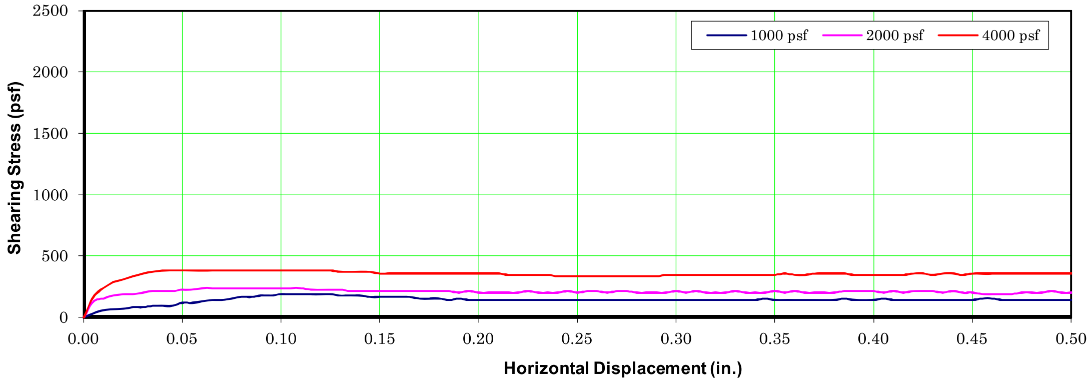
Bamiyan Marketplace

Lake Elsinore, California

Earth Systems

1/17/2019	302169-002





DIRECT SHEAR DATA*

Sample Location:	TL-1 @ 0-1 feet	
Material:	Silty Sand (SM)	
Dry Density (pcf):	108.0	
	Initial	Final
Moisture Content (%):	16	18.4
Saturation (%):	79	100
	Peak	Ultimate
ϕ Angle of Friction (degrees):	36	33
c Cohesive Strength (psf):	120	60

Test Type: Peak and Ulitimate

Shear Rate (in/min): 0.007

* Test Method: ASTM D-3080

DIRECT SHEAR TEST

Bamiyan Marketplace

Lake Elsinore, California

Earth Systems

1/17/2019

302169-002

Appendix 4: Historical Site Conditions

Phase I Environmental Site Assessment or Other Information on Past Site Use

ADVANTAGE
ENVIRONMENTAL
CONSULTANTS, LLC.

June 21, 2019

Debbie Kinsinger
Kinsinger Environmental Consulting
5700 Baltimore Dr. #53
La Mesa, California 91942

Re: Regulatory/Historical Review and Environmental Opinion
15749 Grand Avenue
Lake Elsinore, California
AEC Project No. 19-315SD

Dear Mr. Kinsinger:

Advantage Environmental Consultants, LLC (AEC) has completed an environmental review of the property located at 15749 Grand Avenue in Lake Elsinore, California (Site). The Site is a reported 12.55 acres in size and is further identified by County of Riverside Assessor's Parcel Numbers 381-320-020 and -023. The Site is situated generally north of Lake Terrace Drive, south of Grand Avenue, east of Macy Street and west of Ortega Highway (Highway 74).

Site Reconnaissance

A reconnaissance of the Site was conducted by Kinsinger Environmental Consulting. The Site was examined for evidence of the following potential environmental concerns:

Conditions	Not Observed or Noted	Observed or Noted	Significant Concern?
Hazardous Substances/Petroleum Products	X		--
Waste Generation/Storage/Disposal	X		--
Aboveground Storage Tanks	X		--
Underground Storage Tanks	X		--
Polychlorinated Biphenyl Containing Equipment	X		--
Chemical/Petroleum Odors	X		--
Pools of Liquid	X		--
Floor Drains/Sumps/Wells	X		--
Drums	X		--
Stains or Corrosion	X		--
Unidentified Substance Containers	X		--
Stained Soil or Pavement	X		--
Stressed Vegetation	X		--
Pits, Ponds or Lagoons	X		--
Wastewater Discharges/Disposal Systems	X		--
Septic Systems/Cesspools	X		--

Conditions	Not Observed or Noted	Observed or Noted	Significant Concern?
Non-Hazardous Solid Waste Disposal Areas	X		--
Drinking Water Systems/Water Wells	X		--
Other Wells		X	No

No significant environment concerns were noted during the Site reconnaissance. Several groundwater monitoring wells were observed on site that were drilled to document depth to water table.

Regulatory Database Review

AEC reviewed Federal, State and local-level environmental databases searched by Environmental (EDR) for information pertaining to documented and/or suspected releases of regulated hazardous substances and/or petroleum products at the Site and within specified search distances from the Site.

AEC also reviewed unmappable sites listed in the environmental database report by cross-referencing addresses and site names. Unmappable sites are sites that cannot be plotted with confidence, but can be located by zip code or city name. In general, a site cannot be mapped because of inaccurate or missing location information in the record provided by the regulatory agency. Any unmappable sites that AEC identifies within the specified search radii were evaluated as part of the preparation of this report.

The following Federal databases related to potential on-site and off-site sources of contamination were reviewed and interpreted by AEC:

Federal Databases	Search Distance From Site
National Priorities List (NPL)	One mile
Delisted NPL	One mile
Superfund Enterprise Management System (SEMS) Former CERCLIS	One-half mile
Superfund Enterprise Management System Archive (SEMS ARCHIVE) Former CERCLIS NFRAP	One-half mile
Resource Conservation and Recovery Act (RCRA) CORRACTS Hazardous Waste Treatment, Storage and Disposal (TSD) Facilities	One mile
RCRA non-CORRACTS Hazardous Waste TSD Facilities	One-half mile
RCRA Hazardous Waste Generators (RCRA GEN)	One-eighth mile
Emergency Response Notification System (ERNS)	One-eighth mile
Federal Institutional/Engineering Control Registries (IC/EC)	One-half mile

The following State/local databases related to potential on-site and off-site sources of contamination were also searched and reviewed:

State/Local Databases	Search Distance From Site
State-equivalent NPL and CERCLIS (RESPONSE and Envirostor)	One mile

State/Local Databases	Search Distance From Site
State Voluntary Cleanup Sites (VCP)	One-half mile
State Landfill and/or Solid Waste Disposal Sites (SWF/LF)	One-half mile
State Leaking Storage Tank (LUST, SLIC, SAM)	One-half mile
State Registered Storage Tank (UST, AST)	One-eighth mile
State Brownfields	One-half mile

Descriptions/sources of each of the above referenced regulatory databases and the dates these databases were last updated by the applicable regulatory agencies are included in the EDR reports In addition, several non-ASTM databases were searched that are not listed in the table above. Descriptions of these databases and dates that these databases were updated are also included in the EDR report.

The Site is not listed on any of the standard ASTM or non-ASTM databases searched by EDR. Several listings mapped between one-eighth to one mile from the Site were listed on various regulatory databases. Such properties are not considered to be of likely environmental concern to the Site. This opinion is based on several factors including the nature of the regulatory database listings, distance of the off-Site listed properties from the Site, orientation of the listed properties relative to the Site, interpreted direction of groundwater flow, and/or regulatory case status information for the various properties as described in the databases.

Historical Review

A review of a historical aerial photographs and topographic maps indicates that the Site was formerly utilized for agricultural purposes prior to its current condition. During historical agricultural activities throughout the State of California, various pesticides and more specifically organochlorine pesticides were commonly applied during the normal course of agricultural operations. Such compounds have since been banned from production and use in the United States. Section 105215 of the California Health and Safety Code discusses the regulatory reporting of incidents that pertain to pesticide spills and accidental releases of pesticide products. Based on the regulatory and historical research completed during the preparation of this assessment, no information has been revealed that would lead AEC to believe that an accidental spill or release of pesticide products has occurred at the Site. In addition, neither stressed vegetation, nor evidence of the storage of pesticides was observed on the property during the Site reconnaissance or based on regulatory and historical research reviews. However, if the client desires a higher level of confidence regarding the potential presence of residual agricultural chemicals in Site soils, sampling and analysis can be performed.

Site Owner Interview

The Site owner is unaware of environmental concerns in connection with the Site.

Environmental Opinion

Based on the resources consulted during this assessment, AEC has not identified significant environmental concerns associated with the Site. As stated previously, if the client desires a higher level of confidence regarding the potential presence of residual agricultural chemicals in Site soils, sampling and analysis can be performed.

User Reliance and Limitations

This report was prepared for use solely and exclusively by the client. The report is not for the use or benefit of, nor may it be relied upon by, any other person or entity for any purpose without the advance written consent of AEC. This report was conducted in accordance with the scope of services described in the proposal for the completion of this evaluation. No other warranties either express or implied, are made by AEC. AEC's evaluations, analyses, and opinions should not be taken as representations regarding actual subsurface conditions beneath the Site or the value of the Site. Subsurface conditions may differ from the conditions implied by the regulatory records documentation, and can only be reliably evaluated through intrusive techniques. While some observations and discussion in this report may address conditions and/or operations that may be regulated, the regulatory compliance of those conditions and/or operations is outside the scope of this investigation. Nothing in this report constitutes a legal opinion or legal advice. For information regarding specific individual or organizational liability, AEC recommends consultation with independent legal counsel. The scope of services completed as part of this also does not represent one of the practices that constitutes "all appropriate inquiry into the previous ownership and uses of the Site consistent with good commercial or customary practice" as defined in 42 USC Section 9601(35)(B); and consequently, does not satisfy the requirements that permit the user to qualify for the innocent landowner defense or other regulatory immunities under CERCLA liability.

Closure

We appreciate the opportunity to be of service on this project. If you should have any questions regarding this report, or if we can be of further assistance, please contact me at (760) 744-3363.

Sincerely,

Advantage Environmental Consultants, LLC

Daniel Weis
Branch Manager
Western Regional Office

Attachment:

Regulatory Database Report

Appendix 5: LID Infeasibility

LID Technical Infeasibility Analysis

N/A

Appendix 4: Historical Site Conditions

Phase I Environmental Site Assessment or Other Information on Past Site Use

Appendix 5: LID Infeasibility

LID Technical Infeasibility Analysis

Appendix 6: BMP Design Details

BMP Sizing, Design Details and other Supporting Documentation

See WQMP / DMA Exhibit for Discretionary Phase

3.5 Bioretention Facility

Type of BMP	LID – Bioretention
Treatment Mechanisms	Infiltration, Evapotranspiration, Evaporation, Biofiltration
Maximum Drainage Area	This BMP is intended to be integrated into a project's landscaped area in a distributed manner. Typically, contributing drainage areas to Bioretention Facilities range from less than 1 acre to a maximum of around 10 acres.
Other Names	Rain Garden, Bioretention Cell, Bioretention Basin, Biofiltration Basin, Landscaped Filter Basin, Porous Landscape Detention

Description

Bioretention Facilities are shallow, vegetated basins underlain by an engineered soil media. Healthy plant and biological activity in the root zone maintain and renew the macro-pore space in the soil and maximize plant uptake of pollutants and runoff. This keeps the Best Management Practice (BMP) from becoming clogged and allows more of the soil column to function as both a sponge (retaining water) and a highly effective and self-maintaining biofilter. In most cases, the bottom of a Bioretention Facility is unlined, which also provides an opportunity for infiltration to the extent the underlying onsite soil can accommodate. When the infiltration rate of the underlying soil is exceeded, fully biotreated flows are discharged via underdrains. Bioretention Facilities therefore will inherently achieve the maximum feasible level of infiltration and evapotranspiration and achieve the minimum feasible (but highly biotreated) discharge to the storm drain system.

Siting Considerations

These facilities work best when they are designed in a relatively level area. Unlike other BMPs, Bioretention Facilities can be used in smaller landscaped spaces on the site, such as:

- ✓ Parking islands
- ✓ Medians
- ✓ Site entrances

Landscaped areas on the site (such as may otherwise be required through minimum landscaping ordinances), can often be designed as Bioretention Facilities. This can be accomplished by:

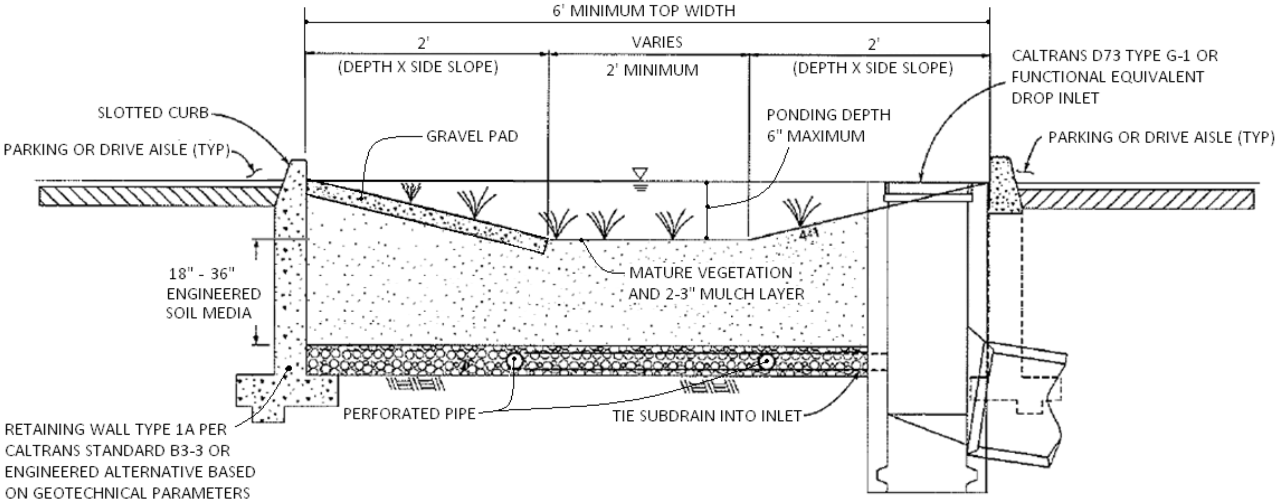
- *Depressing* landscaped areas below adjacent impervious surfaces, rather than elevating those areas
- Grading the site to direct runoff from those impervious surfaces *into* the Bioretention Facility, rather than away from the landscaping
- Sizing and designing the depressed landscaped area as a Bioretention Facility as described in this Fact Sheet

Bioretention Facilities should however not be used downstream of areas where large amounts of sediment can clog the system. Placing a Bioretention Facility at the toe of a steep slope should also be avoided due to the potential for clogging the engineered soil media with erosion from the slope, as well as the potential for damaging the vegetation.

Design and Sizing Criteria

The recommended cross section necessary for a Bioretention Facility includes:

- Vegetated area
- 18' minimum depth of engineered soil media
- 12' minimum gravel layer depth with 6' perforated pipes (added flow control features such as orifice plates may be required to mitigate for HCOC conditions)



While the 18-inch minimum engineered soil media depth can be used in some cases, it is recommended to use 24 inches or a preferred 36 inches to provide an adequate root zone for the chosen plant palate. Such a design also provides for improved removal effectiveness for nutrients. The recommended ponding depth inside of a Bioretention Facility is 6 inches; measured from the flat bottom surface to the top of the water surface as shown in Figure 1.

Because this BMP is filled with an engineered soil media, pore space in the soil and gravel layer is assumed to provide storage volume. However, several considerations must be noted:

- Surcharge storage above the soil surface (6 inches) is important to assure that design flows do not bypass the BMP when runoff exceeds the soil's absorption rate.
- In cases where the Bioretention Facility contains engineered soil media deeper than 36 inches, the pore space within the engineered soil media can only be counted to the 36-inch depth.
- A maximum of 30 percent pore space can be used for the soil media whereas a maximum of 40 percent pore space can be use for the gravel layer.

Figure 1: Standard Layout for a Bioretention Facility

Engineered Soil Media Requirements

The engineered soil media shall be comprised of 85 percent mineral component and 15 percent organic component, by volume, drum mixed prior to placement. The mineral component shall be a Class A sandy loam topsoil that meets the range specified in Table 1 below. The organic component shall be nitrogen stabilized compost[1], such that nitrogen does not leach from the media.

Table 1: Mineral Component Range Requirements

Percent Range	Component
70-80	Sand
15-20	Silt
5-10	Clay

The trip ticket, or certificate of compliance, shall be made available to the inspector to prove the engineered mix meets this specification.

Vegetation Requirements

Vegetative cover is important to minimize erosion and ensure that treatment occurs in the Bioretention Facility. The area should be designed for at least 70 percent mature coverage throughout the Bioretention Facility. To prevent the BMP from being used as walkways, Bioretention Facilities shall be planted with a combination of small trees, densely planted shrubs, and natural grasses. Grasses shall be native or ornamental; preferably ones that do not need to be mowed. The application of fertilizers and pesticides should be minimal. To maintain oxygen levels for the vegetation and promote biodegradation, it is important that vegetation not be completely submerged for any extended period of time. Therefore, a maximum of 6 inches of ponded water shall be used in the design to ensure that plants within the Bioretention Facility remain healthy.

A 2 to 3-inch layer of standard shredded aged hardwood mulch shall be placed as the top layer inside the Bioretention Facility. The 6-inch ponding depth shown in Figure 1 above shall be measured from the top surface of the 2 to 3-inch mulch layer.

Curb Cuts

To allow water to flow into the Bioretention Facility, 1-foot-wide (minimum) curb cuts should be placed approximately every 10 feet around the perimeter of the Bioretention Facility. Figure 2 shows a curb cut in a Bioretention Facility. Curb cut flow lines must be at or above the V_{BMP} water surface level.

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[1] For more information on compost, visit the US Composting Council website at: http://compostingcouncil.org/

Figure 2: Curb Cut located in a Bioretention Facility

To reduce erosion, a gravel pad shall be placed at each inlet point to the Bioretention Facility. The gravel should be 1- to 1.5-inch diameter in size. The gravel should overlap the curb cut opening a minimum of 6 inches. The gravel pad inside the Bioretention Facility should be flush with the finished surface at the curb cut and extend to the bottom of the slope.

In addition, place an apron of stone or concrete, a foot square or larger, inside each inlet to prevent vegetation from growing up and blocking the inlet. See Figure 3.

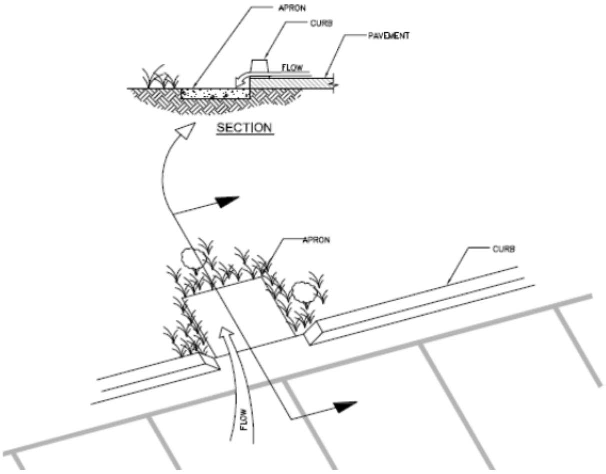


Figure 3: Apron located in a Bioretention Facility

Terracing the Landscaped Filter Basin

It is recommended that Bioretention Facilities be level. In the event the facility site slopes and lacks proper design, water would fill the lowest point of the BMP and then discharge from the basin without being treated. To ensure that the water will be held within the Bioretention Facility on sloped sites, the BMP must be terraced with nonporous check dams to provide the required storage and treatment capacity.

The terraced version of this BMP shall be used on non-flat sites with no more than a 3 percent slope. The surcharge depth cannot exceed 0.5 feet, and side slopes shall not exceed 4:1. Table 2 below shows the spacing of the check dams, and slopes shall be rounded up (i.e., 2.5 percent slope shall use 10' spacing for check dams).

Table 2: Check Dam Spacing

6” Check Dam Spacing	
Slope	**Spacing**
1%	*25'*
2%	*15'*
3%	*10'*

Roof Runoff

Roof downspouts may be directed towards Bioretention Facilities. However, the downspouts must discharge onto a concrete splash block to protect the Bioretention Facility from erosion.

Retaining Walls

It is recommended that Retaining Wall Type 1A, per Caltrans Standard B3-3 or equivalent, be constructed around the entire perimeter of the Bioretention Facility. This practice will protect the sides of the Bioretention Facility from collapsing during construction and maintenance or from high service loads adjacent to the BMP. Where such service loads would not exist adjacent to the BMP, an engineered alternative may be used if signed by a licensed civil engineer.

Side Slope Requirements

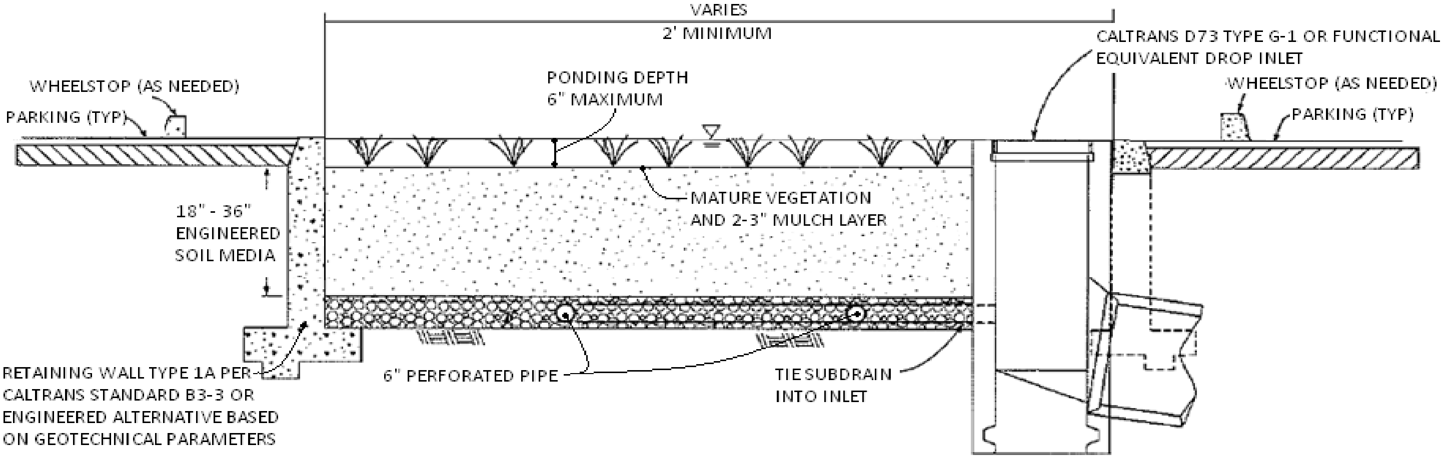
Bioretention Facilities Requiring Side Slopes

The design should assure that the Bioretention Facility does not present a tripping hazard. Bioretention Facilities proposed near pedestrian areas, such as areas parallel to parking spaces or along a walkway, must have a gentle slope to the bottom of the facility. Side slopes inside of a Bioretention Facility shall be 4:1. A typical cross section for the Bioretention Facility is shown in Figure 1.

Bioretention Facilities Not Requiring Side Slopes

Where cars park perpendicular to the Bioretention Facility, side slopes are not required. A 6-inch maximum drop may be used, and the Bioretention Facility must be planted with trees and shrubs to prevent pedestrian access. In this case, a curb is not placed around the Bioretention Facility,

but wheel stops shall be used to prevent vehicles from entering the Bioretention Facility, as shown in Figure 4.



Planter Boxes

Bioretention Facilities can also be placed above ground as planter boxes. Planter boxes must have a minimum width of 2 feet, a maximum surcharge depth of 6 inches, and no side slopes are necessary. Planter boxes must be constructed so as to ensure that the top surface of the engineered soil media will remain level. This option may be constructed of concrete, brick, stone or other stable materials that will not warp or bend. Chemically treated wood or galvanized steel, which has the ability to contaminate stormwater, should not be used. Planter boxes must be lined with an impermeable liner on all sides, including the bottom. Due to the impermeable liner, the inside bottom of the planter box shall be designed and constructed with a cross fall, directing treated flows within the subdrain layer toward the point where subdrain exits the planter box, and subdrains shall be oriented with drain holes oriented down. These provisions will help avoid excessive stagnant water within the gravel underdrain layer. Similar to the in-ground Bioretention Facility versions, this BMP benefits from healthy plants and biological activity in the root zone. Planter boxes should be planted with appropriately selected vegetation.

Figure 5: Planter Box

Source: LA Team Effort

Overflow

An overflow route is needed in the Bioretention Facility design to bypass stored runoff from storm events larger than V_{BMP} or in the event of facility or subdrain clogging. Overflow systems must connect to an acceptable discharge point, such as a downstream conveyance system as shown in Figure 1 and Figure 4. The inlet to the overflow structure shall be elevated inside the Bioretention Facility to be flush with the ponding surface for the design capture volume (V_{BMP}) as shown in Figure 4. This will allow the design capture volume to be fully treated by the Bioretention Facility, and for larger events to safely be conveyed to downstream systems. The overflow inlet shall **not** be located in the entrance of a Bioretention Facility, as shown in Figure 6.

Underdrain Gravel and Pipes

An underdrain gravel layer and pipes shall be provided in accordance with Appendix B – Underdrains.

Figure 6: Incorrect Placement of an Overflow Inlet.

Inspection and Maintenance Schedule

The Bioretention Facility area shall be inspected for erosion, dead vegetation, soggy soils, or standing water. The use of fertilizers and pesticides on the plants inside the Bioretention Facility should be minimized.

Schedule	Activity
Ongoing	• Keep adjacent landscape areas maintained. Remove clippings from landscape maintenance activities. • Remove trash and debris • Replace damaged grass and/or plants • Replace surface mulch layer as needed to maintain a 2-3 inch soil cover.
After storm events	• Inspect areas for ponding
Annually	• Inspect/clean inlets and outlets

Bioretention Facility Design Procedure

1) Enter the area tributary, A_T, to the Bioretention Facility.

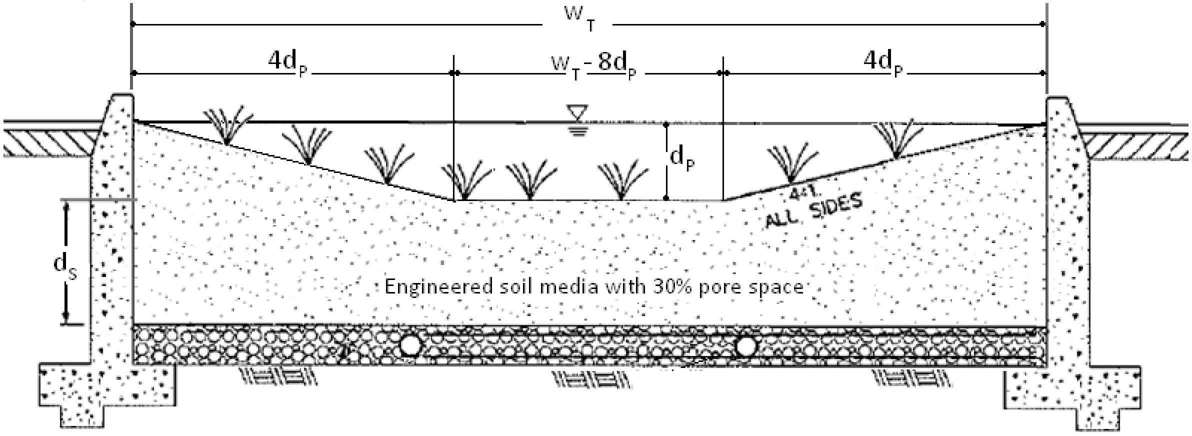
2) Enter the Design Volume, $V_{BMP,}$ determined from Section 2.1 of this Handbook.

3) Select the type of design used. There are two types of Bioretention Facility designs: the standard design used for most project sites that include side slopes, and the modified design used when the BMP is located perpendicular to the parking spaces or with planter boxes that do not use side slopes.

4) Enter the depth of the engineered soil media, d_S. The minimum depth for the engineered soil media can be 18' in limited cases, but it is recommended to use 24' or a preferred 36' to provide an adequate root zone for the chosen plant palette. Engineered soil media deeper than 36' will only get credit for the pore space in the first 36'.

5) Enter the top width of the Bioretention Facility.

6) Calculate the total effective depth, d_E, within the Bioretention Facility. The maximum allowable pore space of the soil media is 30% while the maximum allowable pore space for the gravel layer is 40%. Gravel layer deeper than 12' will only get credit for the pore space in the first 12'.



   a. For the design with side slopes the following equation shall be used to determine the total effective depth. Where, d_P is the depth of ponding within the basin.

$$\mathrm{d_E(ft)} = \frac{0.3 \times \left[\left(\mathrm{w_T(ft)} \times \mathrm{d_S(ft)}\right) + 4\left(\mathrm{d_P(ft)}\right)^2\right] + 0.4\ \times\ 1\mathrm{(ft)} + \mathrm{d_P(ft)}\left[4\mathrm{d_P(ft)} + \left(\mathrm{w_T(ft)} - 8\mathrm{d_P(ft)}\right)\right]}{\mathrm{w_T(ft)}}$$

   This above equation can be simplified if the maximum ponding depth of 0.5’ is used. The equation below is used on the worksheet to find the minimum area required for the Bioretention Facility:

$$\mathrm{d_E(ft)} = (0.3 \times \mathrm{d_S(ft)} +\ 0.4 \text{ x } 1\mathrm{(ft)}) - \left(\frac{0.7\ (\mathrm{ft}^2)}{\mathrm{w_T(ft)}}\right) + 0.5\mathrm{(ft)}$$

b. For the design without side slopes the following equation shall be used to determine the total effective depth:

$$\mathrm{d_E(ft) = d_P(ft) + [(0.3) \times d_S(ft) + \ (0.4)\ \times 1(ft)]}$$

The equation below, using the maximum ponding depth of 0.5', is used on the worksheet to find the minimum area required for the Bioretention Facility:

$$\mathrm{d_E(ft) = 0.5\ (ft) + [(0.3) \times d_S(ft) + \ (0.4)\ \times 1(ft)]}$$

7) Calculate the minimum surface area, A_M, required for the Bioretention Facility. This does not include the curb surrounding the Bioretention Facility or side slopes.

$$\mathrm{A_M(ft^2) = \frac{V_{BMP}(ft^3)}{d_E\ (ft)}}$$

8) Enter the proposed surface area. This area shall not be less than the minimum required surface area.

9) Verify that side slopes are no steeper than 4:1 in the standard design, and are not required in the modified design.

10) Provide the diameter, minimum 6 inches, of the perforated underdrain used in the Bioretention Facility. See Appendix B for specific information regarding perforated pipes.

11) Provide the slope of the site around the Bioretention Facility, if used. The maximum slope is 3 percent for a standard design.

12) Provide the check dam spacing, if the site around the Bioretention Facility is sloped.

13) Describe the vegetation used within the Bioretention Facility.

References Used to Develop this Fact Sheet

Anderson, Dale V. "Landscaped Filter Basin Soil Requirements." Riverside, May 2010.

California Department of Transportation. CalTrans Standard Plans. 15 September 2005. May 2010 <http://www.dot.ca.gov/hq/esc/oe/project_plans/HTM/stdplns-met-new99.htm>.

Camp Dresser and McKee Inc.; Larry Walker Associates. California Stormwater Best Management Practice Handbook for New Development and Redevelopment. California Stormwater Quality Association (CASQA), 2004.

Contra Costa Clean Water Program. Stormwater Quality Requirements for Development Applications. 3rd Edition. Contra Costa, 2006.

County of Los Angeles Public Works. Stormwater Best Management Practice Design and Maintenance Manual. Los Angeles, 2009.

Kim, Hunho, Eric A. Seagren and Allen P. Davis. "Engineered Bioretention for Removal of Nitrate from Stormwater Runoff." Water Environment Research 75.4 (2003): 355-366.

LA Team Effort. LA Team Effort: FREE Planter Boxes for Businesses. 2 November 2009. May 2010 <http://lateameffort.blogspot.com/2009/11/free-planter-boxes-for-businesses-est.html>.

Montgomery County Maryland Department of Permitting Services Water Resources Section. Biofiltration (BF). Montgomery County, 2005.

Program, Ventura Countywide Stormwater Quality Management. Technical Guidance Manual for Stormwater Quality Control Measures. Ventura, 2002.

United States Environmental Protection Agency. Storm Water Technology Fact Sheet Bioretention. Washington D.C, 1999.

Urban Drainage and Flood Control District. Urban Storm Drainage Criteria Manual Volume 3 - Best Management Practices. Vol. 3. Denver, 2008. 3 vols.

Urbonas, Ben R. Stormwater Sand Filter Sizing and Design: A Unit Operations Approach. Denver: Urban Drainage and Flood Control District, 2002.

Appendix 7: Hydromodification

Supporting Detail Relating to Hydrologic Conditions of Concern

Not Applicable for Lake Elsinore tributary area

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.**

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
☐ 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

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
☐ 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/

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
☐ 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.**

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
☐ 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**

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[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

Not Applicable for Discretionary Phase

Appendix 10: Educational Materials

BMP Fact Sheets, Maintenance Guidelines and Other End-User BMP Information

After the Storm

A Citizen's Guide to Understanding Stormwater

For more information contact:

or visit
www.epa.gov/npdes/stormwater
www.epa.gov/nps

United States Environmental Protection Agency

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THE YEAR OF CLEAN WATER
Celebration + Recommitment

WHEN IT RAINS IT DRAINS

What is stormwater runoff?

Stormwater runoff occurs when precipitation from rain or snowmelt flows over the ground. Impervious surfaces like driveways, sidewalks, and streets prevent stormwater from naturally soaking into the ground.

Why is stormwater runoff a problem?

Stormwater can pick up debris, chemicals, dirt, and other pollutants and flow into a storm sewer system or directly to a lake, stream, river, wetland, or coastal water. Anything that enters a storm sewer system is discharged untreated into the waterbodies we use for swimming, fishing, and providing drinking water.

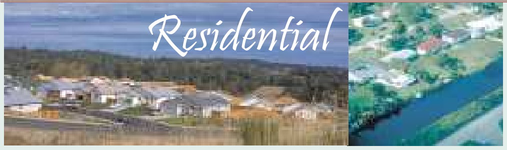
The effects of pollution

Polluted stormwater runoff can have many adverse effects on plants, fish, animals, and people.

- Sediment can cloud the water and make it difficult or impossible for aquatic plants to grow. Sediment also can destroy aquatic habitats.
- Excess nutrients can cause algae blooms. When algae die, they sink to the bottom and decompose in a process that removes oxygen from the water. Fish and other aquatic organisms can't exist in water with low dissolved oxygen levels.
- Bacteria and other pathogens can wash into swimming areas and create health hazards, often making beach closures necessary.
- Debris—plastic bags, six-pack rings, bottles, and cigarette butts—washed into waterbodies can choke, suffocate, or disable aquatic life like ducks, fish, turtles, and birds.
- Household hazardous wastes like insecticides, pesticides, paint, solvents, used motor oil, and other auto fluids can poison aquatic life. Land animals and people can become sick or die from eating diseased fish and shellfish or ingesting polluted water.
- Polluted stormwater often affects drinking water sources. This, in turn, can affect human health and increase drinking water treatment costs.

Stormwater Pollution Solutions

Residential



Recycle or properly dispose of household products that contain chemicals, such as insecticides, pesticides, paint, solvents, and used motor oil and other auto fluids. Don't pour them onto the ground or into storm drains.

Lawn care

Excess fertilizers and pesticides applied to lawns and gardens wash off and pollute streams. In addition, yard clippings and leaves can wash into storm drains and contribute nutrients and organic matter to streams.

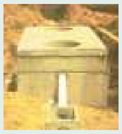
- Don't overwater your lawn. Consider using a soaker hose instead of a sprinkler.
- Use pesticides and fertilizers sparingly. When use is necessary, use these chemicals in the recommended amounts. Use organic mulch or safer pest control methods whenever possible.
- Compost or mulch yard waste. Don't leave it in the street or sweep it into storm drains or streams.
- Cover piles of dirt or mulch being used in landscaping projects.

Auto care

Washing your car and degreasing auto parts at home can send detergents and other contaminants through the storm sewer system. Dumping automotive fluids into storm drains has the same result as dumping the materials directly into a waterbody.

- Use a commercial car wash that treats or recycles its wastewater, or wash your car on your yard so the water infiltrates into the ground.
- Repair leaks and dispose of used auto fluids and batteries at designated drop-off or recycling locations.

Septic systems



Leaking and poorly maintained septic systems release nutrients and pathogens (bacteria and viruses) that can be picked up by stormwater and discharged into nearby waterbodies. Pathogens can cause public health problems and environmental concerns.

- Inspect your system every 3 years and pump your tank as necessary (every 3 to 5 years).
- Don't dispose of household hazardous waste in sinks or toilets.

Pet waste

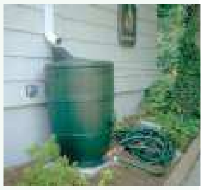
Pet waste can be a major source of bacteria and excess nutrients in local waters.

- When walking your pet, remember to pick up the waste and dispose of it properly. Flushing pet waste is the best disposal method. Leaving pet waste on the ground increases public health risks by allowing harmful bacteria and nutrients to wash into the storm drain and eventually into local waterbodies.

Education is essential to changing people's behavior. Signs and markers near storm drains warn residents that pollutants entering the drains will be carried untreated into a local waterbody.

Residential landscaping

Permeable Pavement—Traditional concrete and asphalt don't allow water to soak into the ground. Instead these surfaces rely on storm drains to divert unwanted water. Permeable pavement systems allow rain and snowmelt to soak through, decreasing stormwater runoff.



Rain Barrels—You can collect rainwater from rooftops in mosquito-proof containers. The water can be used later on lawn or garden areas.

Rain Gardens and Grassy Swales—Specially designed areas planted with native plants can provide natural places for rainwater to collect and soak into the ground. Rain from rooftop areas or paved areas can be diverted into these areas rather than into storm drains.

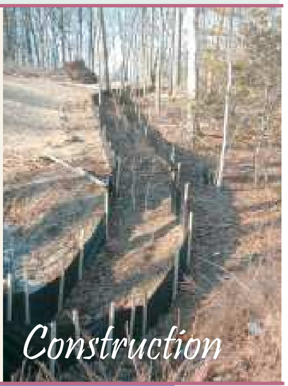
Vegetated Filter Strips—Filter strips are areas of native grass or plants created along roadways or streams. They trap the pollutants stormwater picks up as it flows across driveways and streets.

Commercial

Dirt, oil, and debris that collect in parking lots and paved areas can be washed into the storm sewer system and eventually enter local waterbodies.

- Sweep up litter and debris from sidewalks, driveways and parking lots, especially around storm drains.
- Cover grease storage and dumpsters and keep them clean to avoid leaks.
- Report any chemical spill to the local hazardous waste cleanup team. They'll know the best way to keep spills from harming the environment.

Construction



Erosion controls that aren't maintained can cause excessive amounts of sediment and debris to be carried into the stormwater system. Construction vehicles can leak fuel, oil, and other harmful fluids that can be picked up by stormwater and deposited into local waterbodies.

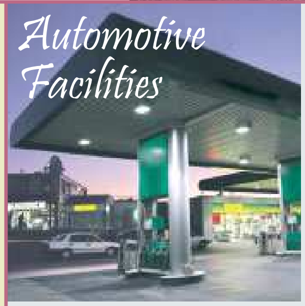
- Divert stormwater away from disturbed or exposed areas of the construction site.
- Install silt fences, vehicle mud removal areas, vegetative cover, and other sediment and erosion controls and properly maintain them, especially after rainstorms.
- Prevent soil erosion by minimizing disturbed areas during construction projects, and seed and mulch bare areas as soon as possible.

Agriculture

Lack of vegetation on streambanks can lead to erosion. Overgrazed pastures can also contribute excessive amounts of sediment to local waterbodies. Excess fertilizers and pesticides can poison aquatic animals and lead to destructive algae blooms. Livestock in streams can contaminate waterways with bacteria, making them unsafe for human contact.

- Keep livestock away from streambanks and provide them a water source away from waterbodies.
- Store and apply manure away from waterbodies and in accordance with a nutrient management plan.
- Vegetate riparian areas along waterways.
- Rotate animal grazing to prevent soil erosion in fields.
- Apply fertilizers and pesticides according to label instructions to save money and minimize pollution.

Automotive Facilities



Uncovered fueling stations allow spills to be washed into storm drains. Cars waiting to be repaired can leak fuel, oil, and other harmful fluids that can be picked up by stormwater.

- Clean up spills immediately and properly dispose of cleanup materials.
- Provide cover over fueling stations and design or retrofit facilities for spill containment.
- Properly maintain fleet vehicles to prevent oil, gas, and other discharges from being washed into local waterbodies.
- Install and maintain oil/water separators.

Forestry

Improperly managed logging operations can result in erosion and sedimentation.

- Conduct preharvest planning to prevent erosion and lower costs.
- Use logging methods and equipment that minimize soil disturbance.
- Plan and design skid trails, yard areas, and truck access roads to minimize stream crossings and avoid disturbing the forest floor.
- Construct stream crossings so that they minimize erosion and physical changes to streams.
- Expedite revegetation of cleared areas.

IRRIGATION RUNOFF

STORMWATER FACT SHEET

Report Irrigation Runoff or Stormwater Pollution:
800.506.2555

RIVERSIDE COUNTY
WATERSHED PROTECTION

OVERWATERING

Overwatering causes irrigation runoff that may contain pollutants such as pesticides, herbicides, fertilizers, pet waste, yard waste, and sediments which can be hazardous to residents and harmful to our environment. Runoff can also serve as a transport mechanism for other pollutants already on the ground or in the curb gutter. Irrigation runoff entering the storm drain system is an illicit discharge.

BEST PRACTICES

Urban runoff begins when yards and landscaped areas are over-irrigated. Irrigation systems require regular maintenance and visual inspection of the system should be performed to prevent over-spray, leaks, and other problems that result in runoff to storm drains, curbs and gutters.

You can **prevent pollution** by conserving water on your property. Water during cooler times of the day (before 10am and after 6pm).

- Adjust sprinklers to stop overspray and runoff.
- Make needed repairs immediately.
- Use drip irrigation, soaker hoses, or micro-spray systems.
- Use an irrigation timer to pre-set watering times.
- Use a control nozzle or similar mechanism when watering by hand.
- Switch to a water-wise landscape - native plants need less fertilizers, herbicides, pesticides and water.

PROTECT OUR WATERSHED

Many people think that when water flows into a storm drain it is treated, but the storm drain system and the sanitary sewer system are not connected. Everything that enters storm drains flows untreated directly into our creeks, rivers, lakes, beaches and ultimately the ocean. Storm water often contains pollutants, including chemicals, trash, and automobile fluids, all of which pollute our watershed and harm fish and wildlife.

Whether at home or work, you can help reduce pollution and improve water quality by using the above Best Management Practices (BMP's) as part of your daily clean up and maintenance routine.

We ♥ our Watershed!

A clean and healthy watershed is important to all of us.

Trash, debris, chemicals and other contaminants from business activities often make their way into the Riverside County storm drain system. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife.

Did you know?

There is a difference between storm drains and sewers.

Storm drains capture rainwater and flow directly to our rivers, lakes and streams – untreated.

Sewers capture and collect water from sinks, toilets and floor drains, and then it is processed and treated before it is released into the environment.

For more information about how you can protect our watershed, please visit:
www.rcwatershed.org

Questions?

If you have questions about Best Management Practices, or if you have questions about illicit dumping and stormwater pollution visit the Pollution Prevention website: rcwatershed.org.

For more information on requirements for all retail food facilities go to Riverside County Environmental Health's website: rivcoeh.org

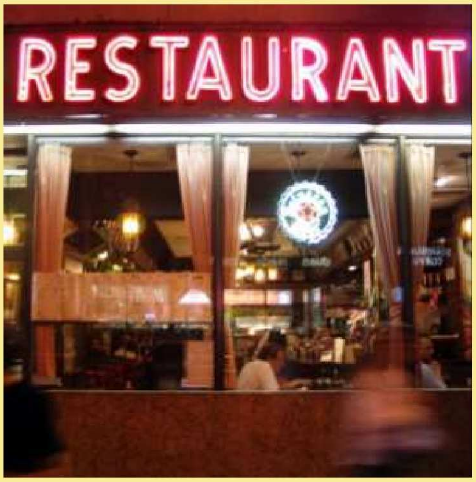
RIVERSIDE COUNTY
WATERSHED PROTECTION

Riverside County Watershed Protection Program is managed by Riverside County Flood Control & Water Conservation District in partnership with 27 Cities, the County of Riverside and the Coachella Valley Water District.

OUR MISSION
"To protect, preserve and enhance the quality of Riverside County watersheds by fostering a community-wide commitment to clean water."

Watershed Protection

Food Service Industry Best Practices



Restaurants
Mobile Food Trucks
Grocery Stores
Bakeries
Delicatessens

Best Kitchen Practices

Recycle Oil & Grease

- Never put oil or grease down the drain. Contain grease and oil by using covered grease storage containers or installing a grease interceptor.
- Never overfill your grease storage container or transport it without a cover.
- Grease control devices must be emptied and cleaned by permitted companies and according to manufacturer's specifications.
- Keep maintenance records on site.
- For a list of oil/grease recycling companies, contact CalRecycle www.calrecycle.ca.gov or contact your local sanitation district.

Managing Spills

- Clean food spills in loading and trash areas by using absorbent materials and sweeping then mopping.
- Discharge mop water into the sewer through a grease interceptor.
- Have spill containment and cleanup kits available.
- To report serious toxic spills, call 911.

Handling Toxic Chemicals

- Dispose of all unwanted toxics materials like cleaners, solvents and detergents through a hazardous waste hauler. These items are not trash!
- Use non-toxic cleaning products whenever possible.
- For information on hazardous waste transporters, call (888) 722-4234.

Dumpster Areas

- Keep dumpster lids closed and the areas around them clean.
- Do not fill with liquid waste or hose them out.
- Call your trash hauler to replace any dumpsters that are damaged or leaking.

Cleaning & Maintenance

- Clean equipment, floor mats, filters and garbage cans in a mop sink, wash rack or floor drain connected to a sanitary sewer.
- Sweep outside areas and put the debris in trash containers DO NOT hose down or sweep into the parking lot or street.
- Outside eating areas and sidewalks may not be hosed down or pressure washed UNLESS the following standards are met:
  - ✓ Use dry cleanup methods prior to any pressure washing – absorbing with kitty litter, sweeping, vacuuming, scraping off dried debris.
  - ✓ Wash waters must be captured for proper disposal: collected waters should be discharged to a sanitary drain.
  - ✓ DO NOT use any chemicals or detergents.
  - ✓ DO NOT wash or pour water in a parking lot, alley, sidewalk or street.

Mobile Food Trucks

- The potential for generating stormwater pollution as part of a mobile food business requires special attention. Cleaning activities are required to be conducted at an approved fixed location with a connection to a sanitary sewer. For more information contact Riverside County Environmental Health at (888) 722-4234.
- Do not discharge wash water into storm drains.
- Clean on a properly equipped wash pad and drain wastewater to a sanitary sewer system.

Food Waste Disposal

- Scrape food waste off of plates, pots and food prep areas and dispose of in the trash.
- Food scraps often contain grease, which can clog sewer pipes and result in costly sewer backups and overflows.
- Never put food waste down the drain.

RECYCLE
USED OIL

INF-2

Bioretention

BMP MAINTENANCE FACT SHEET
FOR
STRUCTURAL BMP INF-2 BIORETENTION

Bioretention (bioretention without underdrain) facilities are vegetated surface water systems that filter water through vegetation and soil, or engineered media prior to infiltrating into native soils. Bioretention facilities are designed to infiltrate the full design capture volume (DCV) into native soils. They have no underdrain, and no impermeable liner. Typical bioretention components include:

- Inflow distribution mechanisms (e.g., perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Shallow surface ponding for captured flows
- Side slope and basin bottom vegetation selected based on climate and ponding depth
- Non-floating mulch layer
- Media layer (planting mix or engineered media) capable of supporting vegetation growth
- Filter course layer consisting of aggregate to prevent the migration of fines into uncompacted native soils or the optional aggregate storage layer
- Optional aggregate storage layer for additional infiltration storage
- Uncompacted native soils at the bottom of the facility
- Overflow structure

Normal Expected Maintenance

Bioretention requires routine maintenance to: remove accumulated materials such as sediment, trash or debris; maintain vegetation health; maintain infiltration capacity of the media layer; replenish mulch; and maintain integrity of side slopes, inlets, energy dissipators, and outlets. A summary table of standard inspection and maintenance indicators is provided within this Fact Sheet.

Non-Standard Maintenance or BMP Failure

If any of the following scenarios are observed, the BMP is not performing as intended to protect downstream waterways from pollution and/or erosion. Corrective maintenance, increased inspection and maintenance, BMP replacement, or a different BMP type will be required.

- The BMP is not drained between storm events. Surface ponding longer than approximately 24 hours following a storm event may be detrimental to vegetation health, and surface ponding longer than approximately 96 hours following a storm event poses a risk of vector (mosquito) breeding. Poor drainage can result from clogging of the media layer, filter course, aggregate storage layer, underlying native soils, or outlet structure. The specific cause of the drainage issue must be determined and corrected. If it is determined that the underlying native soils have been compacted or do not have the infiltration capacity expected, the [City Engineer] shall be contacted prior to any additional repairs or reconstruction.
- Sediment, trash, or debris accumulation greater than 25% of the surface ponding volume within one month. This means the load from the tributary drainage area is too high, reducing BMP function or clogging the BMP. This would require pretreatment measures within the tributary area draining to the BMP to intercept the materials. Pretreatment components, especially for sediment, will extend the life of components that are more expensive to replace such as media, filter course, and aggregate layers.

- Erosion due to concentrated storm water runoff flow that is not readily corrected by adding erosion control blankets, adding stone at flow entry points, or minor re-grading to restore proper drainage according to the original plan. If the issue is not corrected by restoring the BMP to the original plan and grade, the [City Engineer] shall be contacted prior to any additional repairs or reconstruction.

Other Special Considerations

Bioretention is a vegetated structural BMP. Vegetated structural BMPs that are constructed in the vicinity of, or connected to, an existing jurisdictional water or wetland could inadvertently result in creation of expanded waters or wetlands. As such, vegetated structural BMPs have the potential to come under the jurisdiction of the United States Army Corps of Engineers, SDRWQCB, California Department of Fish and Wildlife, or the United States Fish and Wildlife Service. This could result in the need for specific resource agency permits and costly mitigation to perform maintenance of the structural BMP. Along with proper placement of a structural BMP, **routine maintenance is key to preventing this scenario**.

SUMMARY OF STANDARD INSPECTION AND MAINTENANCE FOR INF-2 BIORETENTION		
The property owner is responsible to ensure inspection, operation and maintenance of permanent BMPs on their property unless responsibility has been formally transferred to an agency, community facilities district, homeowners association, property owners association, or other special district. Maintenance frequencies listed in this table are average/typical frequencies. Actual maintenance needs are site-specific, and maintenance may be required more frequently. Maintenance must be performed whenever needed, based on maintenance indicators presented in this table. The BMP owner is responsible for conducting regular inspections to see when maintenance is needed based on the maintenance indicators. During the first year of operation of a structural BMP, inspection is recommended at least once prior to August 31 and then monthly from September through May. Inspection during a storm event is also recommended. After the initial period of frequent inspections, the minimum inspection and maintenance frequency can be determined based on the results of the first year inspections.		
Threshold/Indicator	**Maintenance Action**	**Typical Maintenance Frequency**
Accumulation of sediment, litter, or debris	Remove and properly dispose of accumulated materials, without damage to the vegetation or compaction of the media layer.	• Inspect monthly. If the BMP is 25% full* or more in one month, increase inspection frequency to monthly plus after every 0.1-inch or larger storm event. • Remove any accumulated materials found at each inspection.
Obstructed inlet or outlet structure	Clear blockage.	• Inspect monthly and after every 0.5-inch or larger storm event. • Remove any accumulated materials found at each inspection.
Damage to structural components such as weirs, inlet or outlet structures	Repair or replace as applicable.	• Inspect annually. • Maintenance when needed.
Poor vegetation establishment	Re-seed, re-plant, or re-establish vegetation per original plans.	• Inspect monthly. • Maintenance when needed.
Dead or diseased vegetation	Remove dead or diseased vegetation, re-seed, re-plant, or re-establish vegetation per original plans.	• Inspect monthly. • Maintenance when needed.
Overgrown vegetation	Mow or trim as appropriate.	• Inspect monthly. • Maintenance when needed.
2/3 of mulch has decomposed, or mulch has been removed	Remove decomposed fraction and top off with fresh mulch to a total depth of 3 inches.	• Inspect monthly. • Replenish mulch annually, or more frequently when needed based on inspection.

*"25% full" is defined as ¼ of the depth from the design bottom elevation to the crest of the outflow structure (e.g., if the height to the outflow opening is 12 inches from the bottom elevation, then the materials must be removed when there is 3 inches of accumulation – this should be marked on the outflow structure).

SUMMARY OF STANDARD INSPECTION AND MAINTENANCE FOR INF-2 BIORETENTION (Continued from previous page)		
Threshold/Indicator	**Maintenance Action**	**Typical Maintenance Frequency**
Erosion due to concentrated irrigation flow	Repair/re-seed/re-plant eroded areas and adjust the irrigation system.	• Inspect monthly. • Maintenance when needed.
Erosion due to concentrated storm water runoff flow	Repair/re-seed/re-plant eroded areas, and make appropriate corrective measures such as adding erosion control blankets, adding stone at flow entry points, or minor re-grading to restore proper drainage according to the original plan. If the issue is not corrected by restoring the BMP to the original plan and grade, the [City Engineer] shall be contacted prior to any additional repairs or reconstruction.	• Inspect after every 0.5-inch or larger storm event. If erosion due to storm water flow has been observed, increase inspection frequency to after every 0.1-inch or larger storm event. • Maintenance when needed. If the issue is not corrected by restoring the BMP to the original plan and grade, the [City Engineer] shall be contacted prior to any additional repairs or reconstruction.
Standing water in BMP for longer than 24 hours following a storm event Surface ponding longer than approximately 24 hours following a storm event may be detrimental to vegetation health	Make appropriate corrective measures such as adjusting irrigation system, removing obstructions of debris or invasive vegetation, or repairing/replacing clogged or compacted soils. If it is determined that the underlying native soils have been compacted or do not have the infiltration capacity expected, the [City Engineer] shall be contacted prior to any additional repairs or reconstruction.	• Inspect monthly and after every 0.5-inch or larger storm event. If standing water is observed, increase inspection frequency to after every 0.1-inch or larger storm event. • Maintenance when needed.
Presence of mosquitos/larvae For images of egg rafts, larva, pupa, and adult mosquitos, see http://www.mosquito.org/biology	If mosquitos/larvae are observed: first, immediately remove any standing water by dispersing to nearby landscaping; second, make corrective measures as applicable to restore BMP drainage to prevent standing water. If mosquitos persist following corrective measures to remove standing water, or if the BMP design does not meet the 96-hour drawdown criteria because the underlying native soils have been compacted or do not have the infiltration capacity expected, the [City Engineer] shall be contacted to determine a solution. A different BMP type, or a Vector Management Plan prepared with concurrence from the County of San Diego Department of Environmental Health, may be required.	• Inspect monthly and after every 0.5-inch or larger storm event. If mosquitos are observed, increase inspection frequency to after every 0.1-inch or larger storm event. • Maintenance when needed.

References

American Mosquito Control Association.
http://www.mosquito.org/

California Storm Water Quality Association (CASQA). 2003. Municipal BMP Handbook.
https://www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook

County of San Diego. 2014. Low Impact Development Handbook.
http://www.sandiegocounty.gov/content/sdc/dpw/watersheds/susmp/lid.html

San Diego County Copermittees. 2016. Model BMP Design Manual, Appendix E, Fact Sheet INF-2.
http://www.projectcleanwater.org/index.php?option=com_content&view=article&id=250&Itemid=220

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INF-2

Bioretention

Date:	Inspector:	BMP ID No.:
Permit No.:	APN(s):	
Property / Development Name:	Responsible Party Name and Phone Number:	
Property Address of BMP:	Responsible Party Address:	

INSPECTION AND MAINTENANCE CHECKLIST FOR INF-2 BIORETENTION PAGE 1 of 5			
Threshold/Indicator	**Maintenance Recommendation**	**Date**	**Description of Maintenance Conducted**
Accumulation of sediment, litter, or debris Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Remove and properly dispose of accumulated materials, without damage to the vegetation ☐ If sediment, litter, or debris accumulation exceeds 25% of the surface ponding volume within one month (25% full*), add a forebay or other pre-treatment measures within the tributary area draining to the BMP to intercept the materials. ☐ Other / Comments:		
Poor vegetation establishment Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Re-seed, re-plant, or re-establish vegetation per original plans ☐ Other / Comments:		

*“25% full” is defined as ¼ of the depth from the design bottom elevation to the crest of the outflow structure (e.g., if the height to the outflow opening is 12 inches from the bottom elevation, then the materials must be removed when there is 3 inches of accumulation – this should be marked on the outflow structure).

INF-2

Bioretention

Date:	Inspector:	BMP ID No.:
Permit No.:	APN(s):	

INSPECTION AND MAINTENANCE CHECKLIST FOR INF-2 BIORETENTION PAGE 2 of 5

Threshold/Indicator	Maintenance Recommendation	Date	Description of Maintenance Conducted
Dead or diseased vegetation Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Remove dead or diseased vegetation, re-seed, re-plant, or re-establish vegetation per original plans ☐ Other / Comments:		
Overgrown vegetation Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Mow or trim as appropriate ☐ Other / Comments:		
2/3 of mulch has decomposed, or mulch has been removed Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Remove decomposed fraction and top off with fresh mulch to a total depth of 3 inches ☐ Other / Comments:		

Date:	Inspector:	BMP ID No.:
Permit No.:	APN(s):	

INSPECTION AND MAINTENANCE CHECKLIST FOR INF-2 BIORETENTION PAGE 3 of 5			
Threshold/Indicator	**Maintenance Recommendation**	**Date**	**Description of Maintenance Conducted**
Erosion due to concentrated irrigation flow Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Repair/re-seed/re-plant eroded areas and adjust the irrigation system ☐ Other / Comments:		
Erosion due to concentrated storm water runoff flow Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Repair/re-seed/re-plant eroded areas, and make appropriate corrective measures such as adding erosion control blankets, adding stone at flow entry points, or minor re-grading to restore proper drainage according to the original plan ☐ If the issue is not corrected by restoring the BMP to the original plan and grade, the [City Engineer] shall be contacted prior to any additional repairs or reconstruction ☐ Other / Comments:		

INF-2

Bioretention

Date:	Inspector:	BMP ID No.:
Permit No.:	APN(s):	

INSPECTION AND MAINTENANCE CHECKLIST FOR INF-2 BIORETENTION PAGE 4 of 5			
Threshold/Indicator	**Maintenance Recommendation**	**Date**	**Description of Maintenance Conducted**
Obstructed inlet or outlet structure Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Clear blockage ☐ Other / Comments:		
Damage to structural components such as weirs, inlet or outlet structures Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Repair or replace as applicable ☐ Other / Comments:		

Date:	Inspector:	BMP ID No.:
Permit No.:	APN(s):	

INSPECTION AND MAINTENANCE CHECKLIST FOR INF-2 BIORETENTION PAGE 5 of 5

Threshold/Indicator	Maintenance Recommendation	Date	Description of Maintenance Conducted
Standing water in BMP for longer than 24 hours following a storm event* Surface ponding longer than approximately 24 hours following a storm event may be detrimental to vegetation health Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Make appropriate corrective measures such as adjusting irrigation system, removing obstructions of debris or invasive vegetation, or repairing/replacing clogged or compacted soils. ☐ Other / Comments:		
Presence of mosquitos/larvae For images of egg rafts, larva, pupa, and adult mosquitos, see http://www.mosquito.org/biology Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Apply corrective measures to remove standing water in BMP when standing water occurs for longer than 24-96 hours following a storm event.** ☐ Other / Comments:		

*Surface ponding longer than approximately 24 hours following a storm event may be detrimental to vegetation health, and surface ponding longer than approximately 96 hours following a storm event poses a risk of vector (mosquito) breeding. Poor drainage can result from clogging of the media layer, filter course, aggregate storage layer, underdrain, or outlet structure. The specific cause of the drainage issue must be determined and corrected. If it is determined that the underlying native soils have been compacted or do not have the infiltration capacity expected, the [City Engineer] shall be contacted prior to any additional repairs or reconstruction.

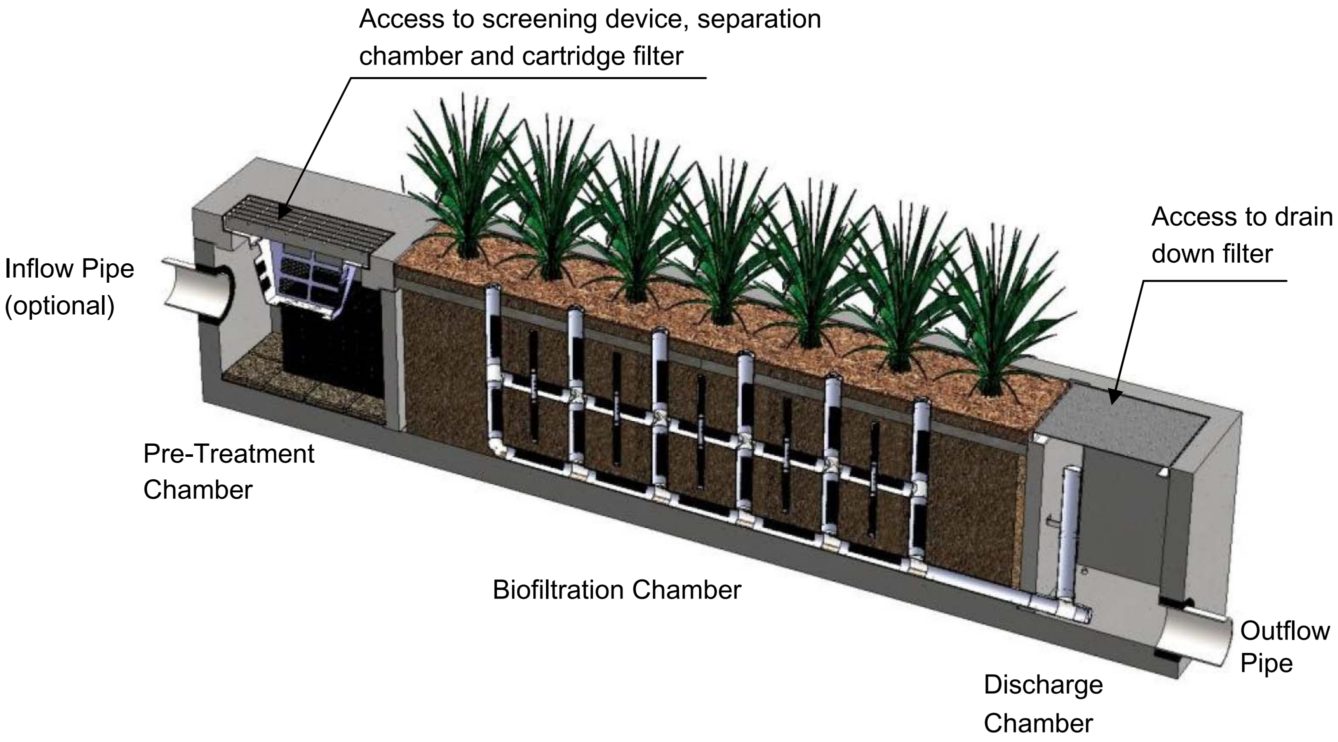
**If mosquitos persist following corrective measures to remove standing water, or if the BMP design does not meet the 96-hour drawdown criteria because the underlying native soils have been compacted or do not have the infiltration capacity expected, the [City Engineer] shall be contacted to determine a solution. A different BMP type, or a Vector Management Plan prepared with concurrence from the County of San Diego Department of Environmental Health, may be required.

Maintenance Guidelines for Modular Wetland System - Linear

Maintenance Summary

- Remove Trash from Screening Device – average maintenance interval is 6 to 12 months.
  - (*5 minute average service time*).
- Remove Sediment from Separation Chamber – average maintenance interval is 12 to 24 months.
  - (*10 minute average service time*).
- Replace Cartridge Filter Media – average maintenance interval 12 to 24 months.
  - (*10-15 minute per cartridge average service time*).
- Replace Drain Down Filter Media – average maintenance interval is 12 to 24 months.
  - (*5 minute average service time*).
- Trim Vegetation – average maintenance interval is 6 to 12 months.
  - (*Service time varies*).

System Diagram



Maintenance Procedures

Screening Device

1. Remove grate or manhole cover to gain access to the screening device in the Pre-Treatment Chamber. Vault type units do not have screening device. Maintenance can be performed without entry.
2. Remove all pollutants collected by the screening device. Removal can be done manually or with the use of a vacuum truck. The hose of the vacuum truck will not damage the screening device.
3. Screening device can easily be removed from the Pre-Treatment Chamber to gain access to separation chamber and media filters below. Replace grate or manhole cover when completed.

Separation Chamber

1. Perform maintenance procedures of screening device listed above before maintaining the separation chamber.
2. With a pressure washer spray down pollutants accumulated on walls and cartridge filters.
3. Vacuum out Separation Chamber and remove all accumulated pollutants. Replace screening device, grate or manhole cover when completed.

Cartridge Filters

1. Perform maintenance procedures on screening device and separation chamber before maintaining cartridge filters.
2. Enter separation chamber.
3. Unscrew the two bolts holding the lid on each cartridge filter and remove lid.
4. Remove each of 4 to 8 media cages holding the media in place.
5. Spray down the cartridge filter to remove any accumulated pollutants.
6. Vacuum out old media and accumulated pollutants.
7. Reinstall media cages and fill with new media from manufacturer or outside supplier. Manufacturer will provide specification of media and sources to purchase.
8. Replace the lid and tighten down bolts. Replace screening device, grate or manhole cover when completed.

Drain Down Filter

1. Remove hatch or manhole cover over discharge chamber and enter chamber.
2. Unlock and lift drain down filter housing and remove old media block. Replace with new media block. Lower drain down filter housing and lock into place.
3. Exit chamber and replace hatch or manhole cover.

Maintenance Notes

1. Following maintenance and/or inspection, it is recommended the maintenance operator prepare a maintenance/inspection record. The record should include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanisms.

2. The owner should keep maintenance/inspection record(s) 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.

3. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.

4. Entry into chambers may require confined space training based on state and local regulations.

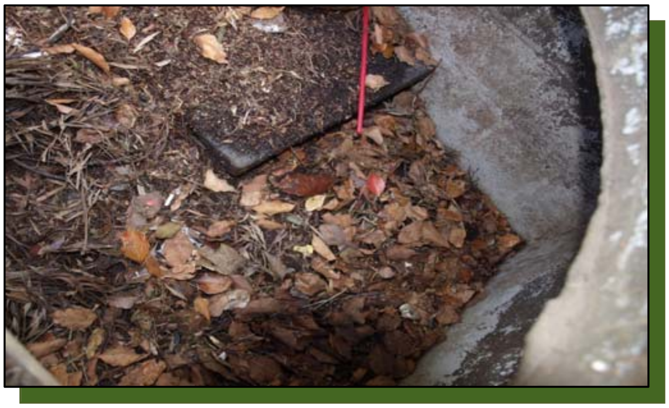
5. No fertilizer shall be used in the Biofiltration Chamber.

6. Irrigation should be provided as recommended by manufacturer and/or landscape architect. Amount of irrigation required is dependent on plant species. Some plants may require irrigation.

Maintenance Procedure Illustration

Screening Device

The screening device is located directly under the manhole or grate over the Pre-Treatment Chamber. It's mounted directly underneath for easy access and cleaning. Device can be cleaned by hand or with a vacuum truck.

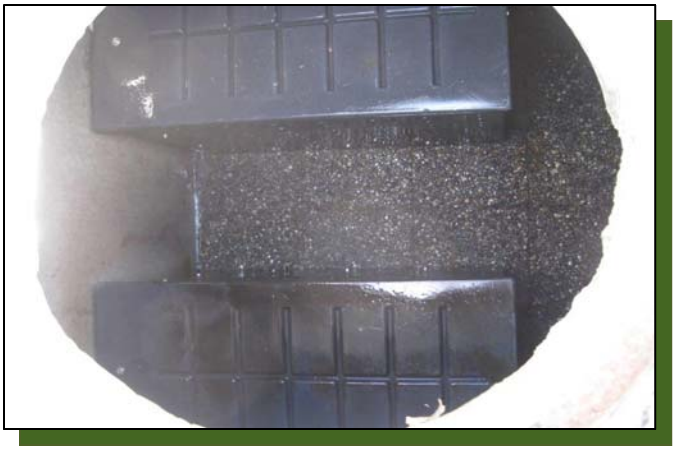


Separation Chamber

The separation chamber is located directly beneath the screening device. It can be quickly cleaned using a vacuum truck or by hand. A pressure washer is useful to assist in the cleaning process.

Cartridge Filters

The cartridge filters are located in the Pre-Treatment chamber connected to the wall adjacent to the biofiltration chamber. The cartridges have removable tops to access the individual media filters. Once the cartridge is open media can be easily removed and replaced by hand or a vacuum truck.



Drain Down Filter

The drain down filter is located in the Discharge Chamber. The drain filter unlocks from the wall mount and hinges up. Remove filter block and replace with new block.

Trim Vegetation

Vegetation should be maintained in the same manner as surrounding vegetation and trimmed as needed. No fertilizer shall be used on the plants. Irrigation per the recommendation of the manufacturer and or landscape architect. Different types of vegetation requires different amounts of irrigation.

Inspection Form

Modular Wetland System, Inc.
P. 760.433-7640
F. 760-433-3176
E. Info@modularwetlands.com

www.modularwetlands.com

Inspection Report
Modular Wetlands System

Project Name ______________________

Project Address ______________________ (city) (Zip Code)

Owner / Management Company ______________________

Contact ______________________ Phone (   )   –

Inspector Name ______________________ Date ____ / ____ / ______ Time __________ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition ______________________ Additional Notes ______________________

For Office Use Only
(Reviewed By)
(Date) Office personnel to complete section to the left.

Inspection Checklist

Modular Wetland System Type (Curb, Grate or UG Vault): __________ Size (22', 14' or etc.): __________

Structural Integrity:	**Yes**	**No**	**Comments**	
Damage to pre-treatment access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?				
Damage to discharge chamber access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?				
Does the MWS unit show signs of structural deterioration (cracks in the wall, damage to frame)?				
Is the inlet/outlet pipe or drain down pipe damaged or otherwise not functioning properly?				
Working Condition:				
Is there evidence of illicit discharge or excessive oil, grease, or other automobile fluids entering and clogging the unit?				
Is there standing water in inappropriate areas after a dry period?				
Is the filter insert (if applicable) at capacity and/or is there an accumulation of debris/trash on the shelf system?				
Does the depth of sediment/trash/debris suggest a blockage of the inflow pipe, bypass or cartridge filter? If yes, specify which one in the comments section. Note depth of accumulation in in pre-treatment chamber.				Depth:
Does the cartridge filter media need replacement in pre-treatment chamber and/or discharge chamber?			Chamber:	
Any signs of improper functioning in the discharge chamber? Note issues in comments section.				
Other Inspection Items:				
Is there an accumulation of sediment/trash/debris in the wetland media (if applicable)?				
Is it evident that the plants are alive and healthy (if applicable)? Please note Plant Information below.				
Is there a septic or foul odor coming from inside the system?				

Waste:	**Yes**	**No**
Sediment / Silt / Clay		
Trash / Bags / Bottles		
Green Waste / Leaves / Foliage		

Recommended Maintenance	
No Cleaning Needed	
Schedule Maintenance as Planned	
Needs Immediate Maintenance	

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes: ______________________

____

____

Maintenance Report

Modular Wetland System, Inc.
P. 760.433-7640
F. 760-433-3176
E. Info@modularwetlands.com

www.modularwetlands.com

Cleaning and Maintenance Report
Modular Wetlands System

For Office Use Only

(Reviewed By)

(Date)
Office personnel to complete section to the left.

Project Name ______________________________

Project Address ______________________________
(city) (Zip Code)

Owner / Management Company ______________________________

Contact ______________________________ Phone ( ) –

Inspector Name ______________________________ Date ____/____/______ Time __________ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition ______________________________ Additional Notes ______________________________

Site Map #	GPS Coordinates of Insert	Manufacturer / Description / Sizing	Trash Accumulation	Foliage Accumulation	Sediment Accumulation	Total Debris Accumulation	Condition of Media 25/50/75/100 (will be changed @ 75%)	Operational Per Manufactures' Specifications (If not, why?)
	Lat: Long:	MWS Catch Basins						
		MWS Sedimentation Basin						
		Media Filter Condition						
		Plant Condition						
		Drain Down Media Condition						
		Discharge Chamber Condition						
		Drain Down Pipe Condition						
		Inlet and Outlet Pipe Condition						

Comments:

3.5 Bioretention Facility

Type of BMP	LID – Bioretention
Treatment Mechanisms	Infiltration, Evapotranspiration, Evaporation, Biofiltration
Maximum Drainage Area	This BMP is intended to be integrated into a project's landscaped area in a distributed manner. Typically, contributing drainage areas to Bioretention Facilities range from less than 1 acre to a maximum of around 10 acres.
Other Names	Rain Garden, Bioretention Cell, Bioretention Basin, Biofiltration Basin, Landscaped Filter Basin, Porous Landscape Detention

Description

Bioretention Facilities are shallow, vegetated basins underlain by an engineered soil media. Healthy plant and biological activity in the root zone maintain and renew the macro-pore space in the soil and maximize plant uptake of pollutants and runoff. This keeps the Best Management Practice (BMP) from becoming clogged and allows more of the soil column to function as both a sponge (retaining water) and a highly effective and self-maintaining biofilter. In most cases, the bottom of a Bioretention Facility is unlined, which also provides an opportunity for infiltration to the extent the underlying onsite soil can accommodate. When the infiltration rate of the underlying soil is exceeded, fully biotreated flows are discharged via underdrains. Bioretention Facilities therefore will inherently achieve the maximum feasible level of infiltration and evapotranspiration and achieve the minimum feasible (but highly biotreated) discharge to the storm drain system.

Siting Considerations

These facilities work best when they are designed in a relatively level area. Unlike other BMPs, Bioretention Facilities can be used in smaller landscaped spaces on the site, such as:

- ✓ Parking islands
- ✓ Medians
- ✓ Site entrances

Landscaped areas on the site (such as may otherwise be required through minimum landscaping ordinances), can often be designed as Bioretention Facilities. This can be accomplished by:

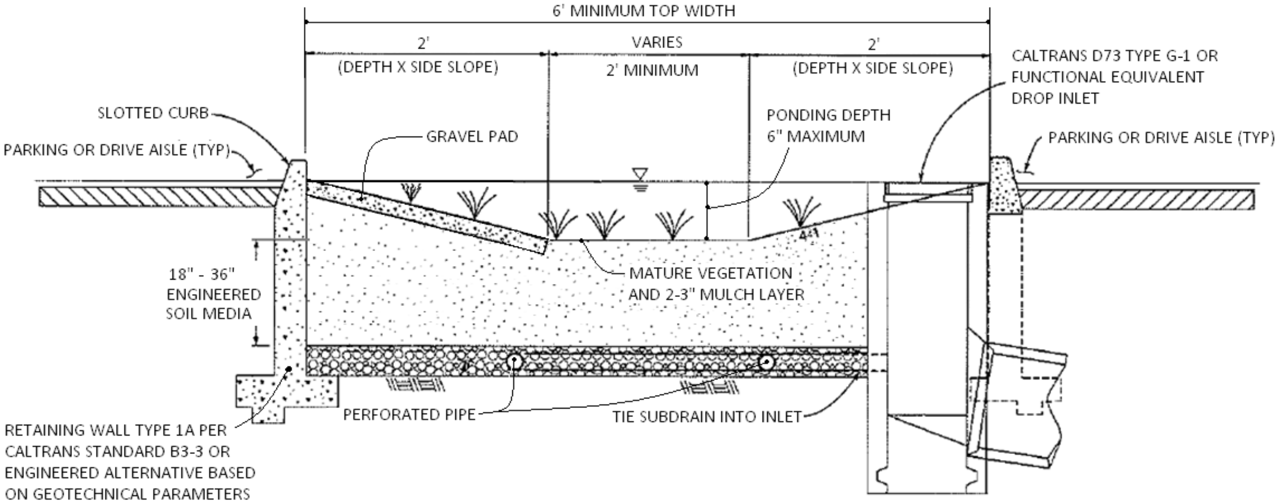
- *Depressing* landscaped areas below adjacent impervious surfaces, rather than elevating those areas
- Grading the site to direct runoff from those impervious surfaces *into* the Bioretention Facility, rather than away from the landscaping
- Sizing and designing the depressed landscaped area as a Bioretention Facility as described in this Fact Sheet

Bioretention Facilities should however not be used downstream of areas where large amounts of sediment can clog the system. Placing a Bioretention Facility at the toe of a steep slope should also be avoided due to the potential for clogging the engineered soil media with erosion from the slope, as well as the potential for damaging the vegetation.

Design and Sizing Criteria

The recommended cross section necessary for a Bioretention Facility includes:

- Vegetated area
- 18' minimum depth of engineered soil media
- 12' minimum gravel layer depth with 6' perforated pipes (added flow control features such as orifice plates may be required to mitigate for HCOC conditions)



While the 18-inch minimum engineered soil media depth can be used in some cases, it is recommended to use 24 inches or a preferred 36 inches to provide an adequate root zone for the chosen plant palate. Such a design also provides for improved removal effectiveness for nutrients. The recommended ponding depth inside of a Bioretention Facility is 6 inches; measured from the flat bottom surface to the top of the water surface as shown in Figure 1.

Because this BMP is filled with an engineered soil media, pore space in the soil and gravel layer is assumed to provide storage volume. However, several considerations must be noted:

- Surcharge storage above the soil surface (6 inches) is important to assure that design flows do not bypass the BMP when runoff exceeds the soil's absorption rate.
- In cases where the Bioretention Facility contains engineered soil media deeper than 36 inches, the pore space within the engineered soil media can only be counted to the 36-inch depth.
- A maximum of 30 percent pore space can be used for the soil media whereas a maximum of 40 percent pore space can be use for the gravel layer.

Figure 1: Standard Layout for a Bioretention Facility

Engineered Soil Media Requirements

The engineered soil media shall be comprised of 85 percent mineral component and 15 percent organic component, by volume, drum mixed prior to placement. The mineral component shall be a Class A sandy loam topsoil that meets the range specified in Table 1 below. The organic component shall be nitrogen stabilized compost[1], such that nitrogen does not leach from the media.

Table 1: Mineral Component Range Requirements

Percent Range	Component
70-80	Sand
15-20	Silt
5-10	Clay

The trip ticket, or certificate of compliance, shall be made available to the inspector to prove the engineered mix meets this specification.

Vegetation Requirements

Vegetative cover is important to minimize erosion and ensure that treatment occurs in the Bioretention Facility. The area should be designed for at least 70 percent mature coverage throughout the Bioretention Facility. To prevent the BMP from being used as walkways, Bioretention Facilities shall be planted with a combination of small trees, densely planted shrubs, and natural grasses. Grasses shall be native or ornamental; preferably ones that do not need to be mowed. The application of fertilizers and pesticides should be minimal. To maintain oxygen levels for the vegetation and promote biodegradation, it is important that vegetation not be completely submerged for any extended period of time. Therefore, a maximum of 6 inches of ponded water shall be used in the design to ensure that plants within the Bioretention Facility remain healthy.

A 2 to 3-inch layer of standard shredded aged hardwood mulch shall be placed as the top layer inside the Bioretention Facility. The 6-inch ponding depth shown in Figure 1 above shall be measured from the top surface of the 2 to 3-inch mulch layer.

Curb Cuts

To allow water to flow into the Bioretention Facility, 1-foot-wide (minimum) curb cuts should be placed approximately every 10 feet around the perimeter of the Bioretention Facility. Figure 2 shows a curb cut in a Bioretention Facility. Curb cut flow lines must be at or above the V_{BMP} water surface level.

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[1] For more information on compost, visit the US Composting Council website at: http://compostingcouncil.org/

Figure 2: Curb Cut located in a Bioretention Facility

To reduce erosion, a gravel pad shall be placed at each inlet point to the Bioretention Facility. The gravel should be 1- to 1.5-inch diameter in size. The gravel should overlap the curb cut opening a minimum of 6 inches. The gravel pad inside the Bioretention Facility should be flush with the finished surface at the curb cut and extend to the bottom of the slope.

In addition, place an apron of stone or concrete, a foot square or larger, inside each inlet to prevent vegetation from growing up and blocking the inlet. See Figure 3.

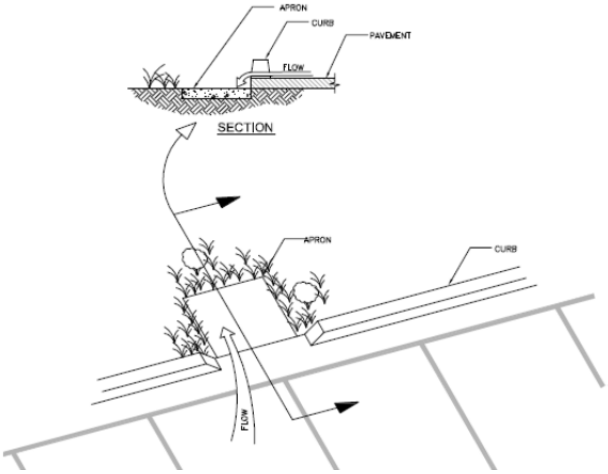


Figure 3: Apron located in a Bioretention Facility

Terracing the Landscaped Filter Basin

It is recommended that Bioretention Facilities be level. In the event the facility site slopes and lacks proper design, water would fill the lowest point of the BMP and then discharge from the basin without being treated. To ensure that the water will be held within the Bioretention Facility on sloped sites, the BMP must be terraced with nonporous check dams to provide the required storage and treatment capacity.

The terraced version of this BMP shall be used on non-flat sites with no more than a 3 percent slope. The surcharge depth cannot exceed 0.5 feet, and side slopes shall not exceed 4:1. Table 2 below shows the spacing of the check dams, and slopes shall be rounded up (i.e., 2.5 percent slope shall use 10' spacing for check dams).

Table 2: Check Dam Spacing

6” Check Dam Spacing	
Slope	**Spacing**
1%	*25'*
2%	*15'*
3%	*10'*

Roof Runoff

Roof downspouts may be directed towards Bioretention Facilities. However, the downspouts must discharge onto a concrete splash block to protect the Bioretention Facility from erosion.

Retaining Walls

It is recommended that Retaining Wall Type 1A, per Caltrans Standard B3-3 or equivalent, be constructed around the entire perimeter of the Bioretention Facility. This practice will protect the sides of the Bioretention Facility from collapsing during construction and maintenance or from high service loads adjacent to the BMP. Where such service loads would not exist adjacent to the BMP, an engineered alternative may be used if signed by a licensed civil engineer.

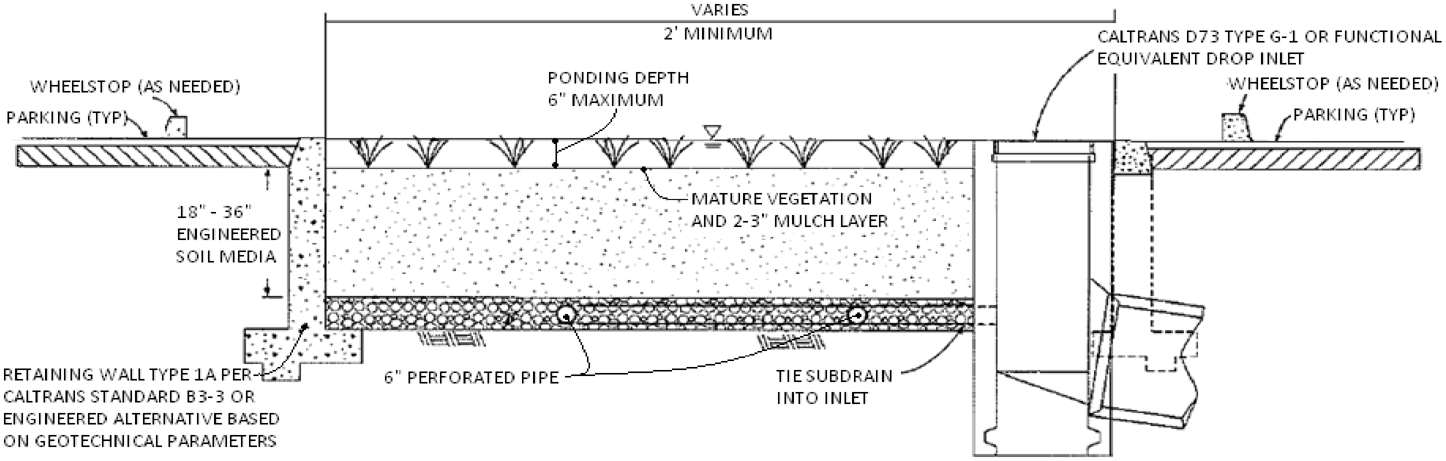
Side Slope Requirements

Bioretention Facilities Requiring Side Slopes

The design should assure that the Bioretention Facility does not present a tripping hazard. Bioretention Facilities proposed near pedestrian areas, such as areas parallel to parking spaces or along a walkway, must have a gentle slope to the bottom of the facility. Side slopes inside of a Bioretention Facility shall be 4:1. A typical cross section for the Bioretention Facility is shown in Figure 1.

Bioretention Facilities Not Requiring Side Slopes

Where cars park perpendicular to the Bioretention Facility, side slopes are not required. A 6-inch maximum drop may be used, and the Bioretention Facility must be planted with trees and shrubs to prevent pedestrian access. In this case, a curb is not placed around the Bioretention Facility,
but wheel stops shall be used to prevent vehicles from entering the Bioretention Facility, as shown in Figure 4.



Planter Boxes

Bioretention Facilities can also be placed above ground as planter boxes. Planter boxes must have a minimum width of 2 feet, a maximum surcharge depth of 6 inches, and no side slopes are necessary. Planter boxes must be constructed so as to ensure that the top surface of the engineered soil media will remain level. This option may be constructed of concrete, brick, stone or other stable materials that will not warp or bend. Chemically treated wood or galvanized steel, which has the ability to contaminate stormwater, should not be used. Planter boxes must be lined with an impermeable liner on all sides, including the bottom. Due to the impermeable liner, the inside bottom of the planter box shall be designed and constructed with a cross fall, directing treated flows within the subdrain layer toward the point where subdrain exits the planter box, and subdrains shall be oriented with drain holes oriented down. These provisions will help avoid excessive stagnant water within the gravel underdrain layer. Similar to the in-ground Bioretention Facility versions, this BMP benefits from healthy plants and biological activity in the root zone. Planter boxes should be planted with appropriately selected vegetation.

Figure 5: Planter Box

Source: LA Team Effort

Overflow

An overflow route is needed in the Bioretention Facility design to bypass stored runoff from storm events larger than V_{BMP} or in the event of facility or subdrain clogging. Overflow systems must connect to an acceptable discharge point, such as a downstream conveyance system as shown in Figure 1 and Figure 4. The inlet to the overflow structure shall be elevated inside the Bioretention Facility to be flush with the ponding surface for the design capture volume (V_{BMP}) as shown in Figure 4. This will allow the design capture volume to be fully treated by the Bioretention Facility, and for larger events to safely be conveyed to downstream systems. The overflow inlet shall **not** be located in the entrance of a Bioretention Facility, as shown in Figure 6.

Underdrain Gravel and Pipes

An underdrain gravel layer and pipes shall be provided in accordance with Appendix B – Underdrains.

Figure 6: Incorrect Placement of an Overflow Inlet.

Inspection and Maintenance Schedule

The Bioretention Facility area shall be inspected for erosion, dead vegetation, soggy soils, or standing water. The use of fertilizers and pesticides on the plants inside the Bioretention Facility should be minimized.

Schedule	Activity
Ongoing	• Keep adjacent landscape areas maintained. Remove clippings from landscape maintenance activities. • Remove trash and debris • Replace damaged grass and/or plants • Replace surface mulch layer as needed to maintain a 2-3 inch soil cover.
After storm events	• Inspect areas for ponding
Annually	• Inspect/clean inlets and outlets

Bioretention Facility Design Procedure

1) Enter the area tributary, A_T, to the Bioretention Facility.

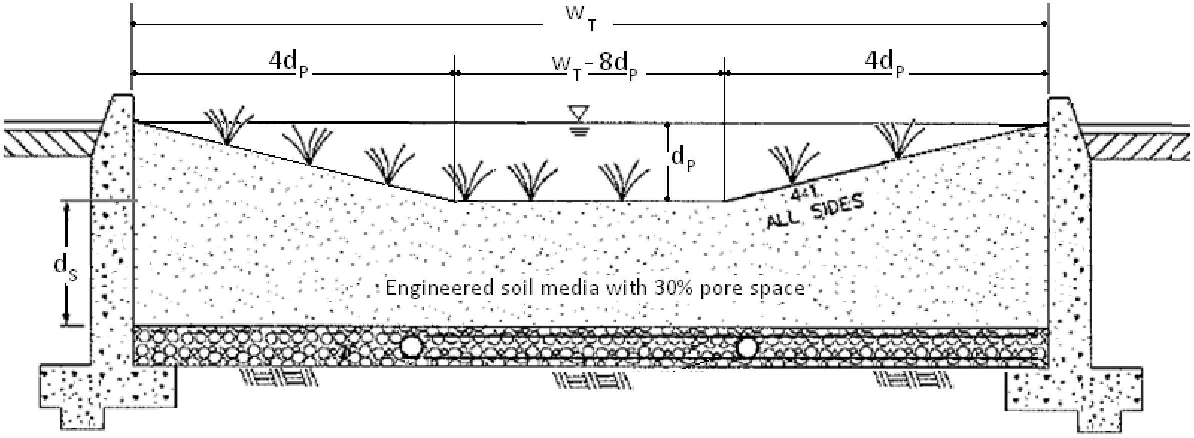
2) Enter the Design Volume, $V_{BMP,}$ determined from Section 2.1 of this Handbook.

3) Select the type of design used. There are two types of Bioretention Facility designs: the standard design used for most project sites that include side slopes, and the modified design used when the BMP is located perpendicular to the parking spaces or with planter boxes that do not use side slopes.

4) Enter the depth of the engineered soil media, d_S. The minimum depth for the engineered soil media can be 18' in limited cases, but it is recommended to use 24' or a preferred 36' to provide an adequate root zone for the chosen plant palette. Engineered soil media deeper than 36' will only get credit for the pore space in the first 36'.

5) Enter the top width of the Bioretention Facility.

6) Calculate the total effective depth, d_E, within the Bioretention Facility. The maximum allowable pore space of the soil media is 30% while the maximum allowable pore space for the gravel layer is 40%. Gravel layer deeper than 12' will only get credit for the pore space in the first 12'.



   a. For the design with side slopes the following equation shall be used to determine the total effective depth. Where, d_P is the depth of ponding within the basin.

$$d_E(ft) = \frac{0.3 \times \left[\left(w_T(ft) \times d_S(ft)\right) + 4\left(d_P(ft)\right)^2\right] + 0.4 \times 1(ft) + d_P(ft)\left[4d_P(ft) + \left(w_T(ft) - 8d_P(ft)\right)\right]}{w_T(ft)}$$

   This above equation can be simplified if the maximum ponding depth of 0.5' is used. The equation below is used on the worksheet to find the minimum area required for the Bioretention Facility:

$$d_E(ft) = (0.3 \times d_S(ft) + 0.4 \text{ x } 1(ft)) - \left(\frac{0.7\ (ft^2)}{w_T(ft)}\right) + 0.5(ft)$$

b. For the design without side slopes the following equation shall be used to determine the total effective depth:

$$\mathrm{d_E(ft) = d_P(ft) + [(0.3) \times d_S(ft) + \ (0.4) \ \times 1(ft)]}$$

The equation below, using the maximum ponding depth of 0.5', is used on the worksheet to find the minimum area required for the Bioretention Facility:

$$\mathrm{d_E(ft) = 0.5 \ (ft) + [(0.3) \times d_S(ft) + \ (0.4) \ \times 1(ft)]}$$

7) Calculate the minimum surface area, A_M, required for the Bioretention Facility. This does not include the curb surrounding the Bioretention Facility or side slopes.

$$\mathrm{A_M(ft^2) = \frac{V_{BMP}(ft^3)}{d_E \ (ft)}}$$

8) Enter the proposed surface area. This area shall not be less than the minimum required surface area.

9) Verify that side slopes are no steeper than 4:1 in the standard design, and are not required in the modified design.

10) Provide the diameter, minimum 6 inches, of the perforated underdrain used in the Bioretention Facility. See Appendix B for specific information regarding perforated pipes.

11) Provide the slope of the site around the Bioretention Facility, if used. The maximum slope is 3 percent for a standard design.

12) Provide the check dam spacing, if the site around the Bioretention Facility is sloped.

13) Describe the vegetation used within the Bioretention Facility.

References Used to Develop this Fact Sheet

Anderson, Dale V. "Landscaped Filter Basin Soil Requirements." Riverside, May 2010.

California Department of Transportation. CalTrans Standard Plans. 15 September 2005. May 2010 <http://www.dot.ca.gov/hq/esc/oe/project_plans/HTM/stdplns-met-new99.htm>.

Camp Dresser and McKee Inc.; Larry Walker Associates. California Stormwater Best Management Practice Handbook for New Development and Redevelopment. California Stormwater Quality Association (CASQA), 2004.

Contra Costa Clean Water Program. Stormwater Quality Requirements for Development Applications. 3rd Edition. Contra Costa, 2006.

County of Los Angeles Public Works. Stormwater Best Management Practice Design and Maintenance Manual. Los Angeles, 2009.

Kim, Hunho, Eric A. Seagren and Allen P. Davis. "Engineered Bioretention for Removal of Nitrate from Stormwater Runoff." Water Environment Research 75.4 (2003): 355-366.

LA Team Effort. LA Team Effort: FREE Planter Boxes for Businesses. 2 November 2009. May 2010 <http://lateameffort.blogspot.com/2009/11/free-planter-boxes-for-businesses-est.html>.

Montgomery County Maryland Department of Permitting Services Water Resources Section. Biofiltration (BF). Montgomery County, 2005.

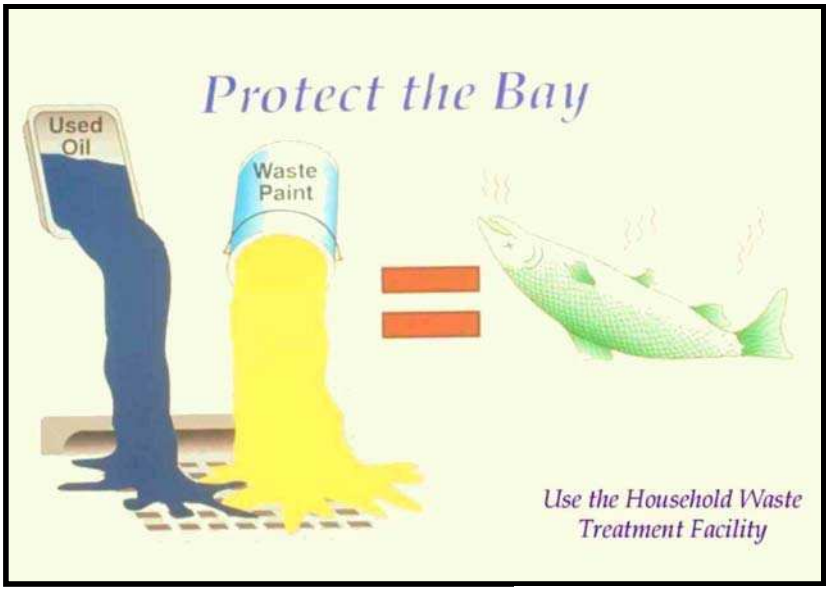
Program, Ventura Countywide Stormwater Quality Management. Technical Guidance Manual for Stormwater Quality Control Measures. Ventura, 2002.

United States Environmental Protection Agency. Storm Water Technology Fact Sheet Bioretention. Washington D.C, 1999.

Urban Drainage and Flood Control District. Urban Storm Drainage Criteria Manual Volume 3 - Best Management Practices. Vol. 3. Denver, 2008. 3 vols.

Urbonas, Ben R. Stormwater Sand Filter Sizing and Design: A Unit Operations Approach. Denver: Urban Drainage and Flood Control District, 2002.

Non-Stormwater Discharges SC-10



Graphic by: Margie Winter

Objectives

- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Non-stormwater discharges are those flows that do not consist entirely of stormwater. For municipalities non-stormwater discharges present themselves in two situations. One is from fixed facilities owned and/or operated by the municipality. The other situation is non-stormwater discharges that are discovered during the normal operation of a field program. Some non-stormwater discharges do not include pollutants and may be discharged to the storm drain. 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 car washing, and surface cleaning. However, there are certain non-stormwater discharges that pose environmental concern. These discharges may originate from illegal dumping or from internal floor drains, appliances, industrial processes, sinks, and toilets that are connected to the nearby storm drainage system. These discharges (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. The ultimate goal is to effectively eliminate non-stormwater discharges to the stormwater drainage system through implementation of measures to detect, correct, and enforce against illicit connections and illegal discharges.

Approach

The municipality must address non-stormwater discharges from its fixed facilities by assessing the types of non-stormwater discharges and implementing BMPs for the discharges determined to pose environmental concern. For field programs

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the field staff must be trained to now what to look for regarding non-stormwater discharges and the procedures to follow in investigating the detected discharges.

Suggested Protocols

Fixed Facility

General

- Post "No Dumping" signs with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Stencil storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- Landscaping and beautification efforts of hot spots might 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.

Illicit Connections

- Locate discharges from the fixed facility drainage system to the municipal storm drain system through review of "as-built" piping schematics.
- Use techniques such as smoke testing, dye testing and television camera inspection (as noted below) to verify physical connections.
- Isolate problem areas and plug illicit discharge points.

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 several days following the end of a storm and groundwater may infiltrate the underground stormwater collection system. Also, non-stormwater discharges are often intermittent and may require periodic inspections.

Review Infield Piping

- Review the "as-built" piping schematic as a way to determine if there are any connections to the stormwater collection system.
- Inspect the path of floor drains in older buildings.

Smoke Testing

- Smoke testing of wastewater and stormwater collection systems is used to detect connections between the two systems.

- During dry weather the stormwater collection system is filled with smoke and then traced to sources. The appearance of smoke at the base of a toilet indicates that there may be a connection between the sanitary and the stormwater system.

Dye Testing

- A dye test can be performed by simply releasing a dye into either your sanitary or process wastewater system and examining the discharge points from the stormwater collection system for discoloration.

TV Inspection of Storm Sewer

- TV Cameras can be employed to visually identify illicit connections to the fixed facility storm drain system.

Illegal Dumping

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- Clean up spills on paved surfaces 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 fact sheet SC-11 Spill Prevention, Control, and Clean Up.

Field Program

General

- Develop clear protocols and lines of communication for effectively prohibiting non-stormwater discharges, especially ones that involve more than one jurisdiction and those that are not classified as hazardous, which are often not responded to as effectively as they need to be.
- Stencil storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as “Dump No Waste Drains to Stream” stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- See SC-74 Stormwater Drainage System Maintenance for additional information.

Field Inspection

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- During routine field program maintenance field staff should look for evidence of illegal discharges or illicit connection:
  - Is there evidence of spills such as paints, discoloring, etc.
  - Are there any odors associated with the drainage system
  - Record locations of apparent illegal discharges/illicit connections and notify appropriate investigating agency.
- If trained, conduct field investigation of non-stormwater discharges to determine whether they pose a threat to water quality.

Recommended Complaint Investigation Equipment

- Field Screening Analysis
  - pH paper or meter
  - Commercial stormwater pollutant screening kit that can detect for reactive phosphorus, nitrate nitrogen, ammonium nitrogen, specific conductance, and turbidity
  - Sample jars
  - Sample collection pole
  - A tool to remove access hole covers
- Laboratory Analysis
  - Sample cooler
  - Ice
  - Sample jars and labels
  - Chain of custody forms.
- Documentation
  - Camera
  - Notebook
  - Pens
  - Notice of Violation forms

- Educational materials

Reporting

- 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 onsite drainage points observed.
- Maintain documentation of illicit connection and illegal dumping incidents, including significant conditionally exempt discharges that are not properly managed.

Enforcement

- Educate the responsible party if identified on the impacts of their actions, explain the stormwater requirements, and provide information regarding Best Management Practices (BMP), as appropriate. Initiate follow-up and/or enforcement procedures.
- If an illegal discharge is traced to a commercial, residential or industrial source, conduct the following activities or coordinate the following activities with the appropriate agency:
  - Contact the responsible party to discuss methods of eliminating the non-stormwater discharge, including disposal options, recycling, and possible discharge to the sanitary sewer (if within POTW limits).
  - Provide information regarding BMPs to the responsible party, where appropriate.
  - Begin enforcement procedures, if appropriate.
  - Continue inspection and follow-up activities until the illicit discharge activity has ceased.
- If an illegal discharge is traced to a commercial or industrial activity, coordinate information on the discharge with the jurisdiction's commercial and industrial facility inspection program.

Training

- Train technical staff to identify and document illegal dumping incidents.
- 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 if one should occur. Employees should be familiar with the Spill Prevention Control and Countermeasure Plan.
- Train employees to identify non-stormwater discharges and report them to the appropriate departments.
- Train staff who have the authority to conduct surveillance and inspections, and write citations for those caught illegally dumping.

- Train municipal staff responsible for surveillance and inspection 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).
- Educate the identified responsible party on the impacts of his or her actions.

Spill Response and Prevention

- See SC-11 Spill Prevention Control and Clean Up

Other Considerations

- The elimination of illegal dumping is dependent on the availability, convenience, and cost of alternative means of disposal. The cost of fees for dumping at a proper waste disposal facility are often more than the fine for an illegal dumping offense, thereby discouraging people from complying with the law. The absence of routine or affordable pickup service for trash and recyclables in some communities also encourages illegal dumping. A lack of understanding regarding applicable laws or the inadequacy of existing laws may also contribute to the problem.
- Municipal codes should include sections prohibiting the discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.
- Many facilities do not have accurate, up-to-date schematic drawings.
- Can be difficult to locate illicit connections especially if there is groundwater infiltration.

Requirements

Costs

- Eliminating illicit connections can be expensive especially if structural modifications are required such re-plumbing cross connections under an existing slab.
- Minor cost to train field crews regarding the identification of non-stormwater discharges. The primary cost is for a fully integrated program to identify and eliminate illicit connections and illegal dumping. However, by combining with other municipal programs (i.e. pretreatment program) cost may be lowered.
- Municipal cost for containment and disposal may be borne by the discharger.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

What constitutes a "non-stormwater" discharge?

- Non-stormwater discharges are discharges not made up entirely of stormwater and include water used directly in the manufacturing process (process wastewater), air conditioning condensate and coolant, non-contact cooling water, cooling equipment condensate, outdoor secondary containment water, vehicle and equipment wash water, landscape irrigation, sink and drinking fountain wastewater, sanitary wastes, or other wastewaters.

Permit Requirements

- Current municipal NPDES permits require municipalities to effectively prohibit non-stormwater discharges unless authorized by a separate NPDES permit or allowed in accordance with the current NPDES permit conditions. Typically the current permits allow certain non-stormwater discharges in the storm drain system as long as the discharges are not significant sources of pollutants. In this context the following non-stormwater discharges are typically allowed:
  - Diverted stream flows;
  - Rising found waters;
  - Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20));
  - Uncontaminated pumped ground water;
  - Foundation drains;
  - Springs;
  - Water from crawl space pumps;
  - Footing drains;
  - Air conditioning condensation;
  - Flows from riparian habitats and wetlands;
  - Water line and hydrant flushing ;
  - Landscape irrigation;
  - Planned and unplanned discharges from potable water sources;
  - Irrigation water;
  - Individual residential car washing; and
  - Lawn watering.

Municipal facilities subject to industrial general permit requirements must include a certification that the stormwater collection system has been tested or evaluated for the presence of non-stormwater discharges. The state's General Industrial Stormwater Permit requires that non-stormwater discharges be eliminated prior to implementation of the facility's SWPPP.

Illegal Dumping

- 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)
  - Responsible parties

Outreach

One of the keys to success of reducing or eliminating illegal dumping is increasing the number of people on the street who are aware of the problem and who have the tools to at least identify the incident, if not correct it. There we a number of ways of accomplishing this:

- Train municipal staff from all departments (public works, utilities, street cleaning, parks and recreation, industrial waste inspection, hazardous waste inspection, sewer maintenance) to recognize and report the incidents.
- Deputize municipal staff who may come into contact with illegal dumping with the authority to write illegal dumping tickets for offenders caught in the act (see below).
- Educate the public. As many as 3 out of 4 people do not understand that in most communities the storm drain does not go to the wastewater treatment plant. Unfortunately, with the heavy emphasis in recent years on public education about solid waste management, including recycling and household hazardous waste, the sewer system (both storm and sanitary) has been the likely recipient of cross-media transfers of waste.
- Provide the public with a mechanism for reporting incidents such as a hot line and/or door hanger (see below).
- Help areas where incidents occur more frequently set up environmental watch programs (like crime watch programs).
- Train volunteers to notice and report the presence and suspected source of an observed pollutant to the appropriate public agency.

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  - Flows from riparian habitats and wetlands;
  - Water line and hydrant flushing ;
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  - Planned and unplanned discharges from potable water sources;
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  - Individual residential car washing; and
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Municipal facilities subject to industrial general permit requirements must include a certification that the stormwater collection system has been tested or evaluated for the presence of non-stormwater discharges. The state's General Industrial Stormwater Permit requires that non-stormwater discharges be eliminated prior to implementation of the facility's SWPPP.

Storm Drain Stenciling

- Stencil storm drain inlets with a message to prohibit illegal dumpings, especially in areas with waste handling facilities.
- Encourage public reporting of improper waste disposal by a HOTLINE number stenciled onto the storm drain inlet.
- See Supplemental Information section of this fact sheet for further detail on stenciling program approach.

Oil Recycling

- Contract collection and hauling of used oil to a private licensed used oil hauler/recycler.
- Comply with all applicable state and federal regulations regarding storage, handling, and transport of petroleum products.
- Create procedures for collection such as; collection locations and schedule, acceptable containers, and maximum amounts accepted.
- The California Integrated Waste Management Board has a Recycling Hotline, (800) 553-2962, that provides information and recycling locations for used oil.

Household Hazardous Waste

- Provide household hazardous waste (HHW) collection facilities. Several types of collection approaches are available including permanent, periodic, or mobile centers, curbside collection, or a combination of these systems.

Training

- Train municipal employees and contractors in proper and consistent methods for waste disposal.
- Train municipal employees to recognize and report illegal dumping.
- Train employees and subcontractors in proper hazardous waste management.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Federal Regulations (RCRA, SARA, CERCLA) and state regulations exist regarding the disposal of hazardous waste.
- Municipalities are required to have a used oil recycling element and a HHW element within their integrated waste management plan.
- Significant liability issues are involved with the collection, handling, and disposal of HHW.

Examples

The City of Palo Alto has developed a public participation program for reporting dumping violations. When a concerned citizen or public employee encounters evidence of illegal dumping, a door hanger (similar in format to hotel "Do Not Disturb" signs) is placed on the front doors in the neighborhood. The door hanger notes that a violation has occurred in the neighborhood, informs the reader why illegal dumping is a problem, and notes that illegal dumping carries a significant financial penalty. Information is also provided on what citizens can do as well as contact numbers for more information or to report a violation.

The Port of Long Beach has a state of the art database incorporating storm drain infrastructure, potential pollutant sources, facility management practices, and a pollutant tracking system.

The State Department of Fish and Game has a hotline for reporting violations called CalTIP (1-800-952-5400). The phone number may be used to report any violation of a Fish and Game code (illegal dumping, poaching, etc.).

The California Department of Toxic Substances Control's Waste Alert Hotline, 1-800-69TOXIC, can be used to report hazardous waste violations.

References and Resources

http://www.stormwatercenter.net/

California's Nonpoint Source Program Plan http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Stormwater Pollution Control Manual - http://dnr.metrokc.gov/wlr/dss/spcm.htm

Orange County Stormwater Program,
http://www.ocwatersheds.com/stormwater/swp_introduction.asp

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program
(http://www.projectcleanwater.org)

Santa Clara Valley Urban Runoff Pollution Prevention Program
http://www.scvurppp-w2k.com/pdf%20documents/PS_ICID.PDF

Spill Prevention, Control & Cleanup SC-11

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	
Nutrients	☑
Trash	
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Spills and leaks, if not properly controlled, can adversely impact the storm drain system and receiving waters. Due to the type of work or the materials involved, many activities that occur either at a municipal facility or as a part of municipal field programs have the potential for accidental spills and leaks. Proper spill response planning and preparation can enable municipal employees to effectively respond to problems when they occur and minimize the discharge of pollutants to the environment.

Approach

- An effective spill response and control plan should include:
  - Spill/leak prevention measures;
  - Spill response procedures;
  - Spill cleanup procedures;
  - Reporting; and
  - Training
- A well thought out and implemented plan can prevent pollutants from entering the storm drainage system and can be used as a tool for training personnel to prevent and control future spills as well.

Pollution Prevention

- Develop and implement a Spill Prevention Control and Response Plan. The plan should include:

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  - A description of the facility, the address, activities and materials involved
  - Identification of key spill response personnel
  - Identification of the potential spill areas or operations prone to spills/leaks
  - Identification of which areas should be or are bermed to contain spills/leaks
  - Facility map identifying the key locations of areas, activities, materials, structural BMPs, etc.
  - Material handling procedures
  - Spill response procedures including:
    - Assessment of the site and potential impacts
    - Containment of the material
    - Notification of the proper personnel and evacuation procedures
    - Clean up of the site
    - Disposal of the waste material and
    - Proper record keeping
- Product substitution – use less toxic materials (i.e. use water based paints instead of oil based paints)
- Recycle, reclaim, or reuse materials whenever possible. This will reduce the amount of materials that are brought into the facility or into the field.

Suggested Protocols

Spill/Leak Prevention Measures

- If possible, move material handling indoors, under cover, or away from storm drains or sensitive water bodies.
- Properly label all containers so that the contents are easily identifiable.
- Berm storage areas so that if a spill or leak occurs, the material is contained.
- Cover outside storage areas either with a permanent structure or with a seasonal one such as a tarp so that rain can not come into contact with the materials.
- Check containers (and any containment sumps) often for leaks and spills. Replace containers that are leaking, corroded, or otherwise deteriorating with containers in good condition. Collect all spilled liquids and properly dispose of them.

- Store, contain and transfer liquid materials in such a manner that if the container is ruptured or the contents spilled, they will not discharge, flow or be washed into the storm drainage system, surface waters, or groundwater.
- Place drip pans or absorbent materials beneath all mounted taps and at all potential drip and spill locations during the filling and unloading of containers. Any collected liquids or soiled absorbent materials should be reused/recycled or properly disposed of.
- For field programs, only transport the minimum amount of material needed for the daily activities and transfer materials between containers at a municipal yard where leaks and spill are easier to control.
- If paved, sweep and clean storage areas monthly, do not use water to hose down the area unless all of the water will be collected and disposed of properly.
- Install a spill control device (such as a tee section) in any catch basins that collect runoff from any storage areas if the materials stored are oil, gas, or other materials that separate from and float on water. This will allow for easier cleanup if a spill occurs.
- If necessary, protect catch basins while conducting field activities so that if a spill occurs, the material will be contained.

Training

- Educate employees about spill prevention, spill response and cleanup on a routine basis.
- Well-trained employees can reduce human errors that lead to accidental releases or spills:
    - The employees should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.
    - Employees should be familiar with the Spill Prevention Control and Countermeasure Plan if one is available.
- Training of staff from all municipal departments should focus on recognizing and reporting potential or current spills/leaks and who they should contact.
- Employees responsible for aboveground storage tanks and liquid transfers for large bulk containers should be thoroughly familiar with the Spill Prevention Control and Countermeasure Plan and the plan should be readily available.

Spill Response and Prevention

- Identify key spill response personnel and train employees on who they are.
- Store and maintain appropriate spill cleanup materials in a clearly marked location near storage areas; and train employees to ensure familiarity with the site's spill control plan and/or proper spill cleanup procedures.
- Locate spill cleanup materials, such as absorbents, where they will be readily accessible (e.g. near storage and maintenance areas, on field trucks).

- Follow the Spill Prevention Control and Countermeasure Plan if one is available.
- If a spill occurs, notify the key spill response personnel immediately. If the material is unknown or hazardous, the local fire department may also need to be contacted.
- If safe to do so, attempt to contain the material and block the nearby storm drains so that the area impacted is minimized. If the material is unknown or hazardous wait for properly trained personnel to contain the materials.
- Perform an assessment of the area where the spill occurred and the downstream area that it could impact. Relay this information to the key spill response and clean up personnel.

Spill Cleanup Procedures

- Small non-hazardous spills
  - Use a rag, damp cloth or absorbent materials for general clean up of liquids
  - Use brooms or shovels for the general clean up of dry materials
  - If water is used, it must be collected and properly disposed of. The wash water can not be allowed to enter the storm drain.
  - Dispose of any waste materials properly
  - Clean or dispose of any equipment used to clean up the spill properly
- Large non-hazardous spills
  - Use absorbent materials for general clean up of liquids
  - Use brooms, shovels or street sweepers for the general clean up of dry materials
  - If water is used, it must be collected and properly disposed of. The wash water can not be allowed to enter the storm drain.
  - Dispose of any waste materials properly
  - Clean or dispose of any equipment used to clean up the spill properly
- For hazardous or very large spills, a private cleanup company or Hazmat team may need to be contacted to assess the situation and conduct the cleanup and disposal of the materials.
- Chemical cleanups of material can be achieved with the use of absorbents, gels, and foams. Remove the adsorbent materials promptly and dispose of according to regulations.
- 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.

Reporting

- Report any spills immediately to the identified key municipal spill response personnel.

- Report spills in accordance with applicable reporting laws. Spills that pose an immediate threat to human health or the environment must be reported immediately to the Office of Emergency Service (OES)

- Spills that pose an immediate threat to human health or the environment may also need to be reported within 24 hours to the Regional Water Quality Control Board.

- Federal regulations require that any oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour)

- After the spill has been contained and cleaned up, a detailed report about the incident should be generated and kept on file (see the section on Reporting below). The incident may also be used in briefing staff about proper procedures

Other Considerations

- State regulations exist for facilities with a storage capacity of 10,000 gallons or more of petroleum to prepare a Spill Prevention Control and Countermeasure Plan (SPCC) Plan (Health & Safety Code Chapter 6.67).

- State regulations also exist for storage of hazardous materials (Health & Safety Code Chapter 6.95), including the preparation of area and business plans for emergency response to the releases or threatened releases.

- Consider requiring smaller secondary containment areas (less than 200 sq. ft.) to be connected to the sanitary sewer, if permitted to do so, prohibiting any hard connections to the storm drain.

Requirements

Costs

- Will vary depending on the size of the facility and the necessary controls.

- Prevention of leaks and spills is inexpensive. Treatment and/or disposal of wastes, contaminated soil and water is very expensive

Maintenance

- This BMP has no major administrative or staffing requirements. However, extra time is needed to properly handle and dispose of spills, which results in increased labor costs

Supplemental Information

Further Detail of the BMP

Reporting

Record keeping and internal reporting represent good operating practices because they can increase the efficiency of the response and containment of a spill. A good record keeping system helps the municipality minimize incident recurrence, correctly respond with appropriate containment and cleanup activities, and comply with legal requirements.

A record keeping and reporting system should be set up for documenting spills, leaks, and other discharges, including discharges of hazardous substances in reportable quantities. Incident records describe the quality and quantity of non-stormwater discharges to the storm drain.

These records should contain the following information:

- Date and time of the incident
- Weather conditions
- Duration of the spill/leak/discharge
- Cause of the spill/leak/discharge
- Response procedures implemented
- Persons notified
- Environmental problems associated with the spill/leak/discharge

Separate record keeping systems should be established to document housekeeping and preventive maintenance inspections, and training activities. All housekeeping and preventive maintenance inspections should be documented. Inspection documentation should contain the following information:

- The date and time the inspection was performed
- Name of the inspector
- Items inspected
- Problems noted
- Corrective action required
- Date corrective action was taken

Other means to document and record inspection results are field notes, timed and dated photographs, videotapes, and drawings and maps.

Examples

The City of Palo Alto includes spill prevention and control as a major element of its highly effective program for municipal vehicle maintenance shops.

References and Resources

King County Stormwater Pollution Control Manual - http://dnr.metrokc.gov/wlr/dss/spcm.htm

Orange County Stormwater Program
http://www.ocwatersheds.com/stormwater/swp_introduction.asp

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP)
http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf

Vehicle and Equipment Fueling SC-20

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

Sediment	
Nutrients	
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑
Oxygen Demanding	

Description

Spills and leaks that occur during vehicle and equipment fueling can contribute hydrocarbons, oil and grease, as well as heavy metals to stormwater runoff. Implementing the following management practices can help prevent fuel spills and leaks.

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.

Pollution Prevention

- Use properly maintained offsite fueling stations whenever possible. These businesses are better equipped to handle fuel and spills properly.

- Educate employees about pollution prevention measures and goals

- Focus pollution prevention activities on containment of spills and leaks, most of which may occur during liquid transfers.

Suggested Protocols

General

- "Spot clean" leaks and drips routinely. Leaks are not cleaned up until the absorbent is picked up and disposed of properly.

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- Label drains within the facility boundary, by paint/stencil (or equivalent), to indicate whether they flow to an oil/water separator, directly to the sewer, or to a storm drain. Labels are not necessary for plumbing fixtures directly connected to the sanitary sewer but may be useful to help eliminate confusion about where the drain leads.

- Post signs to remind employees not to top off the fuel tank when filling and signs that ban employees from changing engine oil or other fluids at that location.

- Report leaking vehicles to fleet maintenance.

- Install inlet catch basin equipped with a small sedimentation basin or grit chamber to remove large particles from stormwater in highly impervious areas. Proper maintenance of these devices is necessary.

- Accumulated non-contaminated stormwater (e.g., in a secondary containment) should be released prior to next storm.

- Ensure the following safeguards are in place:

    - Overflow protection devices on tank systems to warn the operator to automatically shutdown transfer pumps when the tank reaches full capacity.

    - Protective guards around tanks and piping to prevent vehicle or forklift damage.

    - Clearly tagging or labeling all valves to reduce human error.

    - Automatic shut off for severed fuel hoses.

Fuel Dispensing Areas

- Maintain clean fuel-dispensing areas using dry cleanup methods such as sweeping for removal of litter and debris, or use of rags and absorbents for leaks and spills. Do not wash down areas with water.

- Fit underground storage tanks with spill containment and overfill prevention systems meeting the requirements of Section 2635(b) of Title 23 of the California Code of Regulations.

- Fit fuel dispensing nozzles with "hold-open latches" (automatic shutoffs) except where prohibited by local fire departments.

- Post signs at the fuel dispenser or fuel island warning vehicle owners/operators against "topping off" of vehicle fuel tanks.

- Design fueling area to prevent stormwater runoff and spills.

- Cover fueling area with an overhanging roof structure or canopy so that precipitation cannot come in contact with the fueling area and if possible use a perimeter drain or slope pavement inward with drainage to a blind sump (must be properly maintained and water properly disposed of); pave area with concrete rather than asphalt.

- Apply a suitable sealant that protects the asphalt from spilled fuels in areas where covering is infeasible and the fuel island is surrounded by pavement.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Cover storm drains in the vicinity during transfer.

Outdoor Waste Receptacle Area

- Spot clean leaks and drips routinely to prevent runoff of spillage.
- Minimize the possibility of stormwater pollution from outside waste receptacles by using an effective combination of the following:
  - use only watertight waste receptacle(s) and keep the lid(s) closed, or
  - grade and pave the waste receptacle area to prevent runon of stormwater, or
  - install a roof over the waste receptacle area, or
  - install a low containment berm around the waste receptacle area, or
  - use and maintain drip pans under waste receptacles. Containment areas and drip pans must be properly maintained and collected water disposed of properly (e.g., to sanitary sewer). Several drip pans should be stored in a covered location near outdoor waste receptacle area so that they are always available, yet protected from precipitation when not in use.
- Post “no littering” signs.

Air/Water Supply Area

- Minimize the possibility of stormwater pollution from air/water supply areas by implementing an effective combination of the following:
  - spot clean leaks and drips routinely to prevent runoff of spillage, or
  - grade and pave the air/water supply area to prevent runon of stormwater, or
  - install a roof over the air/water supply area, or
  - install a low containment berm around the air/water supply area. Maintain containment areas and dispose of contaminated water properly (e.g., to sanitary sewer).

Inspection

- Aboveground Tank Leak and Spill Control:
  - Check for external corrosion and structural failure.

  - Check for spills and overfills due to operator error.
  - Check for failure of piping system.
  - Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.
  - Visually inspect new tank or container installation for loose fittings, poor welding, and improper or poorly fitted gaskets.
  - Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
  - Periodically, integrity testing should be conducted by a qualified professional.
- Inspect and clean, if necessary, storm drain inlets and catch basins within the facility boundary before October 1 each year.

Training

- Train all employees upon hiring and annually thereafter on proper methods for handling and disposing of waste. Make sure that all employees understand stormwater discharge prohibitions, wastewater discharge requirements, and these best management practices.
- Train employees on proper fueling and cleanup procedures.
- 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.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place stockpiles of spill cleanup materials where they are readily accessible.
- Use adsorbent materials on small spills and general cleaning rather than hosing down the area. Remove the adsorbent materials promptly and dispose properly.
- Store portable absorbent booms (long flexible shafts or barriers made of absorbent material) in unbermed fueling areas.
- Report spills promptly.
- Install an oil/water separator and connect to the sanitary sewer (if allowed), if a dead-end sump is not used to collect spills.

Other Considerations

- Carry out all federal and state requirements regarding underground storage tanks, or install above ground tanks.

Requirements

Costs

- The retrofitting of existing fueling areas to minimize stormwater exposure or spill runoff can be expensive. Good design must occur during the initial installation.
- Extruded curb along the "upstream" side of the fueling area to prevent stormwater runon is of modest cost.

Maintenance

- Clean oil/water separators at appropriate intervals.
- Keep ample supplies of spill cleanup materials onsite.
- Inspect fueling areas, storage tanks, catch basin inserts, containment areas, and drip pans on a regular schedule.

Supplemental Information

Design Considerations

Designing New Installations

The elements listed below should be included in the design and construction of new or substantially remodeled facilities.

Fuel Dispensing Areas

- Fuel dispensing areas must be paved with Portland cement concrete (or, equivalent smooth impervious surface), with a 2% to 4% slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents runon of stormwater to the extent practicable. The fuel dispensing area is defined as extending 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus 1 foot, whichever is less. The paving around the fuel dispensing area may exceed the minimum dimensions of the "fuel dispensing area" stated above.
- The fuel dispensing area must be covered, and the cover's minimum dimensions must be equal to or greater than the area within the grade break or the fuel dispensing area, as defined above. The cover must not drain onto the fuel dispensing area.
- If necessary install and maintain an oil control device in the appropriate catch basin(s) to treat runoff from the fueling area.

Outdoor Waste Receptacle Area

- Grade and pave the outdoor waste receptacle area to prevent runon of stormwater to the extent practicable.

Air/Water Supply Area

- Grade and pave the air/water supply area to prevent runon of stormwater to the extent practicable.

Designated Fueling Area

- If your facility has large numbers of mobile equipment working throughout the site and you currently fuel them with a mobile fuel truck, consider establishing a designated fueling area. With the exception of tracked equipment such as bulldozers and perhaps small forklifts, most vehicles should be able to travel to a designated area with little lost time. Place temporary "caps" over nearby catch basins or manhole covers so that if a spill occurs it is prevented from entering the storm drain.

Examples

The Spill Prevention Control and Countermeasure (SPCC) Plan, which is required by law for some facilities, is an effective program to reduce the number of accidental spills and minimize contamination of stormwater runoff.

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are also applicable to industrial facilities.

References and Resources

Best Management Practice Guide for Retail Gasoline Outlets, California Stormwater Quality Task Force. 1997.

King County Stormwater Pollution Control Manual – http//www.dnr.metrokc.gov/wlr/dss/spcm.htm

Orange County Stormwater Program http://www.ocwatersheds.com/StormWater/swp_introduction.asp

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP)

Vehicle and Equipment Cleaning SC-21

Photo Credit: Geoff Brosseau

Description

Wash water from vehicle and equipment cleaning activities performed outdoors or in areas where wash water flows onto the ground can contribute toxic hydrocarbons and other organic compounds, oils and greases, nutrients, phosphates, heavy metals, and suspended solids to stormwater runoff. Use of the procedures outlined below can prevent or reduce the discharge of pollutants to stormwater during vehicle and equipment cleaning.

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

Pollution Prevention

- If possible, use properly maintained off-site commercial washing and steam cleaning businesses whenever possible. These businesses are better equipped to handle and properly dispose of the wash waters.

- Good housekeeping practices can minimize the risk of contamination from wash water discharges.

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑
Oxygen Demanding	

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Suggested Protocols

General

- Use biodegradable, phosphate-free detergents for washing vehicles as appropriate.
- Mark the area clearly as a wash area.
- Post signs stating that only washing is allowed in wash area and that discharges to the storm drain are prohibited.
- Provide a trash container in wash area.
- Map on-site storm drain locations to avoid discharges to the storm drain system.
- Emphasize the connection between the storm drain system and runoff and help reinforce that car washing activities can have an affect on local water quality. This can be accomplished through storm drain stenciling programs.

Vehicle and Equipment Cleaning

- Design wash areas to properly collect and dispose of wash water when engine cleaning is conducted and when chemical additives, solvents, or degreasers are used. This may include installation of sumps or drain lines to collect wash water or construction of a berm around the designated area and grading of the area to collect wash water as well as prevent stormwater run-on.
- Consider washing vehicles and equipment inside the building if washing/cleaning must occur on-site. This will help to control the targeted constituents by directing them to the sanitary sewer.
- If washing must occur on-site and outdoor:
  - Use designated paved wash areas. Designated wash areas must be well marked with signs indicating where and how washing must be done. This area must be covered or bermed to collect the wash water and graded to direct the wash water to a treatment or disposal facility.
  - Oil changes and other engine maintenance cannot be conducted in the designated washing area. Perform these activities in a place designated for such activities.
  - Cover the wash area when not in use to prevent contact with rain water.
- Use hoses with nozzles that automatically turn off when left unattended.
- Perform pressure cleaning and steam cleaning off-site to avoid generating runoff with high pollutant concentrations. If done on-site, no pressure cleaning and steam cleaning should be done in areas designated as wellhead protection areas for public water supply.

Disposal

- Consider filtering and recycling wash water.

- Discharge equipment wash water to the sanitary sewer, a holding tank, or a process treatment system, regardless of the washing method used.

- Discharge vehicle wash water to (1) the sanitary sewer, a holding tank, or process treatment system or (2) an enclosed recycling system.

- Discharge wash water to sanitary sewer only after contacting the local sewer authority to find out if pretreatment is required.

Training

- Train employees on proper cleaning and wash water disposal procedures and conduct "refresher" courses on a regular basis.

- Train staff on proper maintenance measures for the wash area.

- Train employees and contractors on proper spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control and Cleanup.

- Keep your Spill Prevention Control and Counter Measure (SPCC) Plan up-to-date, and implement accordingly.

- Have spill cleanup materials readily available and in a known location.

- Clean up spills immediately and use dry methods if possible.

- Properly dispose of spill cleanup material.

Other Considerations (Limitations and Regulations)

- Some municipalities may require pretreatment and monitoring of wash water discharges to the sanitary sewer.

- Steam cleaning can generate significant pollutant concentrations requiring that careful consideration be given to the environmental impacts and compliance issues related to steam cleaning.

- Most car washing best management practices are inexpensive, and rely more on good housekeeping practices (where vehicles are washed, planning for the collection of wash water) than on expensive technology. However, the construction of a specialized area for vehicle washing can be expensive for municipal facilities. Also, for facilities that cannot recycle their wash water the cost of pre-treating wash water through either structural practices or planning for collection and hauling of contaminated water to sewage treatment plants can represent a cost limitation.

Requirements

Costs

- Capital costs vary depending on measures implemented

  - Low cost ($500-1,000) for berm construction,
  - Medium cost ($5,000-20,000) for plumbing modifications (including re-routing discharge to sanitary sewer and installing simple sump).
  - High cost ($30,000-150,000) for on-site treatment and recycling.

- O&M costs increase with increasing capital investment.

Maintenance

- Berm repair and patching.
- Sweep washing areas frequently to remove solid debris.
- Inspect and maintain sumps, oil/water separators, and on-site treatment/recycling units.

Supplemental Information

Design Considerations

Designated Cleaning Areas

- Washing operations outside should be conducted in a designated wash area having the following characteristics:
  - Paved with Portland cement concrete,
  - Covered and bermed to prevent contact with stormwater and contain wash water,
  - Sloped for wash water collection,
  - Equipped with an oil/water separator, if necessary.

Examples

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are applicable to industrial vehicle service facilities.

The U.S. Postal Service in West Sacramento has a new vehicle wash system that collects, filters, and recycles the wash water.

References and Resources

http://www.stormwatercenter.net/

King County - ftp://dnr.metrokc.gov/wlr/dss/spcm/Chapter%203.PDF

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP)
http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf

Outdoor Loading/Unloading SC-30

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

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 stormwater runoff or when the area is cleaned. Additionally, rainfall may wash pollutants from machinery used to unload or move materials. Loading and unloading of material may include package products, barrels, and bulk products. Implementation of the following protocols will prevent or reduce the discharge of pollutants to stormwater from outdoor loading/unloading of materials.

Approach

Pollution Prevention

- Keep accurate maintenance logs to evaluate materials removed and improvements made.
- Park tank trucks or delivery vehicles in designated areas so that spills or leaks can be contained.
- Limit exposure of materials with the potential to contaminate stormwater.
- Prevent stormwater runon.
- Regularly check equipment for leaks.

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Suggested Protocols

Loading and Unloading – General Guidelines

- Develop an operations plan that describes procedures for loading and/or unloading.
- Do not conduct loading and unloading during wet weather, whenever possible.
- Cover designated loading/unloading areas to reduce exposure of materials to rain.
- A seal or door skirt between delivery vehicles and building can reduce or prevent exposure to rain.
- Design loading/unloading area to prevent stormwater runon which would include grading or berming the area, and positioning roof downspouts so they direct stormwater away from the loading/unloading areas.
- If feasible, load and unload all materials and equipment in covered areas such as building overhangs at loading docks.
- 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 in the area.
- Grade and/or berm he loading/ unloading area to a drain that is connected to a dead-end sump.

Inspection

- Check loading and unloading equipment regularly for leaks, including valves, pumps, flanges and connections.
- Look for dust or fumes during loading or unloading operations.

Training

- Train employees (e.g. fork lift operators) and contractors on proper spill containment and cleanup.
- Employees trained in spill containment and cleanup should be present during the 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.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Keep your spill prevention Control and countermeasure (SPCC) Plan up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Space, material characteristics and/or time limitations may preclude all transfers from being performed indoors or under cover.

Requirements

Costs

- Should be low except when covering a large loading/unloading area.

Maintenance

- Conduct regular inspections and make repairs as necessary. The frequency of repairs will depend on the age of the facility.
- Check loading and unloading equipment regularly for leaks.
- Regular broom dry-sweeping of area.
- Conduct major clean-out of loading and unloading area and sump prior to October 1 of each year.

Supplemental Information

Further Detail of the BMP

Special Circumstances for Indoor Loading/Unloading of Materials

As appropriate loading or unloading of liquids should occur indoors 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.
    - Transfer area should be designed to prevent runon 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.

  - 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 (if allowed). 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

http://www.stormwatercenter.net/

King County - ftp://dnr.metrokc.gov/wlr/dss/spcm/Chapter%203.PDF

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP) -
http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf

Outdoor Container Storage SC-31

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	
Nutrients	☑
Trash	
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Accidental releases of materials from above ground liquid storage tanks, drums, and dumpsters present the potential for contaminating stormwaters with many different pollutants. Tanks may store many potential stormwater runoff pollutants, such as gasoline, aviation gas, diesel fuel, ammonia, solvents, syrups, etc. Materials spilled, leaked, or lost from storage tanks may accumulate in soils or on other surfaces and be carried away by rainfall runoff. These source controls apply to containers located outside of a building used to temporarily store liquid materials and include installing safeguards against accidental releases, installing secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques.

Approach

Pollution Prevention

- Educate employees about pollution prevention measures and goals

- Keep an accurate, up-to-date inventory of the materials delivered and stored on-site. Re-evaluate inventory needs and consider purchasing alternative products. Properly dispose of outdated products.

- Try to keep chemicals in their original containers, and keep them well labeled.

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Suggested Protocols

General

- Develop an operations plan that describes procedures for loading and/or unloading. Refer to SC-30 Outdoor Loading/Unloading for more detailed BMP information pertaining to loading and unloading of liquids.
- Protect materials from rainfall, runon, runoff, and wind dispersal:
  - Cover the storage area with a roof.
  - Minimize stormwater runon by enclosing the area or building a berm around it.
  - Use a "doghouse" structure for storage of liquid containers.
  - Use covered dumpsters for waste product containers.
- Employ safeguards against accidental releases:
  - Provide overflow protection devices to warn operator or automatic shut down transfer pumps.
  - Provide protection guards (bollards) around tanks and piping to prevent vehicle or forklift damage, and
  - Provide clear tagging or labeling, and restricting access to valves to reduce human error.
- Berm or surround tank or container with secondary containment system using dikes, liners, vaults, or double walled tanks.
- Contact the appropriate regulatory agency regarding environmental compliance for facilities with "spill ponds" designed to intercept, treat, and/or divert spills.
- Have registered and specifically trained professional engineers can identify and correct potential problems such as loose fittings, poor welding, and improper or poorly fitted gaskets for newly installed tank systems.

Storage Areas

- Provide storage tank piping located below product level with a shut-off valve at the tank; ideally this valve should be an automatic shear valve with the shut-off located inside the tank.
- Provide barriers such as posts or guard rails, where tanks are exposed, to prevent collision damage with vehicles.
- Provide secure storage to prevent vandalism.
- Place tight-fitting lids on all containers.
- Enclose or cover the containers where they are stored.

- Raise the containers off the ground by use of pallet or similar method, with provisions for spill control and secondary containment.

- Contain the material in such a manner that if the container leaks or spills, the contents will not discharge, flow, or be washed into the storm drainage system, surface waters or groundwater.

- Place drip pans or absorbent materials beneath all mounted container taps, and at all potential drip and spill locations during filling and unloading of containers. Drip pans must be cleaned periodically, and all collected liquids and soiled absorbent materials must be reused/recycled or properly disposed.

- Ensure that any underground or aboveground storage tanks shall be designed and managed in accordance with applicable regulations, be identified as a potential pollution source, have secondary containment, such as a berm or dike with an impervious surface.

- Rainfall collected in secondary containment system must not contain pollutants for discharge to storm drain system.

Container Management

- Keep containers in good condition without corrosion or leaky seams.

- Place containers in a lean-to structure or otherwise covered to keep rainfall from reaching the drums.

- Replace containers if they are deteriorating to the point where leakage is occurring. Keep all containers undercover to prevent the entry of stormwater. Employees should be made aware of the importance of keeping the containers free from leaks.

- Keep waste container drums in an area such as a service bay. Drums stored outside must be stored in a lean-to type structure, shed or walk-in container.

Storage of Hazardous Materials

- Storage of reactive, ignitable, or flammable liquids must comply with the fire and hazardous waste codes.

- Place containers in a designated area that is paved, free of cracks and gaps, and impervious in order to contain leaks and spills. The area should also be covered.

- Surround stored hazardous materials and waste with a curb or dike to provide the volume to contain 10 percent of the volume of all of the containers or 110 percent of the volume of the largest container, whichever is greater. The area inside the curb should slope to a drain and a dead-end sump should be installed in the drain.

Inspection

- Provide regular inspections:

  - Inspect storage areas regularly for leaks or spills.

- Conduct routine inspections and check for external corrosion of material containers. Also check for structural failure, spills and overfills due to operator error, failure of piping system.
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.
- Visually inspect new tank or container installations for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
- Replace containers that are leaking, corroded, or otherwise deteriorating with ones in good condition. If the liquid chemicals are corrosive, containers made of compatible materials must be used instead of metal drums.
- Label new or secondary containers with the product name and hazards.

Training

- Train employees (e.g. fork lift operators) and contractors in proper spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.
- Train employees in proper storage measures.
- Use a training log or similar method to document training.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date, and implement accordingly.
- 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.
- Employees trained in emergency spill cleanup procedures should be present when dangerous waste, liquid chemicals, or other wastes are delivered.
- Operator errors can be prevented by using engineering safe guards and thus reducing accidental releases of pollutant.
- Store and maintain appropriate spill cleanup materials in a location known to all near the tank storage area.
- See Aboveground Tank Leak and Spill Control section of the Spill Prevention, Control & Cleanup fact sheet (SC-11) for additional information.

Other Considerations

- Storage sheds often must meet building and fire code requirements.
- The local fire district must be consulted for limitations on clearance of roof covers over containers used to store flammable materials.
- All specific standards set by federal and state laws concerning the storage of oil and hazardous materials must be met.
- Storage of reactive, ignitable, or flammable liquids should comply with the Uniform Fire Code and the National Electric Code.
- Storage of oil and hazardous materials must meet specific federal and state standards including:
  - Spill Prevention Control and Countermeasure Plan (SPCC) Plan
  - Secondary containment
  - Integrity and leak detection monitoring
  - Emergency preparedness plans

Requirements

Costs

- Will vary depending on the size of the facility and the necessary controls, such as berms or safeguards against accidental controls.

Maintenance

- Conduct weekly inspection.
- Sweep and clean the storage area regularly if it is paved, do not hose down the area to a storm drain.

Supplemental Information

- The most common causes of unintentional releases are:
  - Installation problems,
  - Failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves),
  - External corrosion and structural failure,
  - Spills and overfills due to operator error, and
  - Leaks during pumping of liquids or gases from truck or rail car to a storage tank or vice versa

Further Detail of the BMP

Dikes

One of the best protective measures against contamination of stormwater is diking. Containment dikes are berms or retaining walls that are designed to hold spills. Diking is an effective pollution prevention measure for above ground storage tanks and railcar or tank truck loading and unloading areas. The dike surrounds the area of concern and holds the spill, keeping spill materials separated from the stormwater side of the dike area. Diking can be used in any industrial or municipal facility, but it is most commonly used for controlling large spills or releases from liquid storage areas and liquid transfer areas.

- For single-wall tanks, containment dikes should be large enough to hold the contents of the storage tank for the facility plus rain water.
- For trucks, diked areas should be capable of holding an amount equal to the volume of the tank truck compartment. Diked construction material should be strong enough to safely hold spilled materials.
- Dike materials can consist of earth, concrete, synthetic materials, metal, or other impervious materials.
- Strong acids or bases may react with metal containers, concrete, and some plastics.
- Where strong acids or bases or stored, alternative dike materials should be considered. More active organic chemicals may need certain special liners for dikes.
- Dikes may also be designed with impermeable materials to increase containment capabilities.
- Dikes should be inspected during or after significant storms or spills to check for washouts or overflows.
- Regular checks of containment dikes to insure the dikes are capable of holding spills should be conducted.
- Inability of a structure to retain stormwater, dike erosion, soggy areas, or changes in vegetation indicate problems with dike structures. Damaged areas should be patched and stabilized immediately.
- Accumulated stormwater in the containment are should be analyzed for pollutants before it is released to surface waters. If pollutants are found or if stormwater quality is not determined, then methods other than discharging to surface waters should be employed (e.g., discharge to sanitary sewer if allowed).
- Earthen dikes may require special maintenance of vegetation such as mulching and irrigation.

Curbing

Curbing is a barrier that surrounds an area of concern. Curbing is similar to containment diking in the way that it prevents spills and leaks from being released into the environment. The curbing is usually small scaled and does not contain large spills like diking. Curbing is common at many facilities in small areas where handling and transfer liquid materials occur. Curbing can redirect stormwater away from the storage area. It is useful in areas where liquid materials are transferred from one container to another. Asphalt is a common material used for curbing; however, curbing materials include earth, concrete, synthetic materials, metal, or other impenetrable materials.

- Spilled materials should be removed immediately from curbed areas to allow space for future spills.
- Curbs should have manually-controlled pump systems rather than common drainage systems for collection of spilled materials.
- The curbed area should be inspected regularly to clear clogging debris.
- Maintenance should also be conducted frequently to prevent overflow of any spilled materials as curbed areas are designed only for smaller spills.
- Curbing has the following advantages:
  - Excellent runon control,
  - Inexpensive,
  - Ease of installment,
  - Provides option to recycle materials spilled in curb areas, and
  - Common industry practice.

Examples

The "doghouse" design has been used to store small liquid containers. The roof and flooring design prevent contact with direct rain or runoff. The doghouse has two solid structural walls and two canvas covered walls. The flooring is wire mesh about secondary containment. The unit has been used successfully at Lockheed Missile and Space Company in Sunnyvale.

References and Resources

British Columbia Lake Stewardship Society. Best Management Practices to Protect Water Quality from Non-Point Source Pollution. March 2000 http://www.nalms.org/bclss/storage.html

King County Stormwater Pollution Control Manual – http://dnr.metrokc.gov/wlr/dss/spcm.htm

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP) -
http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf

Outdoor Equipment Maintenance SC-32

Description

Outside process equipment operations and maintenance can contaminate stormwater runoff. Activities, such as grinding, painting, coating, sanding, degreasing or parts cleaning, landfills and waste piles, solid waste treatment and disposal, are examples of process operations that can lead to contamination of stormwater runoff. Source controls for outdoor process equipment operations and maintenance include reducing the amount of waste created, enclosing or covering all or some of the equipment, installing secondary containment, and training employees.

Approach

Pollution Prevention

- Perform the activity during dry periods.
- Use non-toxic chemicals for maintenance and minimize or eliminate the use of solvents.

Suggested Protocols

- Consider enclosing the activity in a building and connecting the floor drains to the sanitary sewer.
- Cover the work area with a permanent roof.
- Minimize contact of stormwater with outside process equipment operations through berming and drainage routing (runon prevention). If allowed, connect process equipment area to public sewer.
- Dry clean the work area regularly.

Training

- Train employees to perform the activity during dry periods only and to use less or non-toxic materials.
- Train employee and contractors in proper techniques for spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑
Oxygen Demanding	

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Keep your spill prevention control and countermeasure (SPCC) plan up-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Space limitations may preclude enclosing some equipment.
- Storage sheds often must meet building and fire code requirements.

Requirements

Costs

- Costs vary depending on the complexity of the operation and the amount of control necessary for stormwater pollution control.
- Providing cover may be expensive.

Maintenance

- Conduct routine preventive maintenance, including checking process equipment for leaks.
- Clean the storm drain system regularly.

Supplemental Information

Further Detail of the BMP

Hydraulic/Treatment Modifications

In some cases it may be necessary to capture and treat polluted stormwater. If the municipality does not have its own process wastewater treatment system, consider discharging to the public sewer system. Use of the public sewer might be allowed under the following conditions:

- If the activity area is very small (less than a few hundred square feet), the local sewer authority may be willing to allow the area to remain uncovered with the drain connected to the public sewer.
- It may be possible under unusual circumstances to connect a much larger area to the public sewer, as long as the rate of stormwater discharges does not exceed the capacity of the wastewater treatment plant. The stormwater could be stored during the storm and then transferred to the public sewer when the normal flow is low, such as at night.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Stormwater Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Stormwater Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Stormwater Managers Resource Center http://www.stormwatercenter.net/

Waste Handling & Disposal SC-34

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

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, re-use, and recycling; and preventing runon and runoff.

Approach

Pollution Prevention

- Reduction in the amount of waste generated can be accomplished using the following source controls such as:
    - Production planning and sequencing
    - Process or equipment modification
    - Raw material substitution or elimination
    - Loss prevention and housekeeping
    - Waste segregation and separation
    - 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.

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Suggested Protocols

General

- 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 runon 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.
- Check storage 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 storage area regularly. If it is paved, do not hose down the area to a storm drain.
- 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.
- 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.

Controlling Litter

- 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 or leaks regularly. Repair or replace damaged containers as necessary.
- Secure solid waste containers; containers must be closed tightly when not in use.
- Place waste containers under cover if possible.
- 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.

Good Housekeeping

- Use all of the product before disposing of the container.
- 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 storm drains on the facility's property with prohibitive message regarding waste disposal.

Chemical/Hazardous Wastes

- Select designated hazardous waste collection areas on-site.
- Store hazardous materials and wastes in covered containers protected from vandalism, and in compliance with fire and hazardous waste codes.
- Place hazardous waste containers in secondary containment.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.

Runon/Runoff Prevention

- Prevent stormwater runon from entering the waste management area by enclosing the area or building a berm around the area.
- Prevent the waste materials from directly contacting rain.
- Cover waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropyleneor 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.
- Move the activity indoor after ensuring all safety concerns such as fire hazard and ventilation are addressed.

Inspection

- Inspect and replace faulty pumps or hoses regularly to minimize the potential of releases and spills.
- Check waste management areas for leaking containers or spills.
- Repair leaking equipment including valves, lines, seals, or pumps promptly.

Training

- Train staff pollution prevention measures and proper disposal methods.
- Train employees and contractors proper spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.
- Train employees and subcontractors in proper hazardous waste management.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.
- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.
- Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The spill prevention equipment includes:
    - Vehicles equipped with baffles for liquid waste
    - Trucks with sealed gates and spill guards for solid waste

Other Considerations

- Hazardous waste cannot be re-used or recycled; it must be disposed of by a licensed hazardous waste hauler.

Requirements

Costs

- Capital and operation and maintenance costs will vary substantially depending on the size of the facility and the types of waste handled. Costs should be low if there is an inventory program in place.

Maintenance

- None except for maintaining equipment for material tracking program.

Supplemental Information

Further Detail of the BMP

Land Treatment System

- Minimize the runoff of polluted stormwater from land application of municipal waste on-site by:
  - Choosing a site where slopes are under 6%, the soil is permeable, there is a low water table, it is located away from wetlands or marshes, there is a closed drainage system.
  - Avoiding application of waste to the site when it is raining or when the ground is saturated with water.
  - Growing vegetation on land disposal areas to stabilize soils and reduce the volume of surface water runoff from the site.
  - Maintaining adequate barriers between the land application site and the receiving waters. Planted strips are particularly good.
  - Using erosion control techniques such as mulching and matting, filter fences, straw bales, diversion terracing, and sediment basins.
  - Performing routine maintenance to ensure the erosion control or site stabilization measures are working.

References and Resources

King County Stormwater Pollution Control Manual - http://dnr.metrokc.gov/wlr/dss/spcm.htm

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Associations (BASMAA). On-line: http://www.basmaa.org

Building & Grounds Maintenance SC-41

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, and abnormal pH. Utilizing the following protocols 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

Pollution Prevention

- Switch to non-toxic chemicals for maintenance when 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.

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Suggested Protocols

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 waste 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 water 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 he 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. Ensure that this practice does not kill grass.

Landscaping Activities

- Do not apply any chemicals (insecticide, herbicide, or fertilizer) directly to surface waters, unless the application is approved and permitted by the state.
- 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.
- Check irrigation schedules so pesticides will not be washed away and to minimize non-stormwater discharge.

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 paint brushes 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. 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. In which case you should direct the water through hay bales and filter fabric or use other sediment filters or traps.

- Store toxic material under cover with secondary containment 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 or mechanical weeding where practical.

Fertilizer and Pesticide 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.

- Follow manufacturers' recommendations and label directions. Pesticides must never be applied if precipitation is occuring or predicted. Do not apply insecticides within 100 feet of surface waters such as lakes, ponds, wetlands, and streams.

- Use less toxic pesticides that will do the job, whenever possible. Avoid use of copper-based pesticides if possible.

- 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.

- Work fertilizers into the soil rather than dumping or broadcasting them 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.

- 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.

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.

Training

- Educate and train employees on use of pesticides 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 nature of the staff.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup

- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, and implement accordingly.

- Have spill cleanup materials readily available and in a known location.

- Cleanup spills immediately and use dry methods if possible.

- Properly dispose of spill cleanup material.

Other Considerations

- Alternative pest/weed controls may not be available, suitable, or effective in many cases.

Requirements

Costs

- Overall costs should be low in comparison to other BMPs.

Maintenance

- Sweep paved areas regularly to collect loose particles, and wipe up spills with rags and other absorbent material immediately, do not hose down the area to a storm drain.

Supplemental Information

Further Detail of the BMP

Fire Sprinkler Line Flushing

Building 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, polyphosphates 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, between flushes and 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

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

King County - ftp://dnr.metrokc.gov/wlr/dss/spcm/Chapter%203.PDF

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Mobile Cleaners Pilot Program: Final Report. 1997. Bay Area Stormwater Management Agencies Association (BASSMA) http://www.basmaa.org/

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA) http://www.basmaa.org/

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP) -
http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf

Parking/Storage Area Maintenance SC-43

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Parking lots and storage areas can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The following protocols are intended to prevent or reduce the discharge of pollutants from parking/storage areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

Approach

Pollution Prevention

- Encourage alternative designs and maintenance strategies for impervious parking lots. (See New Development and Redevelopment BMP Handbook).

- Keep accurate maintenance logs to evaluate BMP implementation.

Suggested Protocols

General

- Keep the parking and storage areas clean and orderly. Remove debris in a timely fashion.

- Allow sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.

- Utilize sand filters or oleophilic collectors for oily waste in low concentrations.

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- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.

Controlling Litter

- Post “No Littering” signs and enforce anti-litter laws.
- Provide an adequate number of litter receptacles.
- Clean out and cover litter receptacles frequently to prevent spillage.
- Provide trash receptacles in parking lots to discourage litter.
- Routinely sweep, shovel and dispose of litter in the trash.

Surface cleaning

- Use dry cleaning methods (e.g. sweeping or vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system.
- Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- Sweep all parking lots at least once before the onset of the wet season.
- If water is used follow the procedures below:
    - Block the storm drain or contain runoff.
    - Wash water should be collected and pumped to the sanitary sewer or discharged to a pervious surface, do not allow wash water to enter storm drains.
    - Dispose of parking lot sweeping debris and dirt at a landfill.
- When cleaning heavy oily deposits:
    - Use absorbent materials on oily spots prior to sweeping or washing.
    - Dispose of used absorbents appropriately.

Surface Repair

- Pre-heat, transfer or load hot bituminous material away from storm drain inlets.
- Apply concrete, asphalt, and seal coat during dry weather to prevent contamination form contacting stormwater runoff.
- Cover and seal nearby storm drain inlets (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc., where applicable. Leave covers in place until job is complete and until all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.

- Use only as much water as necessary for dust control, to avoid runoff.

- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Inspection

- Have designated personnel conduct inspections of the parking facilities and stormwater conveyance systems associated with them on a regular basis.

- Inspect cleaning equipment/sweepers for leaks on a regular basis.

Training

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.

- Train employees and contractors in proper techniques for spill containment and cleanup.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.

- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, nad implement accordingly.

- Have spill cleanup materials readily available and in a known location.

- Cleanup spills immediately and use dry methods if possible.

- Properly dispose of spill cleanup material.

Other Considerations

- Limitations related to sweeping activities at large parking facilities may include high equipment costs, the need for sweeper operator training, and the inability of current sweeper technology to remove oil and grease.

Requirements

Costs

Cleaning/sweeping costs can be quite large, construction and maintenance of stormwater structural controls can be quite expensive as well.

Maintenance

- Sweep parking lot to minimize cleaning with water.

- Clean out oil/water/sand separators regularly, especially after heavy storms.

- Clean parking facilities on a regular basis to prevent accumulated wastes and pollutants from being discharged into conveyance systems during rainy conditions.

Supplemental Information

Further Detail of the BMP

Surface Repair

Apply concrete, asphalt, and seal coat during dry weather to prevent contamination form contacting stormwater runoff. Where applicable, cover and seal nearby storm drain inlets (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and until all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal. Use only as much water as necessary for dust control, to avoid runoff.

References and Resources

http://www.stormwatercenter.net/

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality control Board. July 1998 (Revised February 2002 by the California Coastal Commission).

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA) http://www.basma.org

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP)
http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf

Housekeeping Practices SC-60

Description

Promote efficient and safe housekeeping practices (storage, use, and cleanup) when handling potentially harmful materials such as fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals. Related information is provided in BMP fact sheets SC-11 Spill Prevention, Control & Cleanup and SC-34 Waste Handling & Disposal.

Approach

Pollution Prevention

- Purchase only the amount of material that will be needed for foreseeable use. In most cases this will result in cost savings in both purchasing and disposal. See SC-61 Safer Alternative Products for additional information.

- Be aware of new products that may do the same job with less environmental risk and for less or the equivalent cost. Total cost must be used here; this includes purchase price, transportation costs, storage costs, use related costs, clean up costs and disposal costs.

Suggested Protocols

General

- Keep work sites clean and orderly. Remove debris in a timely fashion. Sweep the area.

- Dispose of wash water, sweepings, and sediments, properly.

- Recycle or dispose of fluids properly.

- Establish a daily checklist of office, yard and plant areas to confirm cleanliness and adherence to proper storage and security. Specific employees should be assigned specific inspection responsibilities and given the authority to remedy any problems found.

- Post waste disposal charts in appropriate locations detailing for each waste its hazardous nature (poison, corrosive, flammable), prohibitions on its disposal (dumpster, drain, sewer) and the recommended disposal method (recycle, sewer, burn, storage, landfill).

- Summarize the chosen BMPs applicable to your operation and post them in appropriate conspicuous places.

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

- Require a signed checklist from every user of any hazardous material detailing amount taken, amount used, amount returned and disposal of spent material.

- Do a before audit of your site to establish baseline conditions and regular subsequent audits to note any changes and whether conditions are improving or deteriorating.

- Keep records of water, air and solid waste quantities and quality tests and their disposition.

- Maintain a mass balance of incoming, outgoing and on hand materials so you know when there are unknown losses that need to be tracked down and accounted for.

- Use and reward employee suggestions related to BMPs, hazards, pollution reduction, work place safety, cost reduction, alternative materials and procedures, recycling and disposal.

- Have, and review regularly, a contingency plan for spills, leaks, weather extremes etc. Make sure all employees know about it and what their role is so that it comes into force automatically.

Training

- Train all employees, management, office, yard, manufacturing, field and clerical in BMPs and pollution prevention and make them accountable.

- Train municipal employees who handle potentially harmful materials in good housekeeping practices.

- Train personnel who use pesticides in the proper use of the pesticides. The California Department of Pesticide Regulation license pesticide dealers, certify pesticide applicators and conduct onsite inspections.

- Train employees and contractors in proper techniques for spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.

- Keep your Spill Prevention Control and Countermeasure (SPCC) plant up-to-date, and implement accordingly.

- Have spill cleanup materials readily available and in a known location.

- Cleanup spills immediately and use dry methods if possible.

- Properly dispose of spill cleanup material.

Other Considerations

- There are no major limitations to this best management practice.

- There are no regulatory requirements to this BMP. Existing regulations already require municipalities to properly store, use, and dispose of hazardous materials

Requirements

Costs

- Minimal cost associated with this BMP. Implementation of good housekeeping practices may result in cost savings as these procedures may reduce the need for more costly BMPs.

Maintenance

- Ongoing maintenance required to keep a clean site. Level of effort is a function of site size and type of activities.

Supplemental Information

Further Detail of the BMP

- The California Integrated Waste Management Board's Recycling Hotline, 1-800-553-2962, provides information on household hazardous waste collection programs and facilities.

Examples

There are a number of communities with effective programs. The most pro-active include Santa Clara County and the City of Palo Alto, the City and County of San Francisco, and the Municipality of Metropolitan Seattle (Metro).

References and Resources

British Columbia Lake Stewardship Society. Best Management Practices to Protect Water Quality from Non-Point Source Pollution. March 2000. http://www.nalms.org/bclss/bmphome.html#bmp

King County Stormwater Pollution Control Manual - http://dnr.metrokc.gov/wlr/dss/spcm.htm

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities, Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July, 1998, Revised by California Coastal Commission, February 2002.

Orange County Stormwater Program
http://www.ocwatersheds.com/stormwater/swp_introduction.asp

San Mateo STOPPP - (http://stoppp.tripod.com/bmp.html)

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Streets, roads, and highways are significant sources of pollutants in stormwater discharges, and operation and maintenance (O&M) practices, if not conducted properly, can contribute to the problem. Stormwater pollution from roadway and bridge maintenance should be addressed on a site-specific basis. Use of the procedures outlined below, that address street sweeping and repair, bridge and structure maintenance, and unpaved roads will reduce pollutants in stormwater.

Approach

Pollution Prevention

- Use the least toxic materials available (e.g. water based paints, gels or sprays for graffiti removal)
- Recycle paint and other materials whenever possible.
- Enlist the help of citizens to keep yard waste, used oil, and other wastes out of the gutter.

Suggested Protocols

Street Sweeping and Cleaning

- Maintain a consistent sweeping schedule. Provide minimum monthly sweeping of curbed streets.
- Perform street cleaning during dry weather if possible.

- Avoid wet cleaning or flushing of street, and utilize dry methods where possible.
- Consider increasing sweeping frequency based on factors such as traffic volume, land use, field observations of sediment and trash accumulation, proximity to water courses, etc. For example:
  - Increase the sweeping frequency for streets with high pollutant loadings, especially in high traffic and industrial areas.
  - Increase the sweeping frequency just before the wet season to remove sediments accumulated during the summer.
  - Increase the sweeping frequency for streets in special problem areas such as special events, high litter or erosion zones.
- Maintain cleaning equipment in good working condition and purchase replacement equipment as needed. Old sweepers should be replaced with new technologically advanced sweepers (preferably regenerative air sweepers) that maximize pollutant removal.
- Operate sweepers at manufacturer requested optimal speed levels to increase effectiveness.
- To increase sweeping effectiveness consider the following:
  - Institute a parking policy to restrict parking in problematic areas during periods of street sweeping.
  - Post permanent street sweeping signs in problematic areas; use temporary signs if installation of permanent signs is not possible.
  - Develop and distribute flyers notifying residents of street sweeping schedules.
- Regularly inspect vehicles and equipment for leaks, and repair immediately.
- If available use vacuum or regenerative air sweepers in the high sediment and trash areas (typically industrial/commercial).
- Keep accurate logs of the number of curb-miles swept and the amount of waste collected.
- Dispose of street sweeping debris and dirt at a landfill.
- Do not store swept material along the side of the street or near a storm drain inlet.
- Keep debris storage to a minimum during the wet season or make sure debris piles are contained (e.g. by berming the area) or covered (e.g. with tarps or permanent covers).

Street Repair and Maintenance

Pavement marking

- Schedule pavement marking activities for dry weather.

- Develop paint handling procedures for proper use, storage, and disposal of paints.
- Transfer and load paint and hot thermoplastic away from storm drain inlets.
- Provide drop cloths and drip pans in paint mixing areas.
- Properly maintain application equipment.
- Street sweep thermoplastic grindings. Yellow thermoplastic grindings may require special handling as they may contain lead.
- Paints containing lead or tributyltin are considered a hazardous waste and must be disposed of properly.
- Use water based paints whenever possible. If using water based paints, clean the application equipment in a sink that is connected to the sanitary sewer.
- Properly store leftover paints if they are to be kept for the next job, or dispose of properly.

Concrete installation and repair

- Schedule asphalt and concrete activities for dry weather.
- Take measures to protect any nearby storm drain inlets and adjacent watercourses, prior to breaking up asphalt or concrete (e.g. place san bags around inlets or work areas).
- Limit the amount of fresh concrete or cement mortar mixed, mix only what is needed for the job.
- Store concrete materials under cover, away from drainage areas. Secure bags of cement after they are open. Be sure to keep wind-blown cement powder away from streets, gutters, storm drains, rainfall, and runoff.
- Return leftover materials to the transit mixer. Dispose of small amounts of hardened excess concrete, grout, and mortar in the trash.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile, or dispose in the trash.
- When making saw cuts in pavement, use as little water as possible and perform during dry weather. Cover each storm drain inlet completely with filter fabric or plastic during the sawing operation and contain the slurry by placing straw bales, sandbags, or gravel dams around the inlets. After the liquid drains or evaporates, shovel or vacuum the slurry residue from the pavement or gutter and remove from site. Alternatively, a small onsite vacuum may be used to pick up the slurry as this will prohibit slurry from reaching storm drain inlets.
- Wash concrete trucks off site or in designated areas on site designed to preclude discharge of wash water to drainage system.

Patching, resurfacing, and surface sealing

- Schedule patching, resurfacing and surface sealing for dry weather.
- Stockpile materials away from streets, gutter areas, storm drain inlets or watercourses. During wet weather, cover stockpiles with plastic tarps or berm around them if necessary to prevent transport of materials in runoff.
- Pre-heat, transfer or load hot bituminous material away from drainage systems or watercourses.
- Where applicable, cover and seal nearby storm drain inlets (with waterproof material or mesh) and maintenance holes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and until all water from emulsified oil sealants has drained or evaporated. Clean any debris from covered maintenance holes and storm drain inlets when the job is complete.
- Prevent excess material from exposed aggregate concrete or similar treatments from entering streets or storm drain inlets. Designate an area for clean up and proper disposal of excess materials.
- Use only as much water as necessary for dust control, to avoid runoff.
- Sweep, never hose down streets to clean up tracked dirt. Use a street sweeper or vacuum truck. Do not dump vacuumed liquid in storm drains.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Equipment cleaning maintenance and storage

- Inspect equipment daily and repair any leaks. Place drip pans or absorbent materials under heavy equipment when not in use.
- Perform major equipment repairs at the corporation yard, when practical.
- If refueling or repairing vehicles and equipment must be done onsite, use a location away from storm drain inlets and watercourses.
- Clean equipment including sprayers, sprayer paint supply lines, patch and paving equipment, and mud jacking equipment at the end of each day. Clean in a sink or other area (e.g. vehicle wash area) that is connected to the sanitary sewer.

Bridge and Structure Maintenance

Paint and Paint Removal

- Transport paint and materials to and from job sites in containers with secure lids and tied down to the transport vehicle.
- Do not transfer or load paint near storm drain inlets or watercourses.

- Test and inspect spray equipment prior to starting to paint. Tighten all hoses and connections and do not overfill paint container.
- Plug nearby storm drain inlets prior to starting painting where there is significant risk of a spill reaching storm drains. Remove plugs when job is completed.
- If sand blasting is used to remove paint, cover nearby storm drain inlets prior to starting work.
- Perform work on a maintenance traveler or platform, or use suspended netting or tarps to capture paint, rust, paint removing agents, or other materials, to prevent discharge of materials to surface waters if the bridge crosses a watercourse. If sanding, use a sander with a vacuum filter bag.
- Capture all clean-up water, and dispose of properly.
- Recycle paint when possible (e.g. paint may be used for graffiti removal activities). Dispose of unused paint at an appropriate household hazardous waste facility.

Graffiti Removal

- Schedule graffiti removal activities for dry weather.
- Protect nearby storm drain inlets prior to removing graffiti from walls, signs, sidewalks, or other structures needing graffiti abatement. Clean up afterwards by sweeping or vacuuming thoroughly, and/or by using absorbent and properly disposing of the absorbent.
- When graffiti is removed by painting over, implement the procedures under Painting and Paint Removal above.
- Direct runoff from sand blasting and high pressure washing (with no cleaning agents) into a landscaped or dirt area. If such an area is not available, filter runoff through an appropriate filtering device (e.g. filter fabric) to keep sand, particles, and debris out of storm drains.
- If a graffiti abatement method generates wash water containing a cleaning compound (such as high pressure washing with a cleaning compound), plug nearby storm drains and vacuum/pump wash water to the sanitary sewer.
- Consider using a waterless and non-toxic chemical cleaning method for graffiti removal (e.g. gels or spray compounds).

Repair Work

- Prevent concrete, steel, wood, metal parts, tools, or other work materials from entering storm drains or watercourses.
- Thoroughly clean up the job site when the repair work is completed.
- When cleaning guardrails or fences follow the appropriate surface cleaning methods (depending on the type of surface) outlined in SC-71 Plaza & Sidewalk Cleaning fact sheet.

- If painting is conducted, follow the painting and paint removal procedures above.
- If graffiti removal is conducted, follow the graffiti removal procedures above.
- If construction takes place, see the Construction Activity BMP Handbook.
- Recycle materials whenever possible.

Unpaved Roads and Trails

- Stabilize exposed soil areas to prevent soil from eroding during rain events. This is particularly important on steep slopes.
- For roadside areas with exposed soils, the most cost-effective choice is to vegetate the area, preferably with a mulch or binder that will hold the soils in place while the vegetation is establishing. Native vegetation should be used if possible.
- If vegetation cannot be established immediately, apply temporary erosion control mats/blankets; a comma straw, or gravel as appropriate.
- If sediment is already eroded and mobilized in roadside areas, temporary controls should be installed. These may include: sediment control fences, fabric-covered triangular dikes, gravel-filled burlap bags, biobags, or hay bales staked in place.

Non-Stormwater Discharges

Field crews should be aware of non-stormwater discharges as part of their ongoing street maintenance efforts.

- Refer to SC-10 Non-Stormwater Discharges
- Identify location, time and estimated quantity of discharges.
- Notify appropriate personnel.

Training

- Train employees regarding proper street sweeping operation and street repair and maintenance.
- Instruct employees and subcontractors to ensure that measures to reduce the stormwater impacts of roadway/bridge maintenance are being followed.
- Require engineering staff and/or consulting A/E firms to address stormwater quality in new bridge designs or existing bridge retrofits.
- Use a training log or similar method to document training.
- Train employees on proper spill containment and clean up, and in identifying non-stormwater discharges.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.

- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, and implement accordingly.

- Have spill cleanup materials readily available and in a known location.

- Cleanup spills immediately and use dry methods if possible.

- Properly dispose of spill cleanup material.

Other Considerations

- Densely populated areas or heavily used streets may require parking regulations to clear streets for cleaning.

- No currently available conventional sweeper is effective at removing oil and grease. Mechanical sweepers are not effective at removing finer sediments.

- Limitations may arise in the location of new bridges. The availability and cost of land and other economic and political factors may dictate where the placement of a new bridge will occur. Better design of the bridge to control runoff is required if it is being placed near sensitive waters.

Requirements

Costs

- The maintenance of local roads and bridges is already a consideration of most community public works or transportation departments. Therefore, the cost of pollutant reducing management practices will involve the training and equipment required to implement these new practices.

- The largest expenditures for street sweeping programs are in staffing and equipment. The capital cost for a conventional street sweeper is between $60,000 and $120,000. Newer technologies might have prices approaching $180,000. The average useful life of a conventional sweeper is about four years, and programs must budget for equipment replacement. Sweeping frequencies will determine equipment life, so programs that sweep more often should expect to have a higher cost of replacement.

- A street sweeping program may require the following.
    - Sweeper operators, maintenance, supervisory, and administrative personnel are required.
    - Traffic control officers may be required to enforce parking restrictions.
    - Skillful design of cleaning routes is required for program to be productive.
    - Arrangements must be made for disposal of collected wastes.

- If investing in newer technologies, training for operators must be included in operation and maintenance budgets. Costs for public education are small, and mostly deal with the need to obey parking restrictions and litter control. Parking tickets are an effective reminder to obey parking rules, as well as being a source of revenue.

Maintenance

- Not applicable

Supplemental Information

Further Detail of the BMP

Street sweeping

There are advantages and disadvantages to the two common types of sweepers. The best choice depends on your specific conditions. Many communities find it useful to have a compliment of both types in their fleet.

Mechanical Broom Sweepers - More effective at picking up large debris and cleaning wet streets. Less costly to purchase and operate. Create more airborne dust.

Vacuum Sweepers - More effective at removing fine particles and associated heavy metals. Ineffective at cleaning wet streets. Noisier than mechanical broom sweepers which may restrict areas or times of operation. May require an advance vehicle to remove large debris.

Street Flushers - Not affected by biggest interference to cleaning, parked cars. May remove finer sediments, moving them toward the gutter and stormwater inlets. For this reason, flushing fell out of favor and is now used primarily after sweeping. Flushing may be effective for combined sewer systems. Presently street flushing is not allowed under most NPDES permits.

Cross-Media Transfer of Pollutants

The California Air Resources Board (ARB) has established state ambient air quality standards including a standard for respirable particulate matter (less than or equal to 10 microns in diameter, symbolized as PM10). In the effort to sweep up finer sediments to remove attached heavy metals, municipalities should be aware that fine dust, that cannot be captured by the sweeping equipment and becomes airborne, could lead to issues of worker and public safety.

Bridges

Bridges that carry vehicular traffic generate some of the more direct discharges of runoff to surface waters. Bridge scupper drains cause a direct discharge of stormwater into receiving waters and have been shown to carry relatively high concentrations of pollutants. Bridge maintenance also generates wastes that may be either directly deposited to the water below or carried to the receiving water by stormwater. The following steps will help reduce the stormwater impacts of bridge maintenance:

- Site new bridges so that significant adverse impacts to wetlands, sensitive areas, critical habitat, and riparian vegetation are minimized.

- Design new bridges to avoid the use of scupper drains and route runoff to land for treatment control. Existing scupper drains should be cleaned on a regular basis to avoid sediment/debris accumulation.

- Reduce the discharge of pollutants to surface waters during maintenance by using suspended traps, vacuums, or booms in the water to capture paint, rust, and paint removing agents. Many of these wastes may be hazardous. Properly dispose of this waste by referring to CA21 (Hazardous Waste Management) in the Construction Handbook.

- Train employees and subcontractors to reduce the discharge of wastes during bridge maintenance.

De-icing

- Do not over-apply deicing salt and sand, and routinely calibrate spreaders.

- Near reservoirs, restrict the application of deicing salt and redirect any runoff away from reservoirs.

- Consider using alternative deicing agents (less toxic, biodegradable, etc.).

References and Resources

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July. 1998.

Orange County Stormwater Program
http://www.ocwatersheds.com/stormwater/swp_introduction.asp

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

Santa Clara Valley Urban Runoff Pollution Prevention Program. 2001. Fresh Concrete and Mortar Application Best Management Practices for the Construction Industry. June.

Santa Clara Valley Urban Runoff Pollution Prevention Program. 2001. Roadwork and Paving Best Management Practices for the Construction Industry. June.

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Roadway and Bridge Maintenance. On-line
http://www.epa.gov/npdes/menuofbmps/poll_13.htm

Plaza and Sidewalk Cleaning SC-71

Description

Pollutants on sidewalks and other pedestrian traffic areas and plazas are typically due to littering and vehicle use. This fact sheet describes good housekeeping practices that can be incorporated into the municipality's existing cleaning and maintenance program.

Approach

Pollution Prevention

- Use dry cleaning methods whenever practical for surface cleaning activities.

- Use the least toxic materials available (e.g. water based paints, gels or sprays for graffiti removal).

Suggested Protocols

Surface Cleaning

- Regularly broom (dry) sweep sidewalk, plaza and parking lot areas to minimize cleaning with water.

- Dry cleanup first (sweep, collect, and dispose of debris and trash) when cleaning sidewalks or plazas, then wash with or without soap.

- Block the storm drain or contain runoff when cleaning with water. Discharge wash water to landscaping or collect water and pump to a tank or discharge to sanitary sewer if allowed. (Permission may be required from local sanitation district.)

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

- Block the storm drain or contain runoff when washing parking areas, driveways or drive-throughs. Use absorbents to pick up oil; then dry sweep. Clean with or without soap. Collect water and pump to a tank or discharge to sanitary sewer if allowed. Street Repair and Maintenance.

Graffiti Removal

- Avoid graffiti abatement activities during rain events.
- Implement the procedures under Painting and Paint Removal in SC-70 Roads, Streets, and Highway Operation and Maintenance fact sheet when graffiti is removed by painting over.
- Direct runoff from sand blasting and high pressure washing (with no cleaning agents) into a dirt or landscaped area after treating with an appropriate filtering device.
- Plug nearby storm drain inlets and vacuum/pump wash water to the sanitary sewer if authorized to do so if a graffiti abatement method generates wash water containing a cleaning compound (such as high pressure washing with a cleaning compound). Ensure that a non-hazardous cleaning compound is used or dispose as hazardous waste, as appropriate.

Surface Removal and Repair

- Schedule surface removal activities for dry weather if possible.
- Avoid creating excess dust when breaking asphalt or concrete.
- Take measures to protect nearby storm drain inlets prior to breaking up asphalt or concrete (e.g. place hay bales or sand bags around inlets). Clean afterwards by sweeping up as much material as possible.
- Designate an area for clean up and proper disposal of excess materials.
- Remove and recycle as much of the broken pavement as possible to avoid contact with rainfall and stormwater runoff.
- When making saw cuts in pavement, use as little water as possible. Cover each storm drain inlet completely with filter fabric during the sawing operation and contain the slurry by placing straw bales, sandbags, or gravel dams around the inlets. After the liquid drains or evaporates, shovel or vacuum the slurry residue from the pavement or gutter and remove from site.
- Always dry sweep first to clean up tracked dirt. Use a street sweeper or vacuum truck. Do not dump vacuumed liquid in storm drains. Once dry sweeping is complete, the area may be hosed down if needed. Wash water should be directed to landscaping or collected and pumped to the sanitary sewer if allowed.

Concrete Installation and Repair

- Schedule asphalt and concrete activities for dry weather.

- Take measures to protect any nearby storm drain inlets and adjacent watercourses, prior to breaking up asphalt or concrete (e.g. place san bags around inlets or work areas).

- Limit the amount of fresh concrete or cement mortar mixed, mix only what is needed for the job.

- Store concrete materials under cover, away from drainage areas. Secure bags of cement after they are open. Be sure to keep wind-blown cement powder away from streets, gutters, storm drains, rainfall, and runoff.

- Return leftover materials to the transit mixer. Dispose of small amounts of hardened excess concrete, grout, and mortar in the trash.

- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile, or dispose in the trash.

- Protect applications of fresh concrete from rainfall and runoff until the material has dried.

- Do not allow excess concrete to be dumped onsite, except in designated areas.

- Wash concrete trucks off site or in designated areas on site designed to preclude discharge of wash water to drainage system.

Controlling Litter

- Post “No Littering” signs and enforce anti-litter laws.

- Provide litter receptacles in busy, high pedestrian traffic areas of the community, at recreational facilities, and at community events.

- Cover litter receptacles and clean out frequently to prevent leaking/spillage or overflow.

- Clean parking lots on a regular basis with a street sweeper.

Training

- Provide regular training to field employees and/or contractors regarding surface cleaning and proper operation of equipment.

- Train employee and contractors in proper techniques for spill containment and cleanup.

- Use a training log or similar method to document training.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.

- Have spill cleanup materials readily available and in a known location.

- Cleanup spills immediately and use dry methods if possible.

- Properly dispose of spill cleanup material.

Other Considerations

- Limitations related to sweeping activities at large parking facilities may include current sweeper technology to remove oil and grease.
- Surface cleaning activities that require discharges to the local sewering agency will require coordination with the agency.
- Arrangements for disposal of the swept material collected must be made, as well as accurate tracking of the areas swept and the frequency of sweeping.

Requirements

Costs

- The largest expenditures for sweeping and cleaning of sidewalks, plazas, and parking lots are in staffing and equipment. Sweeping of these areas should be incorporated into street sweeping programs to reduce costs.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

Community education, such as informing residents about their options for recycling and waste disposal, as well as the consequences of littering, can instill a sense of citizen responsibility and potentially reduce the amount of maintenance required by the municipality.

Additional BMPs that should be considered for parking lot areas include:

- Allow sheet runoff to flow into biofilters (vegetated strip and swale) and infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low concentrations.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.
- Structural BMPs such as storm drain inlet filters can be very effective in reducing the amount of pollutants discharged from parking facilities during periods of rain.

References and Resources

Bay Area Stormwater Management Agencies Association (BASMAA). 1996. Pollution From Surface Cleaning Folder http://www.basmaa.org

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July. 1998.

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Orange County Stormwater Program
http://www.ocwatersheds.com/stormwater/swp_introduction.asp

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

Santa Clara Valley Urban Runoff Pollution Prevention Program. Maintenance Best Management Practices for the Construction Industry. Brochures: Landscaping, Gardening, and Pool; Roadwork and Paving; and Fresh Concrete and Mortar Application. June 2001.

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Plan. 2001. Municipal Activities Model Program Guidance. November.

Landscape Maintenance SC-73

Objectives

- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	
Oxygen Demanding	☑

Description

Landscape maintenance activities include vegetation removal; herbicide and insecticide application; fertilizer application; watering; and other gardening and lawn care practices. Vegetation control typically involves a combination of chemical (herbicide) application and mechanical methods. All of these maintenance practices have the potential to contribute pollutants to the storm drain system. The major objectives of this BMP are to minimize the discharge of pesticides, herbicides and fertilizers to the storm drain system and receiving waters; prevent the disposal of landscape waste into the storm drain system by collecting and properly disposing of clippings and cuttings, and educating employees and the public.

Approach

Pollution Prevention

- Implement an integrated pest management (IPM) program. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools.

- Choose low water using flowers, trees, shrubs, and groundcover.

- Consider alternative landscaping techniques such as naturescaping and xeriscaping.

- Conduct appropriate maintenance (i.e. properly timed fertilizing, weeding, pest control, and pruning) to help preserve the landscapes water efficiency.

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- Consider grass cycling (grass cycling is the natural recycling of grass by leaving the clippings on the lawn when mowing. Grass clippings decompose quickly and release valuable nutrients back into the lawn).

Suggested Protocols

Mowing, Trimming, and Weeding

- Whenever possible use mechanical methods of vegetation removal (e.g mowing with tractor-type or push mowers, hand cutting with gas or electric powered weed trimmers) rather than applying herbicides. Use hand weeding where practical.

- Avoid loosening the soil when conducting mechanical or manual weed control, this could lead to erosion. Use mulch or other erosion control measures when soils are exposed.

- Performing mowing at optimal times. Mowing should not be performed if significant rain events are predicted.

- Mulching mowers may be recommended for certain flat areas. Other techniques may be employed to minimize mowing such as selective vegetative planting using low maintenance grasses and shrubs.

- Collect lawn and garden clippings, pruning waste, tree trimmings, and weeds. Chip if necessary, and compost or dispose of at a landfill (see waste management section of this fact sheet).

- Place temporarily stockpiled material away from watercourses, and berm or cover stockpiles to prevent material releases to storm drains.

Planting

- Determine existing native vegetation features (location, species, size, function, importance) and consider the feasibility of protecting them. Consider elements such as their effect on drainage and erosion, hardiness, maintenance requirements, and possible conflicts between preserving vegetation and the resulting maintenance needs.

- Retain and/or plant selected native vegetation whose features are determined to be beneficial, where feasible. Native vegetation usually requires less maintenance (e.g., irrigation, fertilizer) than planting new vegetation.

- Consider using low water use groundcovers when planting or replanting.

Waste Management

- Compost leaves, sticks, or other collected vegetation or dispose of at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.

- Place temporarily stockpiled material away from watercourses and storm drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.

- Reduce the use of high nitrogen fertilizers that produce excess growth requiring more frequent mowing or trimming.

- Avoid landscape wastes in and around storm drain inlets by either using bagging equipment or by manually picking up the material.

Irrigation

- Where practical, use automatic timers to minimize runoff.
- Use popup sprinkler heads in areas with a lot of activity or where there is a chance the pipes may be broken. Consider the use of mechanisms that reduce water flow to sprinkler heads if broken.
- Ensure that there is no runoff from the landscaped area(s) if re-claimed water is used for irrigation.
- If bailing of muddy water is required (e.g. when repairing a water line leak), do not put it in the storm drain; pour over landscaped areas.
- Irrigate slowly or pulse irrigate to prevent runoff and then only irrigate as much as is needed.
- Apply water at rates that do not exceed the infiltration rate of the soil.

Fertilizer and Pesticide Management

- Utilize a comprehensive management system that incorporates integrated pest management (IPM) techniques. There are many methods and types of IPM, including the following:
    - Mulching can be used to prevent weeds where turf is absent, fencing installed to keep rodents out, and netting used to keep birds and insects away from leaves and fruit.
    - Visible insects can be removed by hand (with gloves or tweezers) and placed in soapy water or vegetable oil. Alternatively, insects can be sprayed off the plant with water or in some cases vacuumed off of larger plants.
    - Store-bought traps, such as species-specific, pheromone-based traps or colored sticky cards, can be used.
    - Slugs can be trapped in small cups filled with beer that are set in the ground so the slugs can get in easily.
    - In cases where microscopic parasites, such as bacteria and fungi, are causing damage to plants, the affected plant material can be removed and disposed of (pruning equipment should be disinfected with bleach to prevent spreading the disease organism).
    - Small mammals and birds can be excluded using fences, netting, tree trunk guards.
    - Beneficial organisms, such as bats, birds, green lacewings, ladybugs, praying mantis, ground beetles, parasitic nematodes, trichogramma wasps, seed head weevils, and spiders that prey on detrimental pest species can be promoted.
- 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 pesticides only if there is an actual pest problem (not on a regular preventative schedule).
- Do not use pesticides if rain is expected. Apply pesticides only when wind speeds are low (less than 5 mph).
- Do not mix or prepare pesticides for application near storm drains.
- Prepare the minimum amount of pesticide needed for the job and use the lowest rate that will effectively control the pest.
- Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Calibrate fertilizer and pesticide application equipment to avoid excessive application.
- Periodically test soils for determining proper fertilizer use.
- Sweep pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Purchase only the amount of pesticide that you can reasonably use in a given time period (month or year depending on the product).
- Triple rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Dispose of empty pesticide containers according to the instructions on the container label.

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.
- Inspect pesticide/fertilizer equipment and transportation vehicles daily.

Training

- Educate and train employees on use of pesticides and in pesticide application techniques to prevent pollution. Pesticide application must be under the supervision of a California qualified pesticide applicator.
- Train/encourage municipal maintenance crews to use IPM techniques for managing public green areas.
- Annually train employees within departments responsible for pesticide application on the appropriate portions of the agency’s IPM Policy, SOPs, and BMPs, and the latest IPM techniques.

- Employees who are not authorized and trained to apply pesticides should be periodically (at least annually) informed that they cannot use over-the-counter pesticides in or around the workplace.
- Use a training log or similar method to document training.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Have spill cleanup materials readily available and in a know in location
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- The Federal Pesticide, Fungicide, and Rodenticide Act and California Title 3, Division 6, Pesticides and Pest Control Operations place strict controls over pesticide application and handling and specify training, annual refresher, and testing requirements. The regulations generally cover: a list of approved pesticides and selected uses, updated regularly; general application information; equipment use and maintenance procedures; and record keeping. The California Department of Pesticide Regulations and the County Agricultural Commission coordinate and maintain the licensing and certification programs. All public agency employees who apply pesticides and herbicides in “agricultural use” areas such as parks, golf courses, rights-of-way and recreation areas should be properly certified in accordance with state regulations. Contracts for landscape maintenance should include similar requirements.
- All employees who handle pesticides should be familiar with the most recent material safety data sheet (MSDS) files.
- Municipalities do not have the authority to regulate the use of pesticides by school districts, however the California Healthy Schools Act of 2000 (AB 2260) has imposed requirements on California school districts regarding pesticide use in schools. Posting of notification prior to the application of pesticides is now required, and IPM is stated as the preferred approach to pest management in schools.

Requirements

Costs

Additional training of municipal employees will be required to address IPM techniques and BMPs. IPM methods will likely increase labor cost for pest control which may be offset by lower chemical costs.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

Waste Management

Composting is one of the better disposal alternatives if locally available. Most municipalities either have or are planning yard waste composting facilities as a means of reducing the amount of waste going to the landfill. Lawn clippings from municipal maintenance programs as well as private sources would probably be compatible with most composting facilities

Contractors and Other Pesticide Users

Municipal agencies should develop and implement a process to ensure that any contractor employed to conduct pest control and pesticide application on municipal property engages in pest control methods consistent with the IPM Policy adopted by the agency. Specifically, municipalities should require contractors to follow the agency's IPM policy, SOPs, and BMPs; provide evidence to the agency of having received training on current IPM techniques when feasible; provide documentation of pesticide use on agency property to the agency in a timely manner.

References and Resources

King County Stormwater Pollution Control Manual. Best Management Practices for Businesses. 1995. King County Surface Water Management. July. On-line: http://dnr.metrokc.gov/wlr/dss/spcm.htm

Los Angeles County Stormwater Quality Model Programs. Public Agency Activities http://ladpw.org/wmd/npdes/model_links.cfm

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July. 1998.

Orange County Stormwater Program http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Landscaping and Lawn Care. Office of Water. Office of Wastewater Management. On-line: http://www.epa.gov/npdes/menuofbmps/poll_8.htm

Drainage System Maintenance SC-74

Photo Credit: Geoff Brosseau

Objectives

- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

As a consequence of its function, the stormwater conveyance system collects and transports urban runoff that may contain certain pollutants. Maintaining catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis will remove pollutants, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

Approach

Suggested Protocols

Catch Basins/Inlet Structures

- Municipal staff should regularly inspect facilities to ensure 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.
  - Stenciling of catch basins and inlets (see SC-75 Waste Handling and Disposal).
- Clean catch basins, storm drain inlets, and other conveyance structures in high pollutant load areas just 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. Clean and repair as needed.
- Keep accurate logs of the number of catch basins cleaned.
- Record the amount of waste collected.
- 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 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 of. Do not dewater near a storm drain or stream.
- Except for small communities with relatively few catch basins that may be cleaned manually, most municipalities will require mechanical cleaners such as eductors, vacuums, or bucket loaders.

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 flushed effluent and pump to the sanitary sewer for treatment.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge from cleaning a storm drain pump station or other facility to reach the storm drain system.
- Conduct quarterly routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.
- Sample collected sediments to determine if landfill disposal is possible, or illegal discharges in the watershed are occurring.

Open Channel

- Consider modification of storm channel characteristics to improve channel hydraulics, to increase pollutant removals, and to 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 (emphasis added) state of any river, stream, or lake in California, must enter into a steam or Lake Alteration Agreement with the Department of Fish and Game. 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 Federal Corps of Engineers and USFWS

Illicit Connections and Discharges

- During routine maintenance of conveyance system and drainage structures field staff should look for evidence of illegal discharges or illicit connections:
  - Is there evidence of spills such as paints, discoloring, etc.
  - Are there any odors associated with the drainage system
  - Record locations of apparent illegal discharges/illicit connections
  - Track flows back to potential dischargers and conduct aboveground inspections. This can be done through visual inspection of up gradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
  - Once the origin of flow is established, require illicit discharger to eliminate the discharge.
- Stencil storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as “Dump No Waste Drains to Stream” 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.

Illegal Dumping

- Regularly inspect and clean up hot spots and other storm drainage areas 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)
  - 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.

- The State Department of Fish and Game has a hotline for reporting violations called Cal TIP (1-800-952-5400). The phone number may be used to report any violation of a Fish and Game code (illegal dumping, poaching, etc.).

- The California Department of Toxic Substances Control's Waste Alert Hotline, 1-800-69TOXIC, can be used to report hazardous waste violations.

Training

- Train crews in proper maintenance activities, including record keeping and disposal.

- Only properly trained individuals are allowed to handle hazardous materials/wastes.

- Train municipal employees from all departments (public works, utilities, street cleaning, parks and recreation, industrial waste inspection, hazardous waste inspection, sewer maintenance) to recognize and report illegal dumping.

- Train municipal employees and educate businesses, contractors, and the general public in proper and consistent methods for disposal.

- Train municipal staff regarding non-stormwater discharges (See SC-10 Non-Stormwater Discharges).

Spill Response and Prevention

- Refer to SC-11, Prevention, Control & Cleanup

- Have spill cleanup materials readily available and in a known location.

- Cleanup spills immediately and use dry methods if possible.

- Properly dispose of spill cleanup material.

Other Considerations

- Cleanup 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.

- 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, liquid/sediment disposal, and disposal of flushed effluent to sanitary sewer may be prohibited in some areas.

- Regulations may include adoption of substantial penalties for illegal dumping and disposal.

- Municipal codes should include sections prohibiting the discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.

- Private property access rights may be needed to track illegal discharges up gradient.

- Requirements of municipal ordinance authority for suspected source verification testing for illicit connections necessary for guaranteed rights of entry.

Requirements

Costs

- An aggressive catch basin cleaning program could require a significant capital and O&M budget. A careful study of cleaning effectiveness should be undertaken before increased cleaning is implemented. Catch basin cleaning costs are less expensive if vacuum street sweepers are available; cleaning catch basins manually can cost approximately twice as much as cleaning the basins with a vacuum attached to a sweeper.

- 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. Encouraging reporting of illicit discharges by employees can offset costs by saving expense on inspectors and directing resources more efficiently. Some programs have used funds available from “environmental fees” or special assessment districts to fund their illicit connection elimination programs.

Maintenance

- Two-person teams may be required to clean catch basins with vactor trucks.

- Identifying illicit discharges requires teams of at least two people (volunteers can be used), plus administrative personnel, depending on the complexity of the storm sewer system.

- Arrangements must be made for proper disposal of collected wastes.

- Requires technical staff to detect and investigate illegal dumping violations, and to coordinate public education.

Supplemental Information

Further Detail of the BMP

Storm Drain flushing

Sanitary sewer flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in sanitary sewer systems. The same principles that make sanitary sewer flushing effective can be used to flush storm drains. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as to an open channel, to another point where flushing will be initiated, or over to the sanitary sewer and on to 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. The 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, releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce the impacts of stormwater pollution, a second inflatable device, placed well downstream, may be used to re-collect 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 re-collect 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 percent for organics and 55-65 percent 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 or that fire hydrant line flushing coincide with storm drain flushing.

Flow Management

Flow management has been one of the principal motivations for designing urban stream corridors in the past. Such needs may or may not be compatible with the stormwater quality goals in the stream corridor.

Downstream flood peaks can be suppressed by reducing through flow velocity. This can be accomplished by reducing gradient with grade control structures or increasing roughness with boulders, dense vegetation, or complex banks forms. Reducing velocity correspondingly increases flood height, so all such measures have a natural association with floodplain open space. Flood elevations laterally adjacent to the stream can be lowered by increasing through flow velocity.

However, increasing velocity increases flooding downstream and inherently conflicts with channel stability and human safety. Where topography permits, another way to lower flood elevation is to lower the level of the floodway with drop structures into a large but subtly excavated bowl where flood flows we allowed to spread out.

Stream Corridor Planning

Urban streams receive and convey stormwater flows from developed or developing watersheds. Planning of stream corridors thus interacts with urban stormwater management programs. If local programs are intended to control or protect downstream environments by managing flows delivered to the channels, then it is logical that such programs should be supplemented by management of the materials, forms, and uses of the downstream riparian corridor. Any proposal for steam alteration or management should be investigated for its potential flow and stability effects on upstream, downstream, and laterally adjacent areas. The timing and rate of flow from various tributaries can combine in complex ways to alter flood hazards. Each section of channel is unique, influenced by its own distribution of roughness elements, management activities, and stream responses.

Flexibility to adapt to stream features and behaviors as they evolve must be included in stream reclamation planning. The amenity and ecology of streams may be enhanced through the landscape design options of 1) corridor reservation, 2) bank treatment, 3) geomorphic restoration, and 4) grade control.

Corridor reservation - Reserving stream corridors and valleys to accommodate natural stream meandering, aggradation, degradation, and over bank flows allows streams to find their own form and generate less ongoing erosion. In California, open stream corridors in recent urban developments have produced recreational open space, irrigation of streamside plantings, and the aesthetic amenity of flowing water.

Bank treatment - The use of armoring, vegetative cover, and flow deflection may be used to influence a channel's form, stability, and biotic habitat. To prevent bank erosion, armoring can be done with rigid construction materials, such as concrete, masonry, wood planks and logs, riprap, and gabions. Concrete linings have been criticized because of their lack of provision of biotic habitat. In contrast, riprap and gabions make relatively porous and flexible linings. Boulders, placed in the bed reduce velocity and erosive power.

Riparian vegetation can stabilize the banks of streams that are at or near a condition of equilibrium. Binding networks of roots increase bank shear strength. During flood flows, resilient vegetation is forced into erosion-inhibiting mats. The roughness of vegetation leads to lower velocity, further reducing erosive effects. Structural flow deflection can protect banks from erosion or alter fish habitat. By concentrating flow, a deflector causes a pool to be scoured in the bed.

Geomorphic restoration – Restoration refers to alteration of disturbed streams so their form and behavior emulate those of undisturbed streams. Natural meanders are retained, with grading to gentle slopes on the inside of curves to allow point bars and riffle-pool sequences to develop. Trees are retained to provide scenic quality, biotic productivity, and roots for bank stabilization, supplemented by plantings where necessary.

A restorative approach can be successful where the stream is already approaching equilibrium. However, if upstream urbanization continues new flow regimes will be generated that could disrupt the equilibrium of the treated system.

Grade Control - A grade control structure is a level shelf of a permanent material, such as stone, masonry, or concrete, over which stream water flows. A grade control structure is called a sill, weir, or drop structure, depending on the relation of its invert elevation to upstream and downstream channels.

A sill is installed at the preexisting channel bed elevation to prevent upstream migration of nick points. It establishes a firm base level below which the upstream channel can not erode.

A weir or check dam is installed with invert above the preexisting bed elevation. A weir raises the local base level of the stream and causes aggradation upstream. The gradient, velocity, and erosive potential of the stream channel are reduced. A drop structure lowers the downstream invert below its preexisting elevation, reducing downstream gradient and velocity. Weirs and drop structure control erosion by dissipating energy and reducing slope velocity.

When carefully applied, grade control structures can be highly versatile in establishing human and environmental benefits in stabilized channels. To be successful, application of grade control structures should be guided by analysis of the stream system both upstream and downstream from the area to he reclaimed.

Examples

The California Department of Water Resources began the Urban Stream Restoration Program in 1985. The program provides grant funds to municipalities and community groups to implement stream restoration projects. The projects reduce damages from streambank aid watershed instability arid floods while restoring streams' aesthetic, recreational, and fish and wildlife values.

In Buena Vista Park, upper floodway slopes are gentle and grassed to achieve continuity of usable park land across the channel of small boulders at the base of the slopes.

The San Diego River is a large, vegetative lined channel, which was planted in a variety of species to support riparian wildlife while stabilizing the steep banks of the floodway.

References and Resources

Ferguson, B.K. 1991. Urban Stream Reclamation, p. 324-322, Journal of Soil and Water Conservation.

Los Angeles County Stormwater Quality. Public Agency Activities Model Program. On-line: http://ladpw.org/wmd/npdes/public_TC.cfm

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July. 1998.

Orange County Stormwater Program http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP) Municipal Activities Model Program Guidance. 2001. Project Clean Water. November.

United States Environmental Protection Agency (USEPA). 1999. Stormwater Management Fact Sheet Non-stormwater Discharges to Storm Sewers. EPA 832-F-99-022. Office of Water, Washington, D.C. September.

United States Environmental Protection Agency (USEPA). 1999. Stormwater O&M Fact Sheet Catch Basin Cleaning. EPA 832-F-99-011. Office of Water, Washington, D.C. September.

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Illegal Dumping Control. On line: http://www.epa.gov/npdes/menuofbmps/poll_7.htm

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Storm Drain System Cleaning. On line: http://www.epa.gov/npdes/menuofbmps/poll_16.htm

Waste Handling and Disposal SC-75

Objectives

- Cover
- Contain
- Educate
- Reduce/Reuse

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

It is important to control litter to eliminate trash and other materials in stormwater runoff. Waste reduction is a major component of waste management and should be encouraged through training and public outreach. Management of waste once it is collected may involve reuse, recycling, or proper disposal.

Approach

Pollution Prevention

- Reuse products when possible.
- Encourage recycling programs with recycling bins, used oil collection, etc.

Suggested Protocols

Solid Waste Collection

- Implement procedures, where applicable, to collect, transport, and dispose of solid waste at appropriate disposal facilities in accordance with applicable federal, state, and local laws and regulations.
- Include properly designed trash storage areas. If feasible provide cover over trash storage areas.
- Regularly inspect solid waste containers for structural damage. Repair or replace damaged containers as necessary.

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CALIFORNIA STORMWATER QUALITY ASSOCIATION

- 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.
- Refer to SC-34 Waste Handling and Disposal for more information regarding solid waste facilities.

Waste Reduction and Recycling

- Recycle wastes whenever possible. Many types of waste can be recycled, recycling options for each waste type are limited. All gasoline, antifreeze, waste oil, and lead-acid batteries can be recycled. Latex and oil-based paint can be reused, as well as recycled. Materials that cannot be reused or recycled should either be incinerated or disposed of at a properly permitted landfill.
- Recycling is always preferable to disposal of unwanted materials.
- Recycling bins for glass, metal, newspaper, plastic bottles and other recyclable household solid wastes should be provided at public facilities and/or for residential curbside collection.

Controlling Litter

- Post “No Littering” signs and enforce anti-litter laws.
- Provide litter receptacles in busy, high pedestrian traffic areas of the community, at recreational facilities, and at community events.
- Clean out and cover litter receptacles frequently to prevent spillage.

Illegal Dumping

Substances illegally dumped on streets and into the storm drain system and creeks include paints, used oil and other automotive fluids, construction debris, chemicals, fresh concrete, leaves, grass clipping, and pet wastes.

- Post “No Dumping” signs with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Landscaping and beautification efforts of hot spots might also discourage future dumping.
- See SC-74 Drainage System Maintenance, and SC-10 Non-Stormwater Discharges.

Requirements

Costs

- The costs for a solid waste source control program vary depending on the type of method. The cost of a community education program or a plan to increase the number of trash receptacles can be very minimal. Costs for structural controls such as trash racks, bar screens, and silt traps can be quite costly ranging from $250,000 to $900,000.

- A collection facility or curbside collection for used oil may result in significant costs. Commercial locations (automobile service stations, quick oil change centers, etc.) as collection points eliminate hauling and recycling costs.

- Collection and disposal of hazardous waste can be very expensive and requires trained operators; laboratory and detection equipment; and extensive record keeping including dates, types, and quantities.

- Use of volunteer work forces can lower storm drain stenciling program costs. Stenciling kits require procurement of durable/disposable items. The stenciling program can aid in the cataloging of the storm drain system. One municipality from the state of Washington has estimated that stenciling kits cost approximately $50 each. Stencils may cost about $8 each including the die cost on an order of 1,000. Re-orders cost about $1/stencil. Stencil designs may be available from other communities. Stencil kits should be provided on a loan basis to volunteer groups free of charge with the understanding that kit remnants are to be returned.

Maintenance

- The primary staff demand for stenciling programs is for program setup to provide marketing and training. Ongoing/follow-up staff time is minimal because of volunteer services.

- Staffing requirements are minimal for oil recycling programs if collection/recycling is contracted out to a used oil hauler/recycler or required at commercial locations.

- Staff requirements for maintaining good housekeeping BMPs at waste handling sites is minimal.

Supplemental Information

Further Detail of the BMP

Waste Reduction

An approach to reduce stormwater pollution from waste handling and disposal is to assess activities and reduce waste generation. The assessment is designed to find situations where waste can be eliminated or reduced and emissions and environmental damage can be minimized. The assessment involves collecting process specific information, setting pollution prevention targets, and developing, screening and selecting waste reduction options for further study. Starting a waste reduction program is economically beneficial because of reduced raw material purchases and lower waste disposal fees.

References and Resources

Best Management Practices Program for Pollution Prevention, City and County of San Francisco, Uribe & Associates, Oakland, California, 1990.

Harvard University. 2002. Solid Waste Container Best Management Practices – Fact Sheet On-Line Resources – Environmental Health and Safety.

Model Urban Runoff Program: A How-To-Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July 1998. (Revised February 2002 by the California Coastal Commission).

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp.

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

Water & Sewer Utility Maintenance SC-76

Objectives

- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	
Metals	
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Although the operation and maintenance of public utilities are not considered chronic sources of stormwater pollution, some activities and accidents can result in the discharge of pollutants that can pose a threat to both human health and the quality of receiving waters if they enter the storm drain system. Sewage incident response and investigation may involve a coordinated effort between staff from a number of different departments/agencies. Cities that do not provide maintenance of water and sewer utilities must coordinate with the contracting agency responsible for these activities and ensure that these model procedures are followed.

Approach

Pollution Prevention

Inspect potential non-stormwater discharge flow paths and clear/cleanup any debris or pollutants found (i.e. remove trash, leaves, sediment, and wipe up liquids, including oil spills).

Suggested Protocols

Water Line Maintenance and Cleaning

Procedures can be employed to reduce pollutants from discharges associated with water utility operation and maintenance activities. Planned discharges may include fire hydrant testing, flushing water supply mains after new construction, flushing lines due to complaints of taste and odor, dewatering mains for maintenance work. Unplanned discharges from treated, recycled water, raw water, and groundwater systems operation and maintenance activities can occur from water main

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breaks, sheared fire hydrants, equipment malfunction, and operator error.

Planned discharges

- Identify a suitable discharge option in the following order of preference:
    - Apply to the land.
    - Reuse water for dust suppression, irrigation, or construction compaction.
    - Discharge to a sanitary sewer system with approval.
    - Discharge to the storm drain system using applicable pollution control measures. (Only available to clean water discharges such as water main/ water storage tank/water hydrant flushing).
- If water is discharged to a storm drain, control measures must be put in place to control potential pollutants (i.e. sediment, chlorine, etc.). Examples of some storm drain protection options include:
    - Silt fence – appropriate where the inlet drains a relatively flat area.
    - Gravel and wire mesh sediment filter – Appropriate where concentrated flows are expected.
    - Wooden weir and fabric – use at curb inlets where a compact installation is desired.
- Prior to discharge, inspect discharge flow path and clear/cleanup any debris or pollutants found (i.e. remove trash, leaves, sediment, and wipe up liquids, including oil spills).
- General Design considerations for inlet protection devices include the following:
    - The device should be constructed such that cleaning and disposal of trapped sediment is made easy, while minimizing interference with discharge activities.
    - Devices should be constructed so that any standing water resulting from the discharge will not cause excessive inconvenience or flooding/damage to adjacent land or structures.
- The effectiveness of control devices must be monitored during the discharge period and any necessary repairs or modifications made.

Unplanned Discharges

- Stop the discharge as quickly as possible.
- Inspect flow path of the discharged water:
    - Identify erodible areas which may need to be repaired or protected during subsequent repairs or corrective actions

  - Identify the potential for pollutants to be washed into the waterway

- If repairs or corrective action will cause additional discharges of water, select the appropriate procedures for erosion control, chlorine residual, turbidity, and chemical additives. Prevent potential pollutants from entering the flow path.

Sanitary Sewer Maintenance

Applicable to municipalities who own and operated a sewage collection system. Facilities that are covered under this program include sanitary sewer pipes and pump stations owned and operated by a municipality. The owner of the sanitary sewer facilities is the entity responsible for carrying out this prevention and response program.

- Clean sewer lines on a regular basis to remove grease, grit, and other debris that may lead to sewer backups.

- Establish routine maintenance program. Cleaning should be conducted at an established minimum frequency and more frequently for problem areas such as restaurants that are identified

- Cleaning activities may require removal of tree roots and other identified obstructions.

- During routine maintenance and inspection note the condition of sanitary sewer structures and identify areas that need repair or maintenance. Items to note may include the following:

  - Cracked/deteriorating pipes
  - Leaking joints/seals at manhole
  - Frequent line plugs
  - Line generally flows at or near capacity
  - Suspected infiltration or exfiltration.

- Prioritize repairs based on the nature and severity of the problem. Immediate clearing of blockage or repair is required where an overflow is currently occurring or for urgent problems that may cause an imminent overflow (e.g. pump station failures, sewer line ruptures, sewer line blockages). These repairs may be temporary until scheduled or capital improvements can be completed.

- Review previous sewer maintenance records to help identify "hot spots" or areas with frequent maintenance problems and locations of potential system failure.

Spills and Overflows

- Identify and track sanitary sewer discharges. Identify dry weather infiltration and inflow first. Wet weather overflow connections are very difficult to locate.

- Locate wet weather overflows and leaking sanitary sewers using conventional source identification techniques such as monitoring and field screening. Techniques used to identify other illicit connection sources can also be used for sewer system evaluation surveys (see SC74 Drainage System Operation and Maintenance).

- Implement community awareness programs for monitoring sanitary sewer wet weather overflows. A citizen's hotline for reporting observed overflow conditions should be established to supplement field screening efforts.

- Establish lead department/agency responsible for spill response and containment. Provide coordination within departments.

- When a spill, leak, and/or overflow occurs and when disinfecting a sewage contaminated area, take every effort to ensure that the sewage, disinfectant and/or sewage treated with the disinfectant is not discharged to the storm drain system or receiving waters. Methods may include:

  - Blocking storm drain inlets and catch basins

  - Containing and diverting sewage and disinfectant away from open channels and other storm drain fixtures (using sandbags, inflatable dams, etc.)

  - Removing the material with vacuum equipment

- Record required information at the spill site.

- Perform field tests as necessary to determine the source of the spill.

- Develop notification procedures regarding spill reporting.

Septic Systems

- Ensure that homeowners, installers, and inspectors are educated in proper maintenance of septic systems. This may require coordination with staff from other departments. Outreach to homeowners should include inspection reminders informing then that inspection and perhaps maintenance is due for their systems. Recommend that the system be inspected annually and pumped-out regularly.

- Programs which seek to address failing septic systems should consider using field screening to pinpoint areas where more detailed onsite inspection surveys are warranted.

Training

- Conduct annual training of water utility personnel and service contractors. (field screening, sampling, smoke/dye testing, TV inspection).

- 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).

Spill Response and Prevention

- See previous section regarding spills and overflows.
- Refer to SC-11, Spill Prevention, Control & Cleanup.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Enact ordinance granting “right-of-entry” to locate potentially responsible parties for sewer overflows.
- Reliance on individual onsite inspection to detect failed septic systems can be a major limitation. The individual onsite inspection is very labor-intensive and requires access to private property to pinpoint the exact location of the failing system.
- A significant limitation to correcting failing septic systems is the lack of techniques available for detecting individual failed septic systems.

Requirements

Costs

- Departmental cooperation recommended for sharing or borrowing staff resources and equipment from municipal wastewater department.
- Infiltration, inflow, and wet weather overflows from sanitary sewers are very labor and equipment intensive to locate.
- The costs associated with detecting and correcting septic system failures are subject to a number of factors, including availability of trained personnel, cost of materials, and the level of follow-up required to fix the system problems.

Maintenance

- Minimum 2-person teams to perform field screening and associated sampling.
- Larger teams required for implementing other techniques (i.e. zinc chloride smoke testing, fluorometric dye testing, television camera inspection and physical inspection with confined space entry) to identify sewer system leaks.
- Program coordination required for handling emergencies, record keeping, etc.
- Many of the problems associated with improper use of septic systems may be attributed to lack of user knowledge on operation and maintenance. Educational materials for homeowners and training courses for installers and inspectors can reduce the incidence of pollution from these widespread and commonly used pollution control devices.

Supplemental Information

Further Detail of the BMP

Onsite Sewage Disposal Systems

New onsite sewage disposal systems should be designed, located, and installed away from open waterbodies and sensitive resources such as wetlands and floodplains. A protective separation between the OSDS and groundwater should also be established. OSDSs should be operated and maintained to prevent surface water discharges and reduce pollutant loadings to groundwater. Inspection of OSDSs should occur regularly and repairs made immediately. New or replacement plumbing fixtures should be of the high efficiency type.

Typical Sanitary Sewer Problems

- Old and deteriorated main and lateral pipes - Sewers range in age from 30 to 100 years with an average age of 50 years.
- Cracked sewer pipes - Existing sewers are mostly clay pipes which can crack as they deteriorate with age and also by earth movement.
- Misaligned and open pipe joints - Most of the mortar used to seal the joints between sections of clay pipe has deteriorated.
- Undersized sewer pipe - The existing sewer system is overloaded due to new sewer hook-ups, underground water infiltration, and illegal roof and/or yard drain connections.
- Defective manholes - Old manholes are made of bricks. Typical problems associated with brick manholes are loose bricks, missing bricks, and misaligned manholes.
- Missing and/or unrecorded sewer pipes and manholes - This problem is typical in the easement/backline sewer. Sewer pipe locations shown on the sewer record map are different from the actual sewer location.
- Sewer main under houses and other improvements - Complaints of sewer main alignment crossing the house and other improvements. A solution to this problem requires an agreement with the property owner for a new sewer easement at a relocated line.

Causes of Sanitary Sewer Backups

- Root infiltration - Tree roots are a major cause of backups.
- Water inflow/infiltration - Rain water entering the sewer pipe causes overflows.
- Solids - Typical solids that buildup in the pipe and cause backups are grease, dirt, bones, tampons, paper towels, diapers, broken dishware, garbage, concrete, and debris.
- Structural defects in pipes and manholes - Sags in the line, cracks, holes, protruding laterals, misaligned pipe, offset joints are all possible causes of backups.

Design Considerations

Sanitary sewer overflows can often be reduced or eliminated by a number of practices, in addition to sewer system cleaning and maintenance, including the following:

- Reducing infiltration and inflow through rehabilitation and repair of broken or leaking sewer lines.
- Enlarging or upgrading the capacity of sewer lines, pump stations, or sewage treatment plants.
- Constructing wet weather storage and treatment facilities to treat excess flows.
- Addressing SSOs during sewer system master planning and facilities planning.

Septic Systems

Two field screening techniques that have been used with success at identifying possible locations of failing septic systems are the brightener test and color infrared (CIR) aerial photography. The first involves the use of specific phosphorus-based elements found in many laundry products, often called brighteners, as an indicator of the presence of failing onsite wastewater systems. The second technique uses color infrared (CIR) aerial photography to characterize the performance of septic systems. This method has been found to be a quick and cost-effective method for assessing the potential impacts of failing systems and uses variations in vegetative growth or stress patterns over septic system field lines to identify those systems that may potentially be malfunctioning. Then a more detailed onsite visual and physical inspection will confirm whether the system has truly failed and the extent of the repairs needed. These inspections may be carried out by county health departments or other authorized personnel.

References and Resources

Alameda Countywide Clean Water Program on-line
http://www.ci.berkeley.ca.us/pw/Storm/stormala.html

Los Angeles County Stormwater Quality. Public Agency Activities Model Program. On-line: http://ladpw.org/wmd/npdes/public_TC.cfm

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1998. Water Utility Operation and Maintenance Discharge Pollution Prevention Plan. June

United States Environmental Protection Agency (USEPA). 2001. Illicit Discharge Detection and Elimination. On-line: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/illi_1.cfm

United States Environmental Protection Agency (USEPA). 2001. Pollution Prevention/Good Housekeeping for Municipal Operators Septic System Controls. On-line: http://www.epa.gov/npdes/menuofbmps/poll_14.htm