Preliminary Water Quality Management Plan

For:

APN 0349-182-11

APN 0349-182-11, WQMP 2022-00152

County of San Bernardino
LAND DEVELOPMENT
PRELIMINARY
APPROVAL
THE APPROVAL OF THIS REPORT SHALL NOT BE CONSTRUED TO BE A PERMIT FOR ANY DEVELOPMENT OR SITE IMPROVEMENT
By: Timothy Cheng (D8256)
Date: 07/28/2023 10:20:29 AM
This report has Preliminary Approval. Prior to Final Approval of the report, all outstanding comments and requirements shall be met.
timothy.cheng@lus.sbcounty.gov
General: (909) 387-8311 Direct: (909) 387-4096

Prepared for:

Henry Oliver

4370 Hallmark Parkway, Ste. 101

San Bernardino, Ca 92407

951-232-4378 Ph.

Prepared by:

Sake Engineers Inc.

400 S. Ramona Ave. Ste. 202

Corona, Ca 92879

(951) 279-4041 Ph.

Sam Akbarpour

Sam@Sakeengineers.com

Submittal Date: 6-30-2022

Revision Date: 6-9-2023, 7-18-2023

Approval Date:_____

Project Owner's Certification

This Water Quality Management Plan (WQMP) has been prepared for Henry Oliver by Sake Engineers Inc.. The WQMP is intended to comply with the requirements of the County of San Bernardino and the NPDES Area wide Stormwater Program requiring the preparation of a WQMP. The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with San Bernardino County's Municipal Storm Water Management Program and the intent of the NPDES Permit for San Bernardino County and the incorporated cities of San Bernardino County within the Santa Ana Region. Once the undersigned transfers its interest in the property, its successors in interest and the city/county shall be notified of the transfer. The new owner will be informed of its responsibility under this WQMP. A copy of the approved WQMP shall be available on the subject site in perpetuity.

"I certify under a penalty of law that the provisions (implementation, operation, maintenance, and funding) of the WQMP have been accepted and that the plan will be transferred to future successors."

Project Data			
Permit/Application Number(s):	WQMP 2022-00152	Grading Permit Number(s):	
Tract/Parcel Map Number(s):		Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN 0349-182-11

Owner's Signature			
Owner Name: Henry Oliver			
Title	Owner		
Company			
Address	4370 Hallmark Parkway, Ste. 101 San Bernardino, Ca 92407		
Email	saman_bagi@yahoo.com		
Telephone #	951-232-4378		
Signature		Date	7-18-2023

Preparer's Certification

Project Data			
Permit/Application Number(s):	WQMP 2022-00152	Grading Permit Number(s):	
Tract/Parcel Map Number(s):		Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN 0349-182-11

"The selection, sizing and design of stormwater treatment and other stormwater quality and quantity control measures in this plan were prepared under my oversight and meet the requirements of Regional Water Quality Control Board Order No. R8-2010-0036."

Engineer: SamAkbarpour		PE Stamp Below
Title	Civil Engineer	
Company	Sake Engineers Inc.	
Address	400 S. Ramona Ave. Ste. 202 Corona, Ca 92879	
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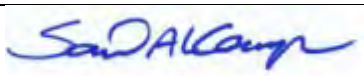
Signature		
Date	7-18-2023	

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Forms

Section 1 Discretionary Permit(s)

Form 1-1 Project Information

Project Name	APN 0349-182-11				
Project Owner Contact Name:	Henry Oliver				
Mailing Address:	4370 Hallmark Parkway, Ste. 101 San Bernardino, Ca 92407	E-mail Address:	saman_bagi@yahoo.com	Telephone:	951-232-4378
Permit/Application Number(s):	WQMP 2022-00152		Tract/Parcel Map Number(s):		
Additional Information/ Comments:	N/A				
Description of Project:	Construction of a proposed gas station canopies, convenience store and drive-thru restaurant located at the intersection of Cajon Blvd. & Glen Helen Parkway in the City of San Bernardino, San Bernardino County, California. Vicinity map attached. The Zone= Glen Helen/Specific Plan-Commercial /Traveller Services, Land-use= Vacant. The existing site is vacant. Existing drainage flows southeast. The whole site is a total of 69,278 SF. The site has one DA which consist is a total of 69,278 SF and 10,385 SF of pervious area and 58,893 SF of impervious area. The proposed DMA will drain to Storm tech system (infiltration underground basin) for water quality, see site plan for location and size.				
Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	N/A				

Section 2 Project Description

2.1 Project Information

This section of the WQMP should provide the information listed below. The information provided for Conceptual/ Preliminary WQMP should give sufficient detail to identify the major proposed site design and LID BMPs and other anticipated water quality features that impact site planning. Final Project WQMP must specifically identify all BMP incorporated into the final site design and provide other detailed information as described herein.

The purpose of this information is to help determine the applicable development category, pollutants of concern, watershed description, and long term maintenance responsibilities for the project, and any applicable water quality credits. This information will be used in conjunction with the information in Section 3, Site Description, to establish the performance criteria and to select the LID BMP or other BMP for the project or other alternative programs that the project will participate in, which are described in Section 4.

Form 2.1-1 Description of Proposed Project

1 Development Category (Select all that apply):

☐ Significant re-development involving the addition or replacement of 5,000 ft^2 or more of impervious surface on an already developed site	☒ New development involving the creation of 10,000 ft^2 or more of impervious surface collectively over entire site	☐ Automotive repair shops with standard industrial classification (SIC) codes 5013, 5014, 5541, 7532- 7534, 7536-7539	☒ Restaurants (with SIC code 5812) where the land area of development is 5,000 ft^2 or more
☐ Hillside developments of 5,000 ft^2 or more which are located on areas with known erosive soil conditions or where the natural slope is 25 percent or more	☐ Developments of 2,500 ft^2 of impervious surface or more adjacent to (within 200 ft) or discharging directly into environmentally sensitive areas or waterbodies listed on the CWA Section 303(d) list of impaired waters.	☒ Parking lots of 5,000 ft^2 or more exposed to storm water	☒ Retail gasoline outlets that are either 5,000 ft^2 or more, or have a projected average daily traffic of 100 or more vehicles per day

☐ Non-Priority / Non-Category Project *May require source control LID BMPs and other LIP requirements. Please consult with local jurisdiction on specific requirements*.

2 Project Area (ft2):	69,278	**3** Number of Dwelling Units:	0	**4** SIC Code:	5812

5 Is Project going to be phased? Yes ☐ No ☒ *If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.*

6 Does Project include roads? Yes ☐ No ☒ *If yes, ensure that applicable requirements for transportation projects are addressed (see Appendix A of TGD for WQMP)*

2.2 Property Ownership/Management

Describe the ownership/management of all portions of the project and site. State whether any infrastructure will transfer to public agencies (City, County, Caltrans, etc.) after project completion. State if a homeowners or property owners association will be formed and be responsible for the long-term maintenance of project stormwater facilities. Describe any lot-level stormwater features that will be the responsibility of individual property owners.

Form 2.2-1 Property Ownership/Management

Describe property ownership/management responsible for long-term maintenance of WQMP stormwater facilities:

Owner will be responsible for maintenance of Storm tech system, see site plan for locations. No infrastructure will transfer to public agencies after project completion. No POA will be formed.

Henry Oliver

4370 Hallmark Parkway, Ste. 101

San Bernardino, Ca 92407

951-232-4378 Ph.

2.3 Potential Stormwater Pollutants

Determine and describe expected stormwater pollutants of concern based on land uses and site activities (refer to Table 3-3 in the TGD for WQMP).

Form 2.3-1 Pollutants of Concern			
Pollutant	Please check: E=Expected, N=Not Expected		Additional Information and Comments
Pathogens (Bacterial / Virus)	E ☒	N ☐	Caused by the transport of animal or human fecal wastes from the watershed.
Nutrients - Phosphorous	E ☒	N ☐	Caused by fertilizers and eroded soils.
Nutrients - Nitrogen	E ☒	N ☐	Caused by fertilizers and eroded soils.
Noxious Aquatic Plants	E ☒	N ☐	Caused by fertilizers and eroded soils.
Sediment	E ☒	N ☐	Caused by eroded land surface.
Metals	E ☒	N ☐	Metals (copper/zinc) could be expected from brake pads from vehicles.
Oil and Grease	E ☒	N ☐	Caused by petroleum hydrocarbon products, motor products from leaking vehicles, esters, oils, fats, waxes, and high molecular-weight fatty acids.
Trash/Debris	E ☒	N ☐	Caused by trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic matter (such as leaves, grass cuttings, and food waste) are general waste products on the landscape.
Pesticides / Herbicides	E ☒	N ☐	Caused by organic compounds used to destroy and/or prevent insects, rodents, fungi, weeds, and other undesirable pests.
Organic Compounds	E ☒	N ☐	Caused by rinsing off objects, toxic levels of solvents and cleaning compounds can be discharged to storm drains. Dirt, grease, and grime retained in the cleaning fluid or rinse water may also adsorb levels of organic compounds that are harmful or hazardous to aquatic life.
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	

2.4 Water Quality Credits

A water quality credit program is applicable for certain types of development projects if it is not feasible to meet the requirements for on-site LID. Proponents for eligible projects, as described below, can apply for water quality credits that would reduce project obligations for selecting and sizing other treatment BMP or participating in other alternative compliance programs. Refer to Section 6.2 in the TGD for WQMP to determine if water quality credits are applicable for the project.

Form 2.4-1 Water Quality Credits

1 Project Types that Qualify for Water Quality Credits: *Select all that apply*

☐ Redevelopment projects that reduce the overall impervious footprint of the project site. [Credit = % impervious reduced]	Higher density development projects ☐ Vertical density [20%] ☐ 7 units/ acre [5%]	☐ Mixed use development, (combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that demonstrate environmental benefits not realized through single use projects) [20%]	☐ Brownfield redevelopment (redevelop real property complicated by presence or potential of hazardous contaminants) [25%]
☐ Redevelopment projects in established historic district, historic preservation area, or similar significant core city center areas [10%]	☐ Transit-oriented developments (mixed use residential or commercial area designed to maximize access to public transportation) [20%]	☐ In-fill projects (conversion of empty lots & other underused spaces < 5 acres, substantially surrounded by urban land uses, into more beneficially used spaces, such as residential or commercial areas) [10%]	☐ Live-Work developments (variety of developments designed to support residential and vocational needs) [20%]

2 Total Credit % 0 *(Total all credit percentages up to a maximum allowable credit of 50 percent)*

Description of Water Quality Credit Eligibility (if applicable)	N/A

Section 3 Site and Watershed Description

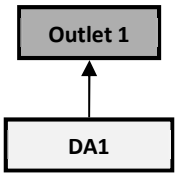
Describe the project site conditions that will facilitate the selection of BMP through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and sub-watershed DMAs) is conveyed to the site outlet(s). Refer to Section 3.2 in the TGD for WQMP. The form below is provided as an example. Then complete Forms 3.2 and 3.3 for each DA on the project site. ***If the project has more than one drainage area for stormwater management, then complete additional versions of these forms for each DA / outlet.***

Form 3-1 Site Location and Hydrologic Features

Site coordinates *take GPS measurement at approximate center of site*	Latitude 34.219267	Longitude -117.401630	Thomas Bros Map page Page 515, Grid C6

1 San Bernardino County climatic region: ☒ Valley ☐ Mountain

2 Does the site have more than one drainage area (DA): Yes☐ No☒ *If no, proceed to Form 3-2. If yes, then use this form to show a conceptual schematic describing DMAs and hydrologic feature connecting DMAs to the site outlet(s). An example is provided below that can be modified for proposed project or a drawing clearly showing DMA and flow routing may be attached*



Example only – modify for project specific WQMP using additional form

Conveyance	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA
DA1 to Outlet 1	DA1 will discharge to proposed Storm Tech System

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1

For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA C	DMA D
1 DMA drainage area (ft^2)	69,278			
2 Existing site impervious area (ft^2)	0			
3 Antecedent moisture condition *For desert areas, use* *http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	II			
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/*	A			
5 Longest flowpath length (ft)	198			
6 Longest flowpath slope (ft/ft)	0.03			
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Open Brush			
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*	Fair			

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1 (use only as needed for additional DMA w/in DA 1)

For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA E	DMA F	DMA G	DMA H
1 DMA drainage area (ft^2)				
2 Existing site impervious area (ft^2)				
3 Antecedent moisture condition *For desert areas, use* *http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*				
4 Hydrologic soil group *Refer to Watershed Mapping Tool –* *http://permitrack.sbcounty.gov/wap/*				
5 Longest flowpath length (ft)				
6 Longest flowpath slope (ft/ft)				
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*				
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*				

Form 3-3 Watershed Description for Drainage Area

Receiving waters *Refer to Watershed Mapping Tool - http://permitrack.sbcounty.gov/wap/* *See 'Drainage Facilities" link at this website*	Lytle Creek Santa Ana River, Reach 4 Santa Ana River, Reach 3 Prado Basin Santa Ana River, Reach 2 Santa Ana River, Reach 1
Applicable TMDLs *Refer to Local Implementation Plan*	Santa Ana Reach 3 - Indicator Bacteria
303(d) listed impairments *Refer to Local Implementation Plan and Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/ and State Water Resources Control Board website – http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/index.shtml*	Santa Ana River Reach 3 – Indicator Bacteria, Copper, Lead Prado flood control basin - pH Santa Ana River Reach 2 – None Santa Ana River Reach 1 – None Pacific Ocean - None
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/*	San Bernardino Kangaroo Rat
Unlined Downstream Water Bodies *Refer to Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/*	Santa Ana River
Hydrologic Conditions of Concern	☒ Yes *Complete Hydrologic Conditions of Concern (HCOC) Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-10 in submittal* ☐ No
Watershed–based BMP included in a RWQCB approved WAP	☐ Yes *Attach verification of regional BMP evaluation criteria in WAP* • *More Effective than On-site LID* • *Remaining Capacity for Project DCV* • *Upstream of any Water of the US* • *Operational at Project Completion* • *Long-Term Maintenance Plan* ☒ No

Section 4 Best Management Practices (BMP)

4.1 Source Control BMP

4.1.1 Pollution Prevention

Non-structural and structural source control BMP are required to be incorporated into all new development and significant redevelopment projects. Form 4.1-1 and 4.1-2 are used to describe specific source control BMPs used in the WQMP or to explain why a certain BMP is not applicable. Table 7-3 of the TGD for WQMP provides a list of applicable source control BMP for projects with specific types of potential pollutant sources or activities. The source control BMP in this table must be implemented for projects with these specific types of potential pollutant sources or activities.

The preparers of this WQMP have reviewed the source control BMP requirements for new development and significant redevelopment projects. The preparers have also reviewed the specific BMP required for project as specified in Forms 4.1-1 and 4.1-2. All applicable non-structural and structural source control BMP shall be implemented in the project.

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N1	Education of Property Owners, Tenants and Occupants on Stormwater BMPs	☒	☐	Property owner shall review and become familiar with site specific WQMP. Additional education materials for day to day operations are contained in Section 6.4
N2	Activity Restrictions	☒	☐	No vehicle washing, no car maintenance & no equipment washing will be allowed . All pesticide applications when absolute necessary shall be performed by a licensed contractor certified by the California Department regulating pesticides.
N3	Landscape Management BMPs	☒	☐	A licensed landscape contractor shall maintain landscape and Infiltration Basin to remove trash/ debris, maintain irrigation system and follow fertilizer and pesticides application guideline by the county.
N4	BMP Maintenance	☒	☐	BMP Maintenance shall be performed in accordance with Section 5 of this report, the Operations & Maintenance Plan in the section 6.4. of this report, or the currently accepted Maintenance Procedures at the time of maintenance.
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	No Title 22 CCR Compliance, site doesn't have medical waste.
N6	Local Water Quality Ordinances	☒	☐	"Project to comply with County of San Bernardino Water Quality Ordinance through implementation of this WQMP"
N7	Spill Contingency Plan	☐	☒	In case of an oil spill have a few absorbent clay bags available at the site for oil spill control and remove. See site plan for storage room where clay bags will be located.
N8	Underground Storage Tank Compliance	☒	☐	Site will propose fueling and will follow state regulations and enforced by County of San Bernardino Environmental Health Services requirements.
N9	Hazardous Materials Disclosure Compliance	☒	☐	Site will propose fueling and will follow Compliance with local ordinances for the management of hazardous materials by local fire protection agencies, San Bernardino County, health care agencies.

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N10	Uniform Fire Code Implementation	☒	☐	Site will propose fueling and will follow with article 80 of the uniform fire code enforced by the fire protection agency.
N11	Litter/Debris Control Program	☒	☐	It shall be the Owner's responsibility to provide proper litter control. Litter controls shall be provided during regularly scheduled landscape maintenance, and as needed to prevent transportation of trash & debris from the site.
N12	Employee Training	☒	☐	Owner shall provide employees with the right education material to follow. This will occur within 3 months of hire and annually after.
N13	Housekeeping of Loading Docks	☐	☒	No loading docks
N14	Catch Basin Inspection Program	☒	☐	Owner is responsible to Check catch basins for trash and debris weekly and after storm event.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	All landscape maintenance contractors will be required to sweep up all landscape cuttings, mowing and fertilizer materials off paved areas weekly and dispose of properly.
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	Not a public agency
N17	Comply with all other applicable NPDES permits	☒	☐	Project must obtain coverage under the Construction General Permit prior to construction.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	☒	☐	Signs stating “drains to the ocean” will be placed above storm drain inlets to warn the public of prohibitions against waste disposal. Owner will be responsible of maintenance.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	No material storage provided.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	-Trash enclosure shall have a solid roof to prevent pollutions. -Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This might include grading the waste handling area to prevent run-on of stormwater.
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☒	☐	Owner shall be required to adhere to the California Statewide "Model Water Efficient Landscape". This will include the implementation of smart irrigation controllers to maximize water conservation. See Landscape maintenance, SD-12 Efficient irrigation brochure in Section 6.4: Educational Material.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	Landscaping areas will be depressed 1-2 inches.
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☐	☒	No existing slopes and channels.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	no dock
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	No maintenance
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No Vehicle Wash Proposed

S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	No outdoor processing proposed

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No Equipment Wash proposed
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☒	☐	Site will propose fueling and will follows: -The fuel dispensing area shall be paved with Portland cement concrete (or equivalent smooth impervious surface). The use of asphalt concrete shall be prohibited. -The fuel dispensing area shall have an appropriate slope (2 percent - 4 percent) to prevent ponding, and must be separated from the rest of the site by a grade break that prevents run-on of stormwater. -An overhanging roof structure or canopy shall be provided. The cover's minimum dimensions must be equal to or greater than the area of the fuel dispensing area in the first item above. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area. The fueling area shall drain to the project's oil grease separator prior to discharging to the MS4.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	No hillside landscaping
S14	Wash water control for food preparation areas	☒	☐	Food establishments (per State Health & Safety Code 27520) shall have either contained areas or sinks, each with sanitary sewer connections for disposal of wash waters containing kitchen and food wastes. If located outside, the contained areas or sinks shall also be structurally covered to prevent entry of stormwater. Adequate signs shall be provided and appropriately placed stating the prohibition of discharging washwater to the storm drain system.

S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	No Community Car Wash Racks are Proposed

4.1.2 Preventative LID Site Design Practices

Site design practices associated with new LID requirements in the MS4 Permit should be considered in the earliest phases of a project. Preventative site design practices can result in smaller DCV for LID BMP and hydromodification control BMP by reducing runoff generation. Describe site design and drainage plan including:

- A narrative of site design practices utilized or rationale for not using practices
- A narrative of how site plan incorporates preventive site design practices
- Include an attached Site Plan layout which shows how preventative site design practices are included in WQMP

Refer to Section 5.2 of the TGD for WQMP for more details.

Form 4.1-3 Preventative LID Site Design Practices Checklist

Site Design Practices *If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets*
Minimize impervious areas: Yes ☒ No ☐ Explanation: Proposed sidewalk and driveway areas have been designed to minimize widths. Impervious area is 58,902 SF (1.35 Ac) and pervious area is 10,376 SF (0.24 Ac).
Maximize natural infiltration capacity: Yes ☒ No ☐ Explanation: Avoid locating constructed elements on highly permeable areas
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: The proposed development mimics the existing drainage pattern as all runoff sheet flows in a southeasterly direction towards the proposed bmp. BMP decreases time of concentration.
Disconnect impervious areas: Yes ☐ No ☒ Explanation: Roof downspouts will outlet to walkway the sheet flow to ribbon gutter.
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation: There is little to no existing vegetation. There are no existing sensitive areas. Project includes new landscaped areas and a storm tech system as an alternative to decrease Time of concentration.
Re-vegetate disturbed areas: Yes ☒ No ☐ Explanation: The proposed landscape area will be re-vegetated, see WQMP site plan for locations.
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: The proposed underground storage/infiltration system is to be excavated only. The limit of the infiltration facility is to be marked off during construction. Compaction must be per manufacturers specifications.
Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes ☐ No ☒ Explanation: All proposed flow will be via ribbon gutter & sheet flow, see WQMP site plan in section 6.1 for locations.
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☒ No ☐ Explanation: Landscaped areas will be staked to minimize unnecessary compaction during construction.

4.2 Project Performance Criteria

The purpose of this section of the Project WQMP is to establish targets for post-development hydrology based on performance criteria specified in the MS4 Permit. These targets include runoff volume for water quality control (referred to as LID design capture volume), and runoff volume, time of concentration, and peak runoff for protection of any downstream waterbody segments with a HCOC. ***If the project has more than one outlet for stormwater runoff, then complete additional versions of these forms for each DA / outlet.***

Methods applied in the following forms include:

- For LID BMP Design Capture Volume (DCV), the San Bernardino County Stormwater Program requires use of the P_6 method (MS4 Permit Section XI.D.6a.ii) – Form 4.2-1
- For HCOC pre- and post-development hydrologic calculation, the San Bernardino County Stormwater Program requires the use of the Rational Method (San Bernardino County Hydrology Manual Section D). Forms 4.2-2 through Form 4.2-5 calculate hydrologic variables including runoff volume, time of concentration, and peak runoff from the project site pre- and post-development using the Hydrology Manual Rational Method approach. For projects greater than 640 acres (1.0 mi^2), the Rational Method and these forms should not be used. For such projects, the Unit Hydrograph Method (San Bernardino County Hydrology Manual Section E) shall be applied for hydrologic calculations for HCOC performance criteria.

Refer to Section 4 in the TGD for WQMP for detailed guidance and instructions.

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1)

1 Project area DA 1 (ft^2): 69,278	**2** Imperviousness after applying preventative site design practices (Imp%): 0.85	**3** Runoff Coefficient (Rc): _0.66 *$R_c = 0.858(Imp\%)^{\wedge 3} - 0.78(Imp\%)^{\wedge 2} + 0.774(Imp\%) + 0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.928 *http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*		
5 Compute P_6, Mean 6-hr Precipitation (inches): 1.37 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)*		
6 Drawdown Rate *Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.*		24-hrs ☐ 48-hrs ☒
7 Compute design capture volume, DCV (ft^3): 10,247.05 *DCV = 1/12 * [Item 1* Item 3 *Item 5 * C_2], where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)* *Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2*		

NOAA Atlas 14, Volume 6, Version 2
Location name: San Bernardino, California, USA*
Latitude: 34.2194°, Longitude: -117.4017°
Elevation: 2040.01 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.157 (0.130-0.191)	0.232 (0.192-0.282)	0.324 (0.268-0.395)	0.394 (0.323-0.485)	0.484 (0.384-0.617)	0.549 (0.427-0.715)	0.613 (0.464-0.817)	0.675 (0.497-0.926)	0.754 (0.532-1.08)	0.813 (0.554-1.21)
10-min	0.225 (0.187-0.273)	0.332 (0.276-0.404)	0.464 (0.384-0.566)	0.565 (0.464-0.695)	0.694 (0.550-0.884)	0.788 (0.611-1.02)	0.878 (0.665-1.17)	0.967 (0.712-1.33)	1.08 (0.763-1.55)	1.17 (0.794-1.73)
15-min	0.272 (0.226-0.330)	0.402 (0.333-0.489)	0.561 (0.464-0.684)	0.683 (0.561-0.841)	0.839 (0.666-1.07)	0.952 (0.739-1.24)	1.06 (0.804-1.42)	1.17 (0.861-1.61)	1.31 (0.922-1.87)	1.41 (0.960-2.09)
30-min	0.410 (0.341-0.498)	0.606 (0.503-0.738)	0.846 (0.700-1.03)	1.03 (0.846-1.27)	1.27 (1.00-1.61)	1.44 (1.12-1.87)	1.60 (1.21-2.14)	1.77 (1.30-2.42)	1.97 (1.39-2.83)	2.13 (1.45-3.16)
60-min	0.628 (0.522-0.763)	0.928 (0.770-1.13)	1.30 (1.07-1.58)	1.58 (1.30-1.94)	1.94 (1.54-2.47)	2.20 (1.71-2.86)	2.45 (1.86-3.27)	2.70 (1.99-3.71)	3.02 (2.13-4.33)	3.26 (2.22-4.83)
2-hr	0.991 (0.823-1.20)	1.36 (1.13-1.65)	1.81 (1.50-2.21)	2.15 (1.77-2.65)	2.60 (2.06-3.31)	2.92 (2.27-3.81)	3.24 (2.45-4.32)	3.55 (2.61-4.87)	3.94 (2.78-5.65)	4.23 (2.88-6.28)
3-hr	1.30 (1.08-1.57)	1.72 (1.43-2.10)	2.25 (1.86-2.75)	2.66 (2.18-3.27)	3.18 (2.53-4.05)	3.57 (2.77-4.64)	3.94 (2.98-5.25)	4.30 (3.16-5.90)	4.77 (3.36-6.83)	5.11 (3.48-7.58)
6-hr	1.96 (1.63-2.38)	2.53 (2.10-3.08)	3.25 (2.69-3.96)	3.80 (3.12-4.68)	4.52 (3.58-5.75)	5.04 (3.91-6.55)	5.54 (4.20-7.39)	6.04 (4.44-8.29)	6.68 (4.71-9.56)	7.14 (4.86-10.6)
12-hr	2.65 (2.21-3.23)	3.44 (2.85-4.18)	4.41 (3.65-5.38)	5.16 (4.24-6.35)	6.14 (4.87-7.82)	6.85 (5.32-8.91)	7.54 (5.71-10.1)	8.22 (6.05-11.3)	9.09 (6.41-13.0)	9.73 (6.62-14.4)
24-hr	3.55 (3.14-4.09)	4.68 (4.14-5.40)	6.09 (5.38-7.04)	7.19 (6.30-8.39)	8.62 (7.30-10.4)	9.66 (8.02-11.9)	10.7 (8.65-13.5)	11.7 (9.21-15.1)	13.0 (9.82-17.5)	13.9 (10.2-19.5)
2-day	4.34 (3.84-4.99)	5.87 (5.20-6.78)	7.82 (6.90-9.04)	9.35 (8.19-10.9)	11.4 (9.63-13.7)	12.9 (10.7-15.8)	14.3 (11.6-18.1)	15.8 (12.5-20.5)	17.7 (13.4-23.9)	19.2 (14.0-26.8)
3-day	4.62 (4.09-5.32)	6.39 (5.65-7.37)	8.65 (7.63-10.0)	10.4 (9.15-12.2)	12.8 (10.9-15.5)	14.6 (12.1-18.0)	16.4 (13.3-20.7)	18.2 (14.4-23.6)	20.6 (15.6-27.8)	22.4 (16.4-31.3)
4-day	4.94 (4.38-5.69)	6.94 (6.14-8.00)	9.50 (8.39-11.0)	11.6 (10.1-13.5)	14.3 (12.1-17.2)	16.4 (13.6-20.2)	18.5 (15.0-23.3)	20.6 (16.2-26.7)	23.5 (17.7-31.6)	25.6 (18.7-35.8)
7-day	5.37 (4.76-6.19)	7.78 (6.88-8.97)	10.9 (9.63-12.6)	13.5 (11.8-15.7)	16.9 (14.3-20.3)	19.5 (16.2-24.0)	22.2 (18.0-28.0)	24.9 (19.6-32.3)	28.6 (21.7-38.6)	31.5 (23.0-43.9)
10-day	5.85 (5.18-6.74)	8.61 (7.62-9.93)	12.2 (10.8-14.1)	15.2 (13.3-17.7)	19.3 (16.3-23.2)	22.4 (18.6-27.5)	25.6 (20.7-32.2)	28.9 (22.8-37.5)	33.5 (25.3-45.1)	37.0 (27.0-51.6)
20-day	6.97 (6.18-8.03)	10.5 (9.25-12.1)	15.1 (13.4-17.5)	19.1 (16.7-22.2)	24.6 (20.8-29.6)	28.9 (24.0-35.6)	33.5 (27.1-42.2)	38.3 (30.2-49.6)	45.0 (34.0-60.7)	50.4 (36.8-70.3)
30-day	8.20 (7.26-9.45)	12.2 (10.8-14.1)	17.8 (15.7-20.6)	22.5 (19.7-26.3)	29.3 (24.8-35.2)	34.7 (28.8-42.6)	40.4 (32.7-50.9)	46.6 (36.7-60.3)	55.3 (41.8-74.6)	62.4 (45.6-87.1)
45-day	10.1 (8.93-11.6)	14.7 (13.0-17.0)	21.3 (18.8-24.6)	27.0 (23.6-31.4)	35.2 (29.8-42.4)	42.0 (34.8-51.6)	49.2 (39.9-62.0)	57.2 (45.1-74.0)	68.7 (51.9-92.7)	78.2 (57.2-109)
60-day	12.0 (10.6-13.8)	17.1 (15.1-19.7)	24.4 (21.5-28.2)	30.8 (26.9-35.9)	40.2 (34.1-48.5)	48.1 (39.9-59.2)	56.7 (46.0-71.5)	66.2 (52.2-85.8)	80.2 (60.7-108)	92.0 (67.3-128)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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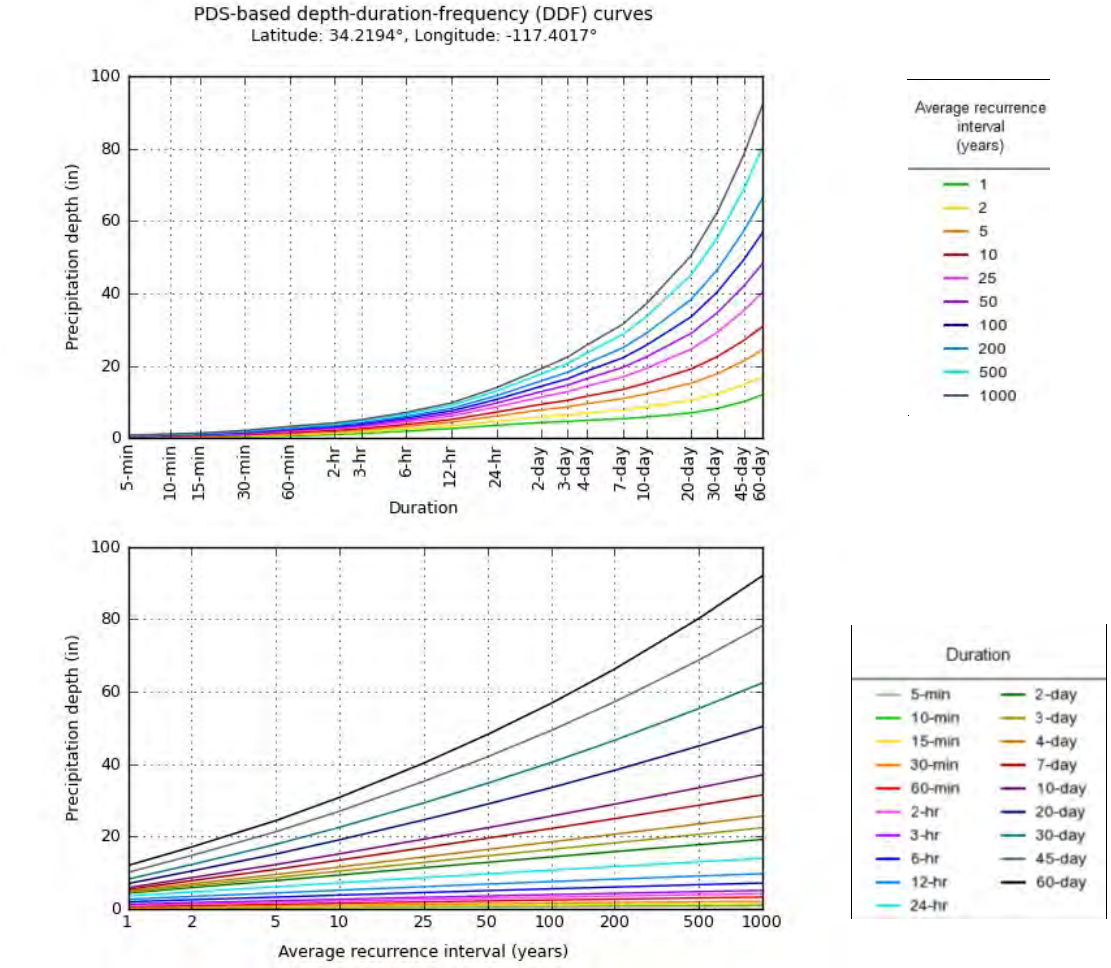
PF graphical



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Created (GMT): Fri Jun 10 16:16:46 2022

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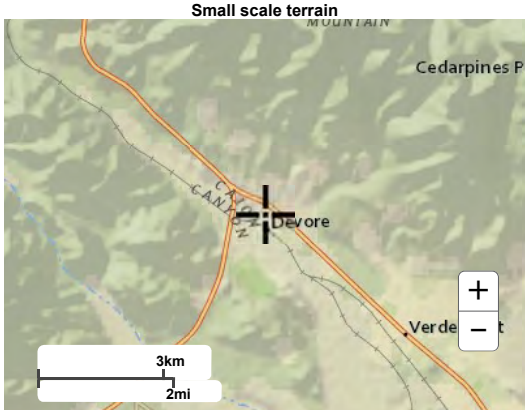
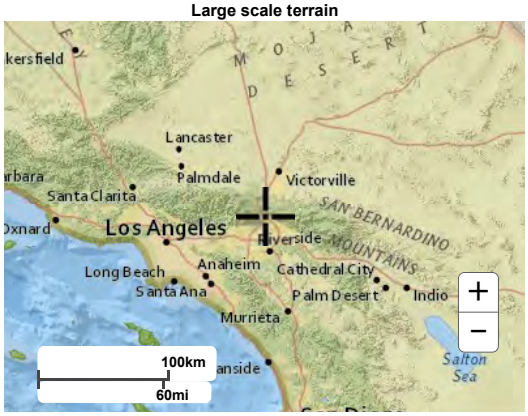
Maps & aerials

Small scale terrain

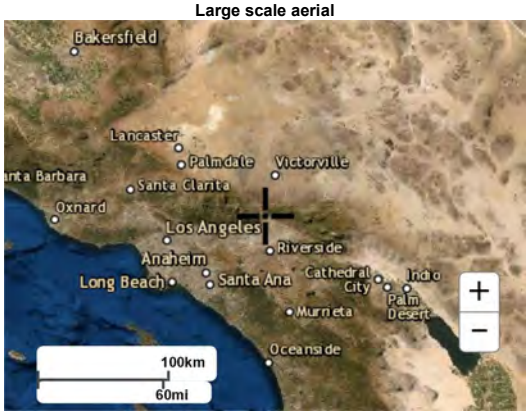


Large scale terrain



Large scale map

Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Form 4.2-2 Summary of HCOC Assessment (DA 1)

Does project have the potential to cause or contribute to an HCOC in a downstream channel: Yes ☒ No ☐

Go to: *http://permitrack.sbcounty.gov/wap/*

If "Yes", then complete HCOC assessment of site hydrology for 2yr storm event using Forms 4.2-3 through 4.2-5 and insert results below

(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual)

If "No," then proceed to Section 4.3 Project Conformance Analysis

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** 4,613 *Form 4.2-3 Item 12*	**2** 12.10 *Form 4.2-4 Item 13*	**3** 2.25 *Form 4.2-5 Item 10*
Post-developed	**4** 21,148 *Form 4.2-3 Item 13*	**5** 7.00 *Form 4.2-4 Item 14*	**6** 4.56 *Form 4.2-5 Item 14*
Difference	**7** *16,535* *Item 4 – Item 1*	**8** *5.1* *Item 2 – Item 5*	**9** *2.31* *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** *358%* *Item 7 / Item 1*	**11** *42%* *Item 8 / Item 2*	**12** *103%* *Item 9 / Item 3*

See next page for calc's.

Synthetic Unit Hydrograph Method

Pre-Development

for

2Year Storm

```
      U n i t   H y d r o g r a p h   A n a l y s i s

      Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 1999, Version 6.0

            Study date  06/18/22

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
------------------------------------------------------------------------------

San Bernardino County Synthetic Unit Hydrology Method
            Manual date - August 1986

Sake Consulting Engineers, inc. Corona, CA      - S/N  4084

------------------------------------------------------------------------------
------------------------------------------------------------------------------

      Storm Event Year = 2

      Antecedent Moisture Condition = 1

 English (in-lb) Input Units Used

 English Rainfall Data (Inches) Input Values Used

 English Units used in output format



Area averaged rainfall intensity isohyetal data:
      Sub-Area        Duration        Isohyetal
      (Ac.)            (hours)         (In)
Rainfall data for year 2
           1.60            1           0.93
------------------------------------------------------------------------------
Rainfall data for year 2
           1.60            6           2.53
------------------------------------------------------------------------------
Rainfall data for year 2
           1.60           24           4.68
------------------------------------------------------------------------------
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

******** Area-averaged max loss rate, Fm ********


SCS curve  SCS curve     Area     Area     Fp(Fig C6)    Ap      Fm
No.(AMCII) NO.(AMC 1)    (Ac.)    Fraction     (In/Hr)  (dec.)   (In/Hr)
 67.0      47.4          1.60      1.000     0.840    1.000    0.840

Area-averaged adjusted loss rate Fm (In/Hr) =  0.840
```

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC1)	S	Pervious Yield Fr
1.60	1.000	67.0	47.4	11.10	0.095

Area-averaged catchment yield fraction, Y = 0.095
Area-averaged low loss fraction, Yb = 0.905
Direct entry of lag time by user
++
Watershed area = 1.60(Ac.)
Catchment Lag time = 0.161 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 51.6316
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.840(In/Hr)
Average low loss rate fraction (Yb) = 0.905 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.440(In)
Computed peak 30-minute rainfall = 0.754(In)
Specified peak 1-hour rainfall = 0.928(In)
Computed peak 3-hour rainfall = 1.716(In)
Specified peak 6-hour rainfall = 2.530(In)
Specified peak 24-hour rainfall = 4.680(In)

Rainfall depth area reduction factors:
Using a total area of 1.60(Ac.) (Ref: fig. E-4)

5-minute factor = 1.000 Adjusted rainfall = 0.440(In)
30-minute factor = 1.000 Adjusted rainfall = 0.754(In)
1-hour factor = 1.000 Adjusted rainfall = 0.928(In)
3-hour factor = 1.000 Adjusted rainfall = 1.716(In)
6-hour factor = 1.000 Adjusted rainfall = 2.530(In)
24-hour factor = 1.000 Adjusted rainfall = 4.680(In)

U n i t H y d r o g r a p h
++

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
(K = 19.35 (CFS))		
1	4.186	0.810
2	32.414	5.462
3	61.985	5.722
4	74.846	2.489
5	82.306	1.444
6	87.355	0.977
7	90.775	0.662
8	93.315	0.491
9	95.205	0.366

10	96.632	0.276
11	97.633	0.194
12	98.245	0.118
13	98.845	0.116
14	99.435	0.114
15	99.804	0.071
16	100.000	0.038

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.4403	0.4403
2	0.5421	0.1018
3	0.6122	0.0701
4	0.6674	0.0552
5	0.7136	0.0462
6	0.7537	0.0401
7	0.7894	0.0357
8	0.8217	0.0323
9	0.8512	0.0296
10	0.8785	0.0273
11	0.9040	0.0255
12	0.9279	0.0239
13	0.9705	0.0425
14	1.0116	0.0411
15	1.0514	0.0398
16	1.0901	0.0387
17	1.1277	0.0376
18	1.1644	0.0367
19	1.2002	0.0358
20	1.2351	0.0350
21	1.2693	0.0342
22	1.3028	0.0335
23	1.3356	0.0328
24	1.3678	0.0322
25	1.3995	0.0316
26	1.4305	0.0311
27	1.4611	0.0305
28	1.4911	0.0301
29	1.5207	0.0296
30	1.5498	0.0291
31	1.5786	0.0287
32	1.6069	0.0283
33	1.6348	0.0279
34	1.6623	0.0276
35	1.6895	0.0272
36	1.7164	0.0269
37	1.7429	0.0265
38	1.7691	0.0262
39	1.7950	0.0259
40	1.8207	0.0256
41	1.8460	0.0253
42	1.8711	0.0251
43	1.8959	0.0248
44	1.9204	0.0246

45	1.9447	0.0243
46	1.9688	0.0241
47	1.9927	0.0238
48	2.0163	0.0236
49	2.0397	0.0234
50	2.0629	0.0232
51	2.0859	0.0230
52	2.1087	0.0228
53	2.1313	0.0226
54	2.1537	0.0224
55	2.1759	0.0222
56	2.1980	0.0221
57	2.2199	0.0219
58	2.2416	0.0217
59	2.2631	0.0216
60	2.2845	0.0214
61	2.3058	0.0212
62	2.3268	0.0211
63	2.3478	0.0209
64	2.3686	0.0208
65	2.3892	0.0206
66	2.4097	0.0205
67	2.4301	0.0204
68	2.4503	0.0202
69	2.4704	0.0201
70	2.4904	0.0200
71	2.5103	0.0199
72	2.5300	0.0197
73	2.5455	0.0155
74	2.5609	0.0154
75	2.5762	0.0153
76	2.5914	0.0152
77	2.6065	0.0151
78	2.6215	0.0150
79	2.6363	0.0149
80	2.6511	0.0148
81	2.6657	0.0147
82	2.6803	0.0146
83	2.6947	0.0145
84	2.7091	0.0144
85	2.7233	0.0143
86	2.7375	0.0142
87	2.7516	0.0141
88	2.7656	0.0140
89	2.7795	0.0139
90	2.7933	0.0138
91	2.8070	0.0137
92	2.8207	0.0136
93	2.8342	0.0136
94	2.8477	0.0135
95	2.8611	0.0134
96	2.8744	0.0133
97	2.8877	0.0132
98	2.9009	0.0132

99	2.9139	0.0131
100	2.9270	0.0130
101	2.9399	0.0130
102	2.9528	0.0129
103	2.9656	0.0128
104	2.9783	0.0127
105	2.9910	0.0127
106	3.0036	0.0126
107	3.0162	0.0125
108	3.0286	0.0125
109	3.0411	0.0124
110	3.0534	0.0123
111	3.0657	0.0123
112	3.0779	0.0122
113	3.0901	0.0122
114	3.1022	0.0121
115	3.1142	0.0120
116	3.1262	0.0120
117	3.1381	0.0119
118	3.1500	0.0119
119	3.1618	0.0118
120	3.1736	0.0118
121	3.1853	0.0117
122	3.1969	0.0117
123	3.2085	0.0116
124	3.2201	0.0115
125	3.2316	0.0115
126	3.2430	0.0114
127	3.2544	0.0114
128	3.2658	0.0113
129	3.2771	0.0113
130	3.2883	0.0112
131	3.2995	0.0112
132	3.3107	0.0112
133	3.3218	0.0111
134	3.3328	0.0111
135	3.3438	0.0110
136	3.3548	0.0110
137	3.3657	0.0109
138	3.3766	0.0109
139	3.3874	0.0108
140	3.3982	0.0108
141	3.4090	0.0107
142	3.4197	0.0107
143	3.4304	0.0107
144	3.4410	0.0106
145	3.4516	0.0106
146	3.4621	0.0105
147	3.4726	0.0105
148	3.4831	0.0105
149	3.4935	0.0104
150	3.5039	0.0104
151	3.5142	0.0103
152	3.5245	0.0103

153	3.5348	0.0103
154	3.5450	0.0102
155	3.5552	0.0102
156	3.5654	0.0102
157	3.5755	0.0101
158	3.5856	0.0101
159	3.5956	0.0101
160	3.6057	0.0100
161	3.6156	0.0100
162	3.6256	0.0099
163	3.6355	0.0099
164	3.6454	0.0099
165	3.6552	0.0098
166	3.6650	0.0098
167	3.6748	0.0098
168	3.6846	0.0097
169	3.6943	0.0097
170	3.7040	0.0097
171	3.7136	0.0097
172	3.7232	0.0096
173	3.7328	0.0096
174	3.7424	0.0096
175	3.7519	0.0095
176	3.7614	0.0095
177	3.7709	0.0095
178	3.7803	0.0094
179	3.7897	0.0094
180	3.7991	0.0094
181	3.8084	0.0094
182	3.8178	0.0093
183	3.8271	0.0093
184	3.8363	0.0093
185	3.8456	0.0092
186	3.8548	0.0092
187	3.8639	0.0092
188	3.8731	0.0092
189	3.8822	0.0091
190	3.8913	0.0091
191	3.9004	0.0091
192	3.9094	0.0090
193	3.9185	0.0090
194	3.9275	0.0090
195	3.9364	0.0090
196	3.9454	0.0089
197	3.9543	0.0089
198	3.9632	0.0089
199	3.9721	0.0089
200	3.9809	0.0088
201	3.9897	0.0088
202	3.9985	0.0088
203	4.0073	0.0088
204	4.0160	0.0087
205	4.0248	0.0087
206	4.0335	0.0087

207	4.0421	0.0087
208	4.0508	0.0087
209	4.0594	0.0086
210	4.0680	0.0086
211	4.0766	0.0086
212	4.0852	0.0086
213	4.0937	0.0085
214	4.1022	0.0085
215	4.1107	0.0085
216	4.1192	0.0085
217	4.1276	0.0085
218	4.1361	0.0084
219	4.1445	0.0084
220	4.1529	0.0084
221	4.1612	0.0084
222	4.1696	0.0083
223	4.1779	0.0083
224	4.1862	0.0083
225	4.1945	0.0083
226	4.2027	0.0083
227	4.2110	0.0082
228	4.2192	0.0082
229	4.2274	0.0082
230	4.2356	0.0082
231	4.2437	0.0082
232	4.2519	0.0081
233	4.2600	0.0081
234	4.2681	0.0081
235	4.2762	0.0081
236	4.2842	0.0081
237	4.2923	0.0080
238	4.3003	0.0080
239	4.3083	0.0080
240	4.3163	0.0080
241	4.3243	0.0080
242	4.3322	0.0080
243	4.3402	0.0079
244	4.3481	0.0079
245	4.3560	0.0079
246	4.3639	0.0079
247	4.3717	0.0079
248	4.3796	0.0078
249	4.3874	0.0078
250	4.3952	0.0078
251	4.4030	0.0078
252	4.4108	0.0078
253	4.4185	0.0078
254	4.4263	0.0077
255	4.4340	0.0077
256	4.4417	0.0077
257	4.4494	0.0077
258	4.4571	0.0077
259	4.4647	0.0077
260	4.4724	0.0076

261	4.4800	0.0076
262	4.4876	0.0076
263	4.4952	0.0076
264	4.5028	0.0076
265	4.5103	0.0076
266	4.5179	0.0075
267	4.5254	0.0075
268	4.5329	0.0075
269	4.5404	0.0075
270	4.5479	0.0075
271	4.5553	0.0075
272	4.5628	0.0075
273	4.5702	0.0074
274	4.5777	0.0074
275	4.5851	0.0074
276	4.5924	0.0074
277	4.5998	0.0074
278	4.6072	0.0074
279	4.6145	0.0073
280	4.6219	0.0073
281	4.6292	0.0073
282	4.6365	0.0073
283	4.6438	0.0073
284	4.6510	0.0073
285	4.6583	0.0073
286	4.6655	0.0072
287	4.6728	0.0072
288	4.6800	0.0072

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0072	0.0065	0.0007
2	0.0072	0.0065	0.0007
3	0.0073	0.0066	0.0007
4	0.0073	0.0066	0.0007
5	0.0073	0.0066	0.0007
6	0.0073	0.0066	0.0007
7	0.0073	0.0066	0.0007
8	0.0074	0.0067	0.0007
9	0.0074	0.0067	0.0007
10	0.0074	0.0067	0.0007
11	0.0074	0.0067	0.0007
12	0.0075	0.0067	0.0007
13	0.0075	0.0068	0.0007
14	0.0075	0.0068	0.0007
15	0.0075	0.0068	0.0007
16	0.0075	0.0068	0.0007
17	0.0076	0.0069	0.0007
18	0.0076	0.0069	0.0007
19	0.0076	0.0069	0.0007
20	0.0076	0.0069	0.0007
21	0.0077	0.0069	0.0007

22	0.0077	0.0070	0.0007
23	0.0077	0.0070	0.0007
24	0.0077	0.0070	0.0007
25	0.0078	0.0070	0.0007
26	0.0078	0.0070	0.0007
27	0.0078	0.0071	0.0007
28	0.0078	0.0071	0.0007
29	0.0079	0.0071	0.0008
30	0.0079	0.0071	0.0008
31	0.0079	0.0072	0.0008
32	0.0080	0.0072	0.0008
33	0.0080	0.0072	0.0008
34	0.0080	0.0072	0.0008
35	0.0080	0.0073	0.0008
36	0.0081	0.0073	0.0008
37	0.0081	0.0073	0.0008
38	0.0081	0.0073	0.0008
39	0.0082	0.0074	0.0008
40	0.0082	0.0074	0.0008
41	0.0082	0.0074	0.0008
42	0.0082	0.0075	0.0008
43	0.0083	0.0075	0.0008
44	0.0083	0.0075	0.0008
45	0.0083	0.0075	0.0008
46	0.0084	0.0076	0.0008
47	0.0084	0.0076	0.0008
48	0.0084	0.0076	0.0008
49	0.0085	0.0077	0.0008
50	0.0085	0.0077	0.0008
51	0.0085	0.0077	0.0008
52	0.0086	0.0077	0.0008
53	0.0086	0.0078	0.0008
54	0.0086	0.0078	0.0008
55	0.0087	0.0078	0.0008
56	0.0087	0.0079	0.0008
57	0.0087	0.0079	0.0008
58	0.0088	0.0079	0.0008
59	0.0088	0.0080	0.0008
60	0.0088	0.0080	0.0008
61	0.0089	0.0080	0.0008
62	0.0089	0.0081	0.0009
63	0.0090	0.0081	0.0009
64	0.0090	0.0081	0.0009
65	0.0090	0.0082	0.0009
66	0.0091	0.0082	0.0009
67	0.0091	0.0083	0.0009
68	0.0092	0.0083	0.0009
69	0.0092	0.0083	0.0009
70	0.0092	0.0084	0.0009
71	0.0093	0.0084	0.0009
72	0.0093	0.0084	0.0009
73	0.0094	0.0085	0.0009
74	0.0094	0.0085	0.0009
75	0.0095	0.0086	0.0009

76	0.0095	0.0086	0.0009
77	0.0096	0.0086	0.0009
78	0.0096	0.0087	0.0009
79	0.0097	0.0087	0.0009
80	0.0097	0.0088	0.0009
81	0.0097	0.0088	0.0009
82	0.0098	0.0088	0.0009
83	0.0098	0.0089	0.0009
84	0.0099	0.0089	0.0009
85	0.0099	0.0090	0.0009
86	0.0100	0.0090	0.0010
87	0.0101	0.0091	0.0010
88	0.0101	0.0091	0.0010
89	0.0102	0.0092	0.0010
90	0.0102	0.0092	0.0010
91	0.0103	0.0093	0.0010
92	0.0103	0.0093	0.0010
93	0.0104	0.0094	0.0010
94	0.0104	0.0094	0.0010
95	0.0105	0.0095	0.0010
96	0.0105	0.0095	0.0010
97	0.0106	0.0096	0.0010
98	0.0107	0.0096	0.0010
99	0.0107	0.0097	0.0010
100	0.0108	0.0098	0.0010
101	0.0109	0.0098	0.0010
102	0.0109	0.0099	0.0010
103	0.0110	0.0100	0.0011
104	0.0111	0.0100	0.0011
105	0.0112	0.0101	0.0011
106	0.0112	0.0101	0.0011
107	0.0113	0.0102	0.0011
108	0.0113	0.0103	0.0011
109	0.0114	0.0104	0.0011
110	0.0115	0.0104	0.0011
111	0.0116	0.0105	0.0011
112	0.0117	0.0105	0.0011
113	0.0118	0.0106	0.0011
114	0.0118	0.0107	0.0011
115	0.0119	0.0108	0.0011
116	0.0120	0.0108	0.0011
117	0.0121	0.0109	0.0012
118	0.0122	0.0110	0.0012
119	0.0123	0.0111	0.0012
120	0.0123	0.0112	0.0012
121	0.0125	0.0113	0.0012
122	0.0125	0.0113	0.0012
123	0.0127	0.0115	0.0012
124	0.0127	0.0115	0.0012
125	0.0129	0.0117	0.0012
126	0.0130	0.0117	0.0012
127	0.0131	0.0118	0.0012
128	0.0132	0.0119	0.0013
129	0.0133	0.0121	0.0013

130	0.0134	0.0121	0.0013
131	0.0136	0.0123	0.0013
132	0.0136	0.0123	0.0013
133	0.0138	0.0125	0.0013
134	0.0139	0.0126	0.0013
135	0.0141	0.0127	0.0013
136	0.0142	0.0128	0.0014
137	0.0144	0.0130	0.0014
138	0.0145	0.0131	0.0014
139	0.0147	0.0133	0.0014
140	0.0148	0.0133	0.0014
141	0.0150	0.0135	0.0014
142	0.0151	0.0136	0.0014
143	0.0153	0.0138	0.0015
144	0.0154	0.0139	0.0015
145	0.0197	0.0178	0.0019
146	0.0199	0.0180	0.0019
147	0.0201	0.0182	0.0019
148	0.0202	0.0183	0.0019
149	0.0205	0.0185	0.0020
150	0.0206	0.0187	0.0020
151	0.0209	0.0189	0.0020
152	0.0211	0.0191	0.0020
153	0.0214	0.0194	0.0020
154	0.0216	0.0195	0.0021
155	0.0219	0.0198	0.0021
156	0.0221	0.0200	0.0021
157	0.0224	0.0203	0.0021
158	0.0226	0.0204	0.0022
159	0.0230	0.0208	0.0022
160	0.0232	0.0210	0.0022
161	0.0236	0.0214	0.0023
162	0.0238	0.0216	0.0023
163	0.0243	0.0220	0.0023
164	0.0246	0.0222	0.0023
165	0.0251	0.0227	0.0024
166	0.0253	0.0229	0.0024
167	0.0259	0.0234	0.0025
168	0.0262	0.0237	0.0025
169	0.0269	0.0243	0.0026
170	0.0272	0.0246	0.0026
171	0.0279	0.0253	0.0027
172	0.0283	0.0256	0.0027
173	0.0291	0.0264	0.0028
174	0.0296	0.0268	0.0028
175	0.0305	0.0276	0.0029
176	0.0311	0.0281	0.0030
177	0.0322	0.0291	0.0031
178	0.0328	0.0297	0.0031
179	0.0342	0.0309	0.0033
180	0.0350	0.0316	0.0033
181	0.0367	0.0332	0.0035
182	0.0376	0.0340	0.0036
183	0.0398	0.0360	0.0038

184	0.0411	0.0372	0.0039
185	0.0239	0.0216	0.0023
186	0.0255	0.0231	0.0024
187	0.0296	0.0267	0.0028
188	0.0323	0.0292	0.0031
189	0.0401	0.0363	0.0038
190	0.0462	0.0418	0.0044
191	0.0701	0.0634	0.0067
192	0.1018	0.0700	0.0318
193	0.4403	0.0700	0.3703
194	0.0552	0.0499	0.0053
195	0.0357	0.0323	0.0034
196	0.0273	0.0247	0.0026
197	0.0425	0.0385	0.0041
198	0.0387	0.0350	0.0037
199	0.0358	0.0324	0.0034
200	0.0335	0.0303	0.0032
201	0.0316	0.0286	0.0030
202	0.0301	0.0272	0.0029
203	0.0287	0.0260	0.0027
204	0.0276	0.0249	0.0026
205	0.0265	0.0240	0.0025
206	0.0256	0.0232	0.0024
207	0.0248	0.0224	0.0024
208	0.0241	0.0218	0.0023
209	0.0234	0.0212	0.0022
210	0.0228	0.0206	0.0022
211	0.0222	0.0201	0.0021
212	0.0217	0.0196	0.0021
213	0.0212	0.0192	0.0020
214	0.0208	0.0188	0.0020
215	0.0204	0.0184	0.0019
216	0.0200	0.0181	0.0019
217	0.0155	0.0140	0.0015
218	0.0152	0.0137	0.0014
219	0.0149	0.0134	0.0014
220	0.0146	0.0132	0.0014
221	0.0143	0.0129	0.0014
222	0.0140	0.0127	0.0013
223	0.0137	0.0124	0.0013
224	0.0135	0.0122	0.0013
225	0.0132	0.0120	0.0013
226	0.0130	0.0118	0.0012
227	0.0128	0.0116	0.0012
228	0.0126	0.0114	0.0012
229	0.0124	0.0112	0.0012
230	0.0122	0.0111	0.0012
231	0.0120	0.0109	0.0011
232	0.0119	0.0107	0.0011
233	0.0117	0.0106	0.0011
234	0.0115	0.0104	0.0011
235	0.0114	0.0103	0.0011
236	0.0112	0.0102	0.0011
237	0.0111	0.0100	0.0011

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238              0.0110          0.0099          0.0010
239              0.0108          0.0098          0.0010
240              0.0107          0.0097          0.0010
241              0.0106          0.0096          0.0010
242              0.0105          0.0095          0.0010
243              0.0103          0.0094          0.0010
244              0.0102          0.0093          0.0010
245              0.0101          0.0092          0.0010
246              0.0100          0.0091          0.0010
247              0.0099          0.0090          0.0009
248              0.0098          0.0089          0.0009
249              0.0097          0.0088          0.0009
250              0.0096          0.0087          0.0009
251              0.0095          0.0086          0.0009
252              0.0094          0.0085          0.0009
253              0.0094          0.0085          0.0009
254              0.0093          0.0084          0.0009
255              0.0092          0.0083          0.0009
256              0.0091          0.0082          0.0009
257              0.0090          0.0082          0.0009
258              0.0089          0.0081          0.0009
259              0.0089          0.0080          0.0008
260              0.0088          0.0080          0.0008
261              0.0087          0.0079          0.0008
262              0.0087          0.0078          0.0008
263              0.0086          0.0078          0.0008
264              0.0085          0.0077          0.0008
265              0.0085          0.0076          0.0008
266              0.0084          0.0076          0.0008
267              0.0083          0.0075          0.0008
268              0.0083          0.0075          0.0008
269              0.0082          0.0074          0.0008
270              0.0081          0.0074          0.0008
271              0.0081          0.0073          0.0008
272              0.0080          0.0073          0.0008
273              0.0080          0.0072          0.0008
274              0.0079          0.0072          0.0008
275              0.0079          0.0071          0.0008
276              0.0078          0.0071          0.0007
277              0.0078          0.0070          0.0007
278              0.0077          0.0070          0.0007
279              0.0077          0.0069          0.0007
280              0.0076          0.0069          0.0007
281              0.0076          0.0068          0.0007
282              0.0075          0.0068          0.0007
283              0.0075          0.0068          0.0007
284              0.0074          0.0067          0.0007
285              0.0074          0.0067          0.0007
286              0.0073          0.0066          0.0007
287              0.0073          0.0066          0.0007
288              0.0072          0.0066          0.0007
-------------------------------------------------------------------------
-------------------------------------------------------------------------
Total soil rain loss =      3.88(In)
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   Total effective rainfall =      0.80(In)
   Peak flow rate in flood hydrograph =      2.25(CFS)
   ------------------------------------------------------------------------
   ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                       24 - H O U R    S T O R M
                   R u n o f f      H y d r o g r a p h
   ------------------------------------------------------------------------
               Hydrograph in   5   Minute intervals ((CFS))

   ------------------------------------------------------------------------
Time(h+m) Volume Ac.Ft   Q(CFS)  0        2.5       5.0       7.5      10.0
------------------------------------------------------------------------
 10+ 0       0.0135      0.02  Q    V    |         |         |         |
 10+ 5       0.0137      0.02  Q    V    |         |         |         |
 10+10       0.0138      0.02  Q    V    |         |         |         |
 10+15       0.0140      0.02  Q    V    |         |         |         |
 10+20       0.0142      0.02  Q    V    |         |         |         |
 10+25       0.0143      0.02  Q    V    |         |         |         |
 10+30       0.0145      0.02  Q    V    |         |         |         |
 10+35       0.0146      0.02  Q    V    |         |         |         |
 10+40       0.0148      0.02  Q    V    |         |         |         |
 10+45       0.0150      0.02  Q    V    |         |         |         |
 10+50       0.0151      0.02  Q    V    |         |         |         |
 10+55       0.0153      0.02  Q    V    |         |         |         |
 11+ 0       0.0155      0.02  Q    V    |         |         |         |
 11+ 5       0.0156      0.02  Q    V    |         |         |         |
 11+10       0.0158      0.03  Q    V    |         |         |         |
 11+15       0.0160      0.03  Q     V   |         |         |         |
 11+20       0.0162      0.03  Q     V   |         |         |         |
 11+25       0.0163      0.03  Q     V   |         |         |         |
 11+30       0.0165      0.03  Q     V   |         |         |         |
 11+35       0.0167      0.03  Q     V   |         |         |         |
 11+40       0.0169      0.03  Q     V   |         |         |         |
 11+45       0.0171      0.03  Q     V   |         |         |         |
 11+50       0.0173      0.03  Q     V   |         |         |         |
 11+55       0.0174      0.03  Q     V   |         |         |         |
 12+ 0       0.0176      0.03  Q     V   |         |         |         |
 12+ 5       0.0178      0.03  Q     V   |         |         |         |
 12+10       0.0180      0.03  Q     V   |         |         |         |
 12+15       0.0183      0.03  Q     V   |         |         |         |
 12+20       0.0185      0.03  Q     V   |         |         |         |
 12+25       0.0188      0.04  Q      V  |         |         |         |
 12+30       0.0190      0.04  Q      V  |         |         |         |
 12+35       0.0193      0.04  Q      V  |         |         |         |
 12+40       0.0195      0.04  Q      V  |         |         |         |
 12+45       0.0198      0.04  Q      V  |         |         |         |
 12+50       0.0200      0.04  Q      V  |         |         |         |
 12+55       0.0203      0.04  Q      V  |         |         |         |
 13+ 0       0.0206      0.04  Q      V  |         |         |         |
 13+ 5       0.0209      0.04  Q      V  |         |         |         |
 13+10       0.0211      0.04  Q      V  |         |         |         |
 13+15       0.0214      0.04  Q       V |         |         |         |
 13+20       0.0217      0.04  Q       V |         |         |         |
 13+25       0.0220      0.04  Q       V |         |         |         |
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13+30       0.0223      0.04  Q       V |          |          |          |
13+35       0.0226      0.04  Q       V |          |          |          |
13+40       0.0229      0.04  Q       V |          |          |          |
13+45       0.0232      0.04  Q       V |          |          |          |
13+50       0.0235      0.04  Q       V |          |          |          |
13+55       0.0238      0.05  Q       V |          |          |          |
14+ 0       0.0241      0.05  Q        V|          |          |          |
14+ 5       0.0245      0.05  Q        V|          |          |          |
14+10       0.0248      0.05  Q        V|          |          |          |
14+15       0.0251      0.05  Q        V|          |          |          |
14+20       0.0255      0.05  Q        V|          |          |          |
14+25       0.0258      0.05  Q        V|          |          |          |
14+30       0.0262      0.05  Q        V|          |          |          |
14+35       0.0265      0.05  Q        V|          |          |          |
14+40       0.0269      0.05  Q         V          |          |          |
14+45       0.0273      0.06  Q         V          |          |          |
14+50       0.0277      0.06  Q         V          |          |          |
14+55       0.0281      0.06  Q         V          |          |          |
15+ 0       0.0285      0.06  Q         V          |          |          |
15+ 5       0.0289      0.06  Q         V          |          |          |
15+10       0.0294      0.06  Q         |V         |          |          |
15+15       0.0298      0.07  Q         |V         |          |          |
15+20       0.0303      0.07  Q         |V         |          |          |
15+25       0.0308      0.07  Q         |V         |          |          |
15+30       0.0312      0.06  Q         |V         |          |          |
15+35       0.0316      0.06  Q         |V         |          |          |
15+40       0.0319      0.06  Q         | V        |          |          |
15+45       0.0323      0.06  Q         | V        |          |          |
15+50       0.0328      0.06  Q         | V        |          |          |
15+55       0.0333      0.07  Q         | V        |          |          |
16+ 0       0.0341      0.11  Q         | V        |          |          |
16+ 5       0.0378      0.54  | Q       |   V      |          |          |
16+10       0.0532      2.24  |       Q |         V          |          |
16+15       0.0687      2.25  |        Q|          |    V     |          |
16+20       0.0758      1.03  |   Q     |          |       V  |          |
16+25       0.0802      0.63  | Q       |          |         V          |
16+30       0.0832      0.45  |Q        |          |          |V         |
16+35       0.0855      0.33  |Q        |          |          | V        |
16+40       0.0873      0.26  |Q        |          |          | V        |
16+45       0.0887      0.21  Q         |          |          |  V       |
16+50       0.0899      0.17  Q         |          |          |  V       |
16+55       0.0908      0.14  Q         |          |          |   V      |
17+ 0       0.0916      0.11  Q         |          |          |   V      |
17+ 5       0.0923      0.10  Q         |          |          |   V      |
17+10       0.0929      0.10  Q         |          |          |    V     |
17+15       0.0935      0.08  Q         |          |          |    V     |
17+20       0.0939      0.06  Q         |          |          |    V     |
17+25       0.0942      0.05  Q         |          |          |    V     |
17+30       0.0946      0.05  Q         |          |          |    V     |
17+35       0.0949      0.04  Q         |          |          |    V     |
17+40       0.0952      0.04  Q         |          |          |    V     |
17+45       0.0955      0.04  Q         |          |          |    V     |
17+50       0.0957      0.04  Q         |          |          |     V    |
17+55       0.0960      0.04  Q         |          |          |     V    |
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18+ 0       0.0963      0.04  Q          |          |          |      V   |
18+ 5       0.0966      0.04  Q          |          |          |      V   |
18+10       0.0968      0.04  Q          |          |          |      V   |
18+15       0.0970      0.03  Q          |          |          |      V   |
18+20       0.0972      0.03  Q          |          |          |      V   |
18+25       0.0974      0.03  Q          |          |          |      V   |
18+30       0.0976      0.03  Q          |          |          |      V   |
18+35       0.0978      0.03  Q          |          |          |      V   |
18+40       0.0980      0.03  Q          |          |          |      V   |
18+45       0.0982      0.03  Q          |          |          |      V   |
18+50       0.0984      0.03  Q          |          |          |       V  |
18+55       0.0985      0.03  Q          |          |          |       V  |
19+ 0       0.0987      0.02  Q          |          |          |       V  |
19+ 5       0.0989      0.02  Q          |          |          |       V  |
19+10       0.0990      0.02  Q          |          |          |       V  |
19+15       0.0992      0.02  Q          |          |          |       V  |
19+20       0.0994      0.02  Q          |          |          |       V  |
19+25       0.0995      0.02  Q          |          |          |       V  |
19+30       0.0997      0.02  Q          |          |          |       V  |
19+35       0.0998      0.02  Q          |          |          |       V  |
19+40       0.1000      0.02  Q          |          |          |       V  |
19+45       0.1001      0.02  Q          |          |          |       V  |
19+50       0.1003      0.02  Q          |          |          |       V  |
19+55       0.1004      0.02  Q          |          |          |       V  |
20+ 0       0.1005      0.02  Q          |          |          |       V  |
20+ 5       0.1007      0.02  Q          |          |          |       V  |
20+10       0.1008      0.02  Q          |          |          |       V  |
20+15       0.1010      0.02  Q          |          |          |        V |
20+20       0.1011      0.02  Q          |          |          |        V |
20+25       0.1012      0.02  Q          |          |          |        V |
20+30       0.1014      0.02  Q          |          |          |        V |
20+35       0.1015      0.02  Q          |          |          |        V |
20+40       0.1016      0.02  Q          |          |          |        V |
20+45       0.1017      0.02  Q          |          |          |        V |
20+50       0.1019      0.02  Q          |          |          |        V |
20+55       0.1020      0.02  Q          |          |          |        V |
21+ 0       0.1021      0.02  Q          |          |          |        V |
21+ 5       0.1022      0.02  Q          |          |          |        V |
21+10       0.1024      0.02  Q          |          |          |        V |
21+15       0.1025      0.02  Q          |          |          |        V |
21+20       0.1026      0.02  Q          |          |          |        V |
21+25       0.1027      0.02  Q          |          |          |        V |
21+30       0.1028      0.02  Q          |          |          |        V |
21+35       0.1029      0.02  Q          |          |          |        V |
21+40       0.1031      0.02  Q          |          |          |        V |
21+45       0.1032      0.02  Q          |          |          |        V |
21+50       0.1033      0.02  Q          |          |          |        V |
21+55       0.1034      0.02  Q          |          |          |        V |
22+ 0       0.1035      0.02  Q          |          |          |        V |
22+ 5       0.1036      0.02  Q          |          |          |         V|
22+10       0.1037      0.02  Q          |          |          |         V|
22+15       0.1038      0.02  Q          |          |          |         V|
22+20       0.1039      0.02  Q          |          |          |         V|
22+25       0.1040      0.02  Q          |          |          |         V|
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   22+30       0.1042      0.02  Q          |          |          |         V|
   22+35       0.1043      0.02  Q          |          |          |         V|
   22+40       0.1044      0.02  Q          |          |          |         V|
   22+45       0.1045      0.02  Q          |          |          |         V|
   22+50       0.1046      0.01  Q          |          |          |         V|
   22+55       0.1047      0.01  Q          |          |          |         V|
   23+ 0       0.1048      0.01  Q          |          |          |         V|
   23+ 5       0.1049      0.01  Q          |          |          |         V|
   23+10       0.1050      0.01  Q          |          |          |         V|
   23+15       0.1051      0.01  Q          |          |          |         V|
   23+20       0.1052      0.01  Q          |          |          |         V|
   23+25       0.1053      0.01  Q          |          |          |         V|
   23+30       0.1054      0.01  Q          |          |          |         V|
   23+35       0.1055      0.01  Q          |          |          |         V|
   23+40       0.1056      0.01  Q          |          |          |         V|
   23+45       0.1057      0.01  Q          |          |          |         V|
   23+50       0.1057      0.01  Q          |          |          |         V|
   23+55       0.1058      0.01  Q          |          |          |         V|
   24+ 0       0.1059      0.01  Q          |          |          |         V|
-------------------------------------------------------------------------------
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Synthetic Unit Hydrograph Method

Post-Development

for

2Year Storm

U n i t H y d r o g r a p h A n a l y s i s

Study date 06/18/22

++

San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Sake Consulting Engineers, inc. Corona, CA - S/N 4084

Storm Event Year = 2

Antecedent Moisture Condition = 1

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 2		
1.60	1	0.93
Rainfall data for year 2		
1.60	6	2.53
Rainfall data for year 2		
1.60	24	4.68

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 1)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
32.0	16.6	1.60	1.000	1.000	0.200	0.200

Area-averaged adjusted loss rate Fm (In/Hr) = 0.200

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC1)	S	Pervious Yield Fr
0.32	0.200	32.0	16.6	23.40	0.000
1.28	0.800	98.0	98.0	0.20	0.950

Area-averaged catchment yield fraction, Y = 0.760
Area-averaged low loss fraction, Yb = 0.240
Direct entry of lag time by user
++
Watershed area = 1.60(Ac.)
Catchment Lag time = 0.093 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 89.2220
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.200(In/Hr)
Average low loss rate fraction (Yb) = 0.240 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.440(In)
Computed peak 30-minute rainfall = 0.754(In)
Specified peak 1-hour rainfall = 0.928(In)
Computed peak 3-hour rainfall = 1.716(In)
Specified peak 6-hour rainfall = 2.530(In)
Specified peak 24-hour rainfall = 4.680(In)

Rainfall depth area reduction factors:
Using a total area of 1.60(Ac.) (Ref: fig. E-4)

5-minute factor = 1.000 Adjusted rainfall = 0.440(In)
30-minute factor = 1.000 Adjusted rainfall = 0.754(In)
1-hour factor = 1.000 Adjusted rainfall = 0.928(In)
3-hour factor = 1.000 Adjusted rainfall = 1.716(In)
6-hour factor = 1.000 Adjusted rainfall = 2.530(In)
24-hour factor = 1.000 Adjusted rainfall = 4.680(In)

U n i t H y d r o g r a p h
++

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
(K = 19.35 (CFS))		
1	13.696	2.650
2	62.430	9.430
3	80.980	3.589
4	89.290	1.608
5	93.839	0.880
6	96.602	0.535
7	98.097	0.289
8	99.124	0.199

9	100.000	0.170

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.4403	0.4403
2	0.5421	0.1018
3	0.6122	0.0701
4	0.6674	0.0552
5	0.7136	0.0462
6	0.7537	0.0401
7	0.7894	0.0357
8	0.8217	0.0323
9	0.8512	0.0296
10	0.8785	0.0273
11	0.9040	0.0255
12	0.9279	0.0239
13	0.9705	0.0425
14	1.0116	0.0411
15	1.0514	0.0398
16	1.0901	0.0387
17	1.1277	0.0376
18	1.1644	0.0367
19	1.2002	0.0358
20	1.2351	0.0350
21	1.2693	0.0342
22	1.3028	0.0335
23	1.3356	0.0328
24	1.3678	0.0322
25	1.3995	0.0316
26	1.4305	0.0311
27	1.4611	0.0305
28	1.4911	0.0301
29	1.5207	0.0296
30	1.5498	0.0291
31	1.5786	0.0287
32	1.6069	0.0283
33	1.6348	0.0279
34	1.6623	0.0276
35	1.6895	0.0272
36	1.7164	0.0269
37	1.7429	0.0265
38	1.7691	0.0262
39	1.7950	0.0259
40	1.8207	0.0256
41	1.8460	0.0253
42	1.8711	0.0251
43	1.8959	0.0248
44	1.9204	0.0246
45	1.9447	0.0243
46	1.9688	0.0241
47	1.9927	0.0238
48	2.0163	0.0236
49	2.0397	0.0234
50	2.0629	0.0232

51	2.0859	0.0230
52	2.1087	0.0228
53	2.1313	0.0226
54	2.1537	0.0224
55	2.1759	0.0222
56	2.1980	0.0221
57	2.2199	0.0219
58	2.2416	0.0217
59	2.2631	0.0216
60	2.2845	0.0214
61	2.3058	0.0212
62	2.3268	0.0211
63	2.3478	0.0209
64	2.3686	0.0208
65	2.3892	0.0206
66	2.4097	0.0205
67	2.4301	0.0204
68	2.4503	0.0202
69	2.4704	0.0201
70	2.4904	0.0200
71	2.5103	0.0199
72	2.5300	0.0197
73	2.5455	0.0155
74	2.5609	0.0154
75	2.5762	0.0153
76	2.5914	0.0152
77	2.6065	0.0151
78	2.6215	0.0150
79	2.6363	0.0149
80	2.6511	0.0148
81	2.6657	0.0147
82	2.6803	0.0146
83	2.6947	0.0145
84	2.7091	0.0144
85	2.7233	0.0143
86	2.7375	0.0142
87	2.7516	0.0141
88	2.7656	0.0140
89	2.7795	0.0139
90	2.7933	0.0138
91	2.8070	0.0137
92	2.8207	0.0136
93	2.8342	0.0136
94	2.8477	0.0135
95	2.8611	0.0134
96	2.8744	0.0133
97	2.8877	0.0132
98	2.9009	0.0132
99	2.9139	0.0131
100	2.9270	0.0130
101	2.9399	0.0130
102	2.9528	0.0129
103	2.9656	0.0128
104	2.9783	0.0127

105	2.9910	0.0127
106	3.0036	0.0126
107	3.0162	0.0125
108	3.0286	0.0125
109	3.0411	0.0124
110	3.0534	0.0123
111	3.0657	0.0123
112	3.0779	0.0122
113	3.0901	0.0122
114	3.1022	0.0121
115	3.1142	0.0120
116	3.1262	0.0120
117	3.1381	0.0119
118	3.1500	0.0119
119	3.1618	0.0118
120	3.1736	0.0118
121	3.1853	0.0117
122	3.1969	0.0117
123	3.2085	0.0116
124	3.2201	0.0115
125	3.2316	0.0115
126	3.2430	0.0114
127	3.2544	0.0114
128	3.2658	0.0113
129	3.2771	0.0113
130	3.2883	0.0112
131	3.2995	0.0112
132	3.3107	0.0112
133	3.3218	0.0111
134	3.3328	0.0111
135	3.3438	0.0110
136	3.3548	0.0110
137	3.3657	0.0109
138	3.3766	0.0109
139	3.3874	0.0108
140	3.3982	0.0108
141	3.4090	0.0107
142	3.4197	0.0107
143	3.4304	0.0107
144	3.4410	0.0106
145	3.4516	0.0106
146	3.4621	0.0105
147	3.4726	0.0105
148	3.4831	0.0105
149	3.4935	0.0104
150	3.5039	0.0104
151	3.5142	0.0103
152	3.5245	0.0103
153	3.5348	0.0103
154	3.5450	0.0102
155	3.5552	0.0102
156	3.5654	0.0102
157	3.5755	0.0101
158	3.5856	0.0101

159	3.5956	0.0101
160	3.6057	0.0100
161	3.6156	0.0100
162	3.6256	0.0099
163	3.6355	0.0099
164	3.6454	0.0099
165	3.6552	0.0098
166	3.6650	0.0098
167	3.6748	0.0098
168	3.6846	0.0097
169	3.6943	0.0097
170	3.7040	0.0097
171	3.7136	0.0097
172	3.7232	0.0096
173	3.7328	0.0096
174	3.7424	0.0096
175	3.7519	0.0095
176	3.7614	0.0095
177	3.7709	0.0095
178	3.7803	0.0094
179	3.7897	0.0094
180	3.7991	0.0094
181	3.8084	0.0094
182	3.8178	0.0093
183	3.8271	0.0093
184	3.8363	0.0093
185	3.8456	0.0092
186	3.8548	0.0092
187	3.8639	0.0092
188	3.8731	0.0092
189	3.8822	0.0091
190	3.8913	0.0091
191	3.9004	0.0091
192	3.9094	0.0090
193	3.9185	0.0090
194	3.9275	0.0090
195	3.9364	0.0090
196	3.9454	0.0089
197	3.9543	0.0089
198	3.9632	0.0089
199	3.9721	0.0089
200	3.9809	0.0088
201	3.9897	0.0088
202	3.9985	0.0088
203	4.0073	0.0088
204	4.0160	0.0087
205	4.0248	0.0087
206	4.0335	0.0087
207	4.0421	0.0087
208	4.0508	0.0087
209	4.0594	0.0086
210	4.0680	0.0086
211	4.0766	0.0086
212	4.0852	0.0086

213	4.0937	0.0085
214	4.1022	0.0085
215	4.1107	0.0085
216	4.1192	0.0085
217	4.1276	0.0085
218	4.1361	0.0084
219	4.1445	0.0084
220	4.1529	0.0084
221	4.1612	0.0084
222	4.1696	0.0083
223	4.1779	0.0083
224	4.1862	0.0083
225	4.1945	0.0083
226	4.2027	0.0083
227	4.2110	0.0082
228	4.2192	0.0082
229	4.2274	0.0082
230	4.2356	0.0082
231	4.2437	0.0082
232	4.2519	0.0081
233	4.2600	0.0081
234	4.2681	0.0081
235	4.2762	0.0081
236	4.2842	0.0081
237	4.2923	0.0080
238	4.3003	0.0080
239	4.3083	0.0080
240	4.3163	0.0080
241	4.3243	0.0080
242	4.3322	0.0080
243	4.3402	0.0079
244	4.3481	0.0079
245	4.3560	0.0079
246	4.3639	0.0079
247	4.3717	0.0079
248	4.3796	0.0078
249	4.3874	0.0078
250	4.3952	0.0078
251	4.4030	0.0078
252	4.4108	0.0078
253	4.4185	0.0078
254	4.4263	0.0077
255	4.4340	0.0077
256	4.4417	0.0077
257	4.4494	0.0077
258	4.4571	0.0077
259	4.4647	0.0077
260	4.4724	0.0076
261	4.4800	0.0076
262	4.4876	0.0076
263	4.4952	0.0076
264	4.5028	0.0076
265	4.5103	0.0076
266	4.5179	0.0075

267	4.5254	0.0075
268	4.5329	0.0075
269	4.5404	0.0075
270	4.5479	0.0075
271	4.5553	0.0075
272	4.5628	0.0075
273	4.5702	0.0074
274	4.5777	0.0074
275	4.5851	0.0074
276	4.5924	0.0074
277	4.5998	0.0074
278	4.6072	0.0074
279	4.6145	0.0073
280	4.6219	0.0073
281	4.6292	0.0073
282	4.6365	0.0073
283	4.6438	0.0073
284	4.6510	0.0073
285	4.6583	0.0073
286	4.6655	0.0072
287	4.6728	0.0072
288	4.6800	0.0072

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0072	0.0017	0.0055
2	0.0072	0.0017	0.0055
3	0.0073	0.0017	0.0055
4	0.0073	0.0017	0.0055
5	0.0073	0.0018	0.0055
6	0.0073	0.0018	0.0056
7	0.0073	0.0018	0.0056
8	0.0074	0.0018	0.0056
9	0.0074	0.0018	0.0056
10	0.0074	0.0018	0.0056
11	0.0074	0.0018	0.0056
12	0.0075	0.0018	0.0057
13	0.0075	0.0018	0.0057
14	0.0075	0.0018	0.0057
15	0.0075	0.0018	0.0057
16	0.0075	0.0018	0.0057
17	0.0076	0.0018	0.0058
18	0.0076	0.0018	0.0058
19	0.0076	0.0018	0.0058
20	0.0076	0.0018	0.0058
21	0.0077	0.0018	0.0058
22	0.0077	0.0018	0.0058
23	0.0077	0.0019	0.0059
24	0.0077	0.0019	0.0059
25	0.0078	0.0019	0.0059
26	0.0078	0.0019	0.0059
27	0.0078	0.0019	0.0059

28	0.0078	0.0019	0.0060
29	0.0079	0.0019	0.0060
30	0.0079	0.0019	0.0060
31	0.0079	0.0019	0.0060
32	0.0080	0.0019	0.0060
33	0.0080	0.0019	0.0061
34	0.0080	0.0019	0.0061
35	0.0080	0.0019	0.0061
36	0.0081	0.0019	0.0061
37	0.0081	0.0019	0.0062
38	0.0081	0.0020	0.0062
39	0.0082	0.0020	0.0062
40	0.0082	0.0020	0.0062
41	0.0082	0.0020	0.0062
42	0.0082	0.0020	0.0063
43	0.0083	0.0020	0.0063
44	0.0083	0.0020	0.0063
45	0.0083	0.0020	0.0063
46	0.0084	0.0020	0.0064
47	0.0084	0.0020	0.0064
48	0.0084	0.0020	0.0064
49	0.0085	0.0020	0.0064
50	0.0085	0.0020	0.0065
51	0.0085	0.0021	0.0065
52	0.0086	0.0021	0.0065
53	0.0086	0.0021	0.0065
54	0.0086	0.0021	0.0066
55	0.0087	0.0021	0.0066
56	0.0087	0.0021	0.0066
57	0.0087	0.0021	0.0066
58	0.0088	0.0021	0.0067
59	0.0088	0.0021	0.0067
60	0.0088	0.0021	0.0067
61	0.0089	0.0021	0.0068
62	0.0089	0.0021	0.0068
63	0.0090	0.0022	0.0068
64	0.0090	0.0022	0.0068
65	0.0090	0.0022	0.0069
66	0.0091	0.0022	0.0069
67	0.0091	0.0022	0.0069
68	0.0092	0.0022	0.0070
69	0.0092	0.0022	0.0070
70	0.0092	0.0022	0.0070
71	0.0093	0.0022	0.0071
72	0.0093	0.0022	0.0071
73	0.0094	0.0023	0.0071
74	0.0094	0.0023	0.0071
75	0.0095	0.0023	0.0072
76	0.0095	0.0023	0.0072
77	0.0096	0.0023	0.0073
78	0.0096	0.0023	0.0073
79	0.0097	0.0023	0.0073
80	0.0097	0.0023	0.0074
81	0.0097	0.0023	0.0074

82	0.0098	0.0024	0.0074
83	0.0098	0.0024	0.0075
84	0.0099	0.0024	0.0075
85	0.0099	0.0024	0.0076
86	0.0100	0.0024	0.0076
87	0.0101	0.0024	0.0076
88	0.0101	0.0024	0.0077
89	0.0102	0.0024	0.0077
90	0.0102	0.0025	0.0077
91	0.0103	0.0025	0.0078
92	0.0103	0.0025	0.0078
93	0.0104	0.0025	0.0079
94	0.0104	0.0025	0.0079
95	0.0105	0.0025	0.0080
96	0.0105	0.0025	0.0080
97	0.0106	0.0026	0.0081
98	0.0107	0.0026	0.0081
99	0.0107	0.0026	0.0082
100	0.0108	0.0026	0.0082
101	0.0109	0.0026	0.0083
102	0.0109	0.0026	0.0083
103	0.0110	0.0026	0.0084
104	0.0111	0.0027	0.0084
105	0.0112	0.0027	0.0085
106	0.0112	0.0027	0.0085
107	0.0113	0.0027	0.0086
108	0.0113	0.0027	0.0086
109	0.0114	0.0028	0.0087
110	0.0115	0.0028	0.0087
111	0.0116	0.0028	0.0088
112	0.0117	0.0028	0.0089
113	0.0118	0.0028	0.0089
114	0.0118	0.0028	0.0090
115	0.0119	0.0029	0.0091
116	0.0120	0.0029	0.0091
117	0.0121	0.0029	0.0092
118	0.0122	0.0029	0.0092
119	0.0123	0.0030	0.0093
120	0.0123	0.0030	0.0094
121	0.0125	0.0030	0.0095
122	0.0125	0.0030	0.0095
123	0.0127	0.0030	0.0096
124	0.0127	0.0031	0.0097
125	0.0129	0.0031	0.0098
126	0.0130	0.0031	0.0098
127	0.0131	0.0031	0.0099
128	0.0132	0.0032	0.0100
129	0.0133	0.0032	0.0101
130	0.0134	0.0032	0.0102
131	0.0136	0.0033	0.0103
132	0.0136	0.0033	0.0104
133	0.0138	0.0033	0.0105
134	0.0139	0.0033	0.0106
135	0.0141	0.0034	0.0107

136	0.0142	0.0034	0.0108
137	0.0144	0.0035	0.0109
138	0.0145	0.0035	0.0110
139	0.0147	0.0035	0.0111
140	0.0148	0.0035	0.0112
141	0.0150	0.0036	0.0114
142	0.0151	0.0036	0.0115
143	0.0153	0.0037	0.0116
144	0.0154	0.0037	0.0117
145	0.0197	0.0047	0.0150
146	0.0199	0.0048	0.0151
147	0.0201	0.0048	0.0153
148	0.0202	0.0049	0.0154
149	0.0205	0.0049	0.0156
150	0.0206	0.0050	0.0157
151	0.0209	0.0050	0.0159
152	0.0211	0.0051	0.0160
153	0.0214	0.0051	0.0162
154	0.0216	0.0052	0.0164
155	0.0219	0.0053	0.0166
156	0.0221	0.0053	0.0168
157	0.0224	0.0054	0.0170
158	0.0226	0.0054	0.0172
159	0.0230	0.0055	0.0175
160	0.0232	0.0056	0.0176
161	0.0236	0.0057	0.0179
162	0.0238	0.0057	0.0181
163	0.0243	0.0058	0.0185
164	0.0246	0.0059	0.0187
165	0.0251	0.0060	0.0190
166	0.0253	0.0061	0.0192
167	0.0259	0.0062	0.0197
168	0.0262	0.0063	0.0199
169	0.0269	0.0065	0.0204
170	0.0272	0.0065	0.0207
171	0.0279	0.0067	0.0212
172	0.0283	0.0068	0.0215
173	0.0291	0.0070	0.0221
174	0.0296	0.0071	0.0225
175	0.0305	0.0073	0.0232
176	0.0311	0.0075	0.0236
177	0.0322	0.0077	0.0245
178	0.0328	0.0079	0.0249
179	0.0342	0.0082	0.0260
180	0.0350	0.0084	0.0266
181	0.0367	0.0088	0.0279
182	0.0376	0.0090	0.0286
183	0.0398	0.0096	0.0303
184	0.0411	0.0099	0.0312
185	0.0239	0.0057	0.0182
186	0.0255	0.0061	0.0194
187	0.0296	0.0071	0.0224
188	0.0323	0.0078	0.0245
189	0.0401	0.0096	0.0305

190	0.0462	0.0111	0.0351
191	0.0701	0.0167	0.0535
192	0.1018	0.0167	0.0851
193	0.4403	0.0167	0.4236
194	0.0552	0.0133	0.0419
195	0.0357	0.0086	0.0271
196	0.0273	0.0066	0.0208
197	0.0425	0.0102	0.0323
198	0.0387	0.0093	0.0294
199	0.0358	0.0086	0.0272
200	0.0335	0.0081	0.0254
201	0.0316	0.0076	0.0240
202	0.0301	0.0072	0.0228
203	0.0287	0.0069	0.0218
204	0.0276	0.0066	0.0209
205	0.0265	0.0064	0.0201
206	0.0256	0.0062	0.0195
207	0.0248	0.0060	0.0188
208	0.0241	0.0058	0.0183
209	0.0234	0.0056	0.0178
210	0.0228	0.0055	0.0173
211	0.0222	0.0053	0.0169
212	0.0217	0.0052	0.0165
213	0.0212	0.0051	0.0161
214	0.0208	0.0050	0.0158
215	0.0204	0.0049	0.0155
216	0.0200	0.0048	0.0152
217	0.0155	0.0037	0.0118
218	0.0152	0.0037	0.0115
219	0.0149	0.0036	0.0113
220	0.0146	0.0035	0.0111
221	0.0143	0.0034	0.0108
222	0.0140	0.0034	0.0106
223	0.0137	0.0033	0.0104
224	0.0135	0.0032	0.0102
225	0.0132	0.0032	0.0101
226	0.0130	0.0031	0.0099
227	0.0128	0.0031	0.0097
228	0.0126	0.0030	0.0096
229	0.0124	0.0030	0.0094
230	0.0122	0.0029	0.0093
231	0.0120	0.0029	0.0091
232	0.0119	0.0029	0.0090
233	0.0117	0.0028	0.0089
234	0.0115	0.0028	0.0088
235	0.0114	0.0027	0.0087
236	0.0112	0.0027	0.0085
237	0.0111	0.0027	0.0084
238	0.0110	0.0026	0.0083
239	0.0108	0.0026	0.0082
240	0.0107	0.0026	0.0081
241	0.0106	0.0025	0.0080
242	0.0105	0.0025	0.0079
243	0.0103	0.0025	0.0079

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244                0.0102          0.0025               0.0078
245                0.0101          0.0024               0.0077
246                0.0100          0.0024               0.0076
247                0.0099          0.0024               0.0075
248                0.0098          0.0024               0.0075
249                0.0097          0.0023               0.0074
250                0.0096          0.0023               0.0073
251                0.0095          0.0023               0.0072
252                0.0094          0.0023               0.0072
253                0.0094          0.0022               0.0071
254                0.0093          0.0022               0.0070
255                0.0092          0.0022               0.0070
256                0.0091          0.0022               0.0069
257                0.0090          0.0022               0.0069
258                0.0089          0.0022               0.0068
259                0.0089          0.0021               0.0067
260                0.0088          0.0021               0.0067
261                0.0087          0.0021               0.0066
262                0.0087          0.0021               0.0066
263                0.0086          0.0021               0.0065
264                0.0085          0.0020               0.0065
265                0.0085          0.0020               0.0064
266                0.0084          0.0020               0.0064
267                0.0083          0.0020               0.0063
268                0.0083          0.0020               0.0063
269                0.0082          0.0020               0.0062
270                0.0081          0.0020               0.0062
271                0.0081          0.0019               0.0061
272                0.0080          0.0019               0.0061
273                0.0080          0.0019               0.0061
274                0.0079          0.0019               0.0060
275                0.0079          0.0019               0.0060
276                0.0078          0.0019               0.0059
277                0.0078          0.0019               0.0059
278                0.0077          0.0019               0.0059
279                0.0077          0.0018               0.0058
280                0.0076          0.0018               0.0058
281                0.0076          0.0018               0.0057
282                0.0075          0.0018               0.0057
283                0.0075          0.0018               0.0057
284                0.0074          0.0018               0.0056
285                0.0074          0.0018               0.0056
286                0.0073          0.0018               0.0056
287                0.0073          0.0018               0.0055
288                0.0072          0.0017               0.0055
------------------------------------------------------------------------
------------------------------------------------------------------------
Total soil rain loss =      1.03(In)
Total effective rainfall =      3.65(In)
Peak flow rate in flood hydrograph =      4.56(CFS)
------------------------------------------------------------------------
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                  24 - H O U R    S T O R M
              R u n o f f      H y d r o g r a p h
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Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	2.5	5.0	7.5	10.0
10+ 0	0.1092	0.18	Q	V			
10+ 5	0.1105	0.18	Q	V			
10+10	0.1117	0.18	Q	V			
10+15	0.1130	0.18	Q	V			
10+20	0.1142	0.19	Q	V			
10+25	0.1155	0.19	Q	V			
10+30	0.1168	0.19	Q	V			
10+35	0.1181	0.19	Q	V			
10+40	0.1194	0.19	Q	V			
10+45	0.1208	0.19	Q	V			
10+50	0.1221	0.19	Q	V			
10+55	0.1235	0.20	Q	V			
11+ 0	0.1248	0.20	Q	V			
11+ 5	0.1262	0.20	Q	V			
11+10	0.1276	0.20	Q	V			
11+15	0.1290	0.20	Q	V			
11+20	0.1304	0.21	Q	V			
11+25	0.1318	0.21	Q	V			
11+30	0.1333	0.21	Q	V			
11+35	0.1347	0.21	Q	V			
11+40	0.1362	0.21	Q	V			
11+45	0.1377	0.22	Q	V			
11+50	0.1392	0.22	Q	V			
11+55	0.1407	0.22	Q	V			
12+ 0	0.1422	0.22	Q	V			
12+ 5	0.1439	0.23	Q	V			
12+10	0.1457	0.27	Q	V			
12+15	0.1476	0.28	Q	V			
12+20	0.1496	0.29	Q	V			
12+25	0.1516	0.29	Q	V			
12+30	0.1536	0.30	Q	V			
12+35	0.1557	0.30	Q	V			
12+40	0.1578	0.30	Q	V			
12+45	0.1599	0.31	Q	V			
12+50	0.1621	0.31	Q	V			
12+55	0.1643	0.32	Q	V			
13+ 0	0.1664	0.32	Q	V			
13+ 5	0.1687	0.32	Q	V			
13+10	0.1709	0.33	Q	V			
13+15	0.1732	0.33	Q	V			
13+20	0.1755	0.33	Q	V			
13+25	0.1778	0.34	Q	V			
13+30	0.1802	0.34	Q	V			
13+35	0.1826	0.35	Q	V			
13+40	0.1850	0.35	Q	V			
13+45	0.1875	0.36	Q	V			
13+50	0.1900	0.36	Q	V			
13+55	0.1926	0.37	Q	V			

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14+ 0       0.1951      0.38  |Q         |     V    |          |          |
14+ 5       0.1978      0.38  |Q         |     V    |          |          |
14+10       0.2005      0.39  |Q         |     V    |          |          |
14+15       0.2032      0.40  |Q         |     V    |          |          |
14+20       0.2060      0.40  |Q         |     V    |          |          |
14+25       0.2088      0.41  |Q         |      V   |          |          |
14+30       0.2117      0.42  |Q         |      V   |          |          |
14+35       0.2147      0.43  |Q         |      V   |          |          |
14+40       0.2177      0.44  |Q         |      V   |          |          |
14+45       0.2208      0.45  |Q         |       V  |          |          |
14+50       0.2240      0.46  |Q         |       V  |          |          |
14+55       0.2273      0.48  |Q         |       V  |          |          |
15+ 0       0.2307      0.49  |Q         |       V  |          |          |
15+ 5       0.2342      0.51  | Q        |        V |          |          |
15+10       0.2378      0.53  | Q        |        V |          |          |
15+15       0.2415      0.54  | Q        |        V |          |          |
15+20       0.2455      0.57  | Q        |         V|          |          |
15+25       0.2493      0.55  | Q        |         V|          |          |
15+30       0.2523      0.44  |Q         |         V|          |          |
15+35       0.2552      0.42  |Q         |         V|          |          |
15+40       0.2582      0.44  |Q         |          |V         |          |
15+45       0.2615      0.48  |Q         |          |V         |          |
15+50       0.2653      0.55  | Q        |          |V         |          |
15+55       0.2699      0.67  | Q        |          | V        |          |
16+ 0       0.2764      0.95  |  Q       |          | V        |          |
16+ 5       0.2918      2.23  |       Q  |          |  V       |          |
16+10       0.3232      4.56  |          |        Q |     V    |          |
16+15       0.3384      2.21  |       Q  |          |      V   |          |
16+20       0.3471      1.27  |    Q     |          |       V  |          |
16+25       0.3532      0.89  |  Q       |          |        V |          |
16+30       0.3588      0.81  |  Q       |          |        V |          |
16+35       0.3635      0.69  | Q        |          |        V |          |
16+40       0.3679      0.62  | Q        |          |         V|          |
16+45       0.3718      0.58  | Q        |          |         V|          |
16+50       0.3751      0.48  |Q         |          |         V|          |
16+55       0.3783      0.46  |Q         |          |          |V         |
17+ 0       0.3813      0.44  |Q         |          |          |V         |
17+ 5       0.3842      0.42  |Q         |          |          |V         |
17+10       0.3870      0.40  |Q         |          |          |V         |
17+15       0.3896      0.39  |Q         |          |          | V        |
17+20       0.3922      0.37  |Q         |          |          | V        |
17+25       0.3947      0.36  |Q         |          |          | V        |
17+30       0.3971      0.35  |Q         |          |          | V        |
17+35       0.3995      0.34  |Q         |          |          | V        |
17+40       0.4018      0.33  |Q         |          |          |  V       |
17+45       0.4040      0.32  |Q         |          |          |  V       |
17+50       0.4062      0.32  |Q         |          |          |  V       |
17+55       0.4083      0.31  |Q         |          |          |  V       |
18+ 0       0.4104      0.30  |Q         |          |          |  V       |
18+ 5       0.4124      0.29  |Q         |          |          |  V       |
18+10       0.4142      0.25  |Q         |          |          |   V      |
18+15       0.4158      0.24  Q          |          |          |   V      |
18+20       0.4174      0.23  Q          |          |          |   V      |
18+25       0.4189      0.22  Q          |          |          |   V      |
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18+30       0.4204      0.21  Q          |          |          |   V      |
18+35       0.4218      0.21  Q          |          |          |   V      |
18+40       0.4233      0.21  Q          |          |          |   V      |
18+45       0.4246      0.20  Q          |          |          |   V      |
18+50       0.4260      0.20  Q          |          |          |    V     |
18+55       0.4273      0.19  Q          |          |          |    V     |
19+ 0       0.4286      0.19  Q          |          |          |    V     |
19+ 5       0.4299      0.19  Q          |          |          |    V     |
19+10       0.4312      0.18  Q          |          |          |    V     |
19+15       0.4325      0.18  Q          |          |          |    V     |
19+20       0.4337      0.18  Q          |          |          |    V     |
19+25       0.4349      0.18  Q          |          |          |    V     |
19+30       0.4361      0.17  Q          |          |          |    V     |
19+35       0.4373      0.17  Q          |          |          |    V     |
19+40       0.4384      0.17  Q          |          |          |     V    |
19+45       0.4396      0.17  Q          |          |          |     V    |
19+50       0.4407      0.16  Q          |          |          |     V    |
19+55       0.4418      0.16  Q          |          |          |     V    |
20+ 0       0.4430      0.16  Q          |          |          |     V    |
20+ 5       0.4440      0.16  Q          |          |          |     V    |
20+10       0.4451      0.16  Q          |          |          |     V    |
20+15       0.4462      0.15  Q          |          |          |     V    |
20+20       0.4473      0.15  Q          |          |          |     V    |
20+25       0.4483      0.15  Q          |          |          |     V    |
20+30       0.4493      0.15  Q          |          |          |     V    |
20+35       0.4503      0.15  Q          |          |          |      V   |
20+40       0.4514      0.15  Q          |          |          |      V   |
20+45       0.4524      0.15  Q          |          |          |      V   |
20+50       0.4533      0.14  Q          |          |          |      V   |
20+55       0.4543      0.14  Q          |          |          |      V   |
21+ 0       0.4553      0.14  Q          |          |          |      V   |
21+ 5       0.4563      0.14  Q          |          |          |      V   |
21+10       0.4572      0.14  Q          |          |          |      V   |
21+15       0.4582      0.14  Q          |          |          |      V   |
21+20       0.4591      0.14  Q          |          |          |      V   |
21+25       0.4600      0.13  Q          |          |          |      V   |
21+30       0.4609      0.13  Q          |          |          |      V   |
21+35       0.4618      0.13  Q          |          |          |      V   |
21+40       0.4628      0.13  Q          |          |          |       V  |
21+45       0.4636      0.13  Q          |          |          |       V  |
21+50       0.4645      0.13  Q          |          |          |       V  |
21+55       0.4654      0.13  Q          |          |          |       V  |
22+ 0       0.4663      0.13  Q          |          |          |       V  |
22+ 5       0.4672      0.13  Q          |          |          |       V  |
22+10       0.4680      0.12  Q          |          |          |       V  |
22+15       0.4689      0.12  Q          |          |          |       V  |
22+20       0.4697      0.12  Q          |          |          |       V  |
22+25       0.4706      0.12  Q          |          |          |       V  |
22+30       0.4714      0.12  Q          |          |          |       V  |
22+35       0.4722      0.12  Q          |          |          |       V  |
22+40       0.4730      0.12  Q          |          |          |       V  |
22+45       0.4739      0.12  Q          |          |          |       V  |
22+50       0.4747      0.12  Q          |          |          |        V |
22+55       0.4755      0.12  Q          |          |          |        V |
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   23+ 0       0.4763      0.12  Q          |          |          |         V|
   23+ 5       0.4771      0.12  Q          |          |          |         V|
   23+10       0.4779      0.11  Q          |          |          |         V|
   23+15       0.4786      0.11  Q          |          |          |         V|
   23+20       0.4794      0.11  Q          |          |          |         V|
   23+25       0.4802      0.11  Q          |          |          |         V|
   23+30       0.4810      0.11  Q          |          |          |         V|
   23+35       0.4817      0.11  Q          |          |          |         V|
   23+40       0.4825      0.11  Q          |          |          |         V|
   23+45       0.4832      0.11  Q          |          |          |         V|
   23+50       0.4840      0.11  Q          |          |          |         V|
   23+55       0.4847      0.11  Q          |          |          |         V|
   24+ 0       0.4855      0.11  Q          |          |          |         V|
-------------------------------------------------------------------------------
```

Form 4.2-3 HCOC Assessment for Runoff Volume (DA 1)

Weighted Curve Number Determination for: Pre-developed DA	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H
1a Land Cover type								
2a Hydrologic Soil Group (HSG)								
3a DMA Area, ft^2 *sum of areas of DMA should equal area of DA*								
4a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*								
Weighted Curve Number Determination for: Post-developed DA	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H
1b Land Cover type								
2b Hydrologic Soil Group (HSG)								
3b DMA Area, ft^2 *sum of areas of DMA should equal area of DA*								
4b Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*								

5 Pre-Developed area-weighted CN:	**7** Pre-developed soil storage capacity, S (in): *S = (1000 / Item 5) - 10*	**9** Initial abstraction, I_a (in): *I_a = 0.2 * Item 7*
6 Post-Developed area-weighted CN:	**8** Post-developed soil storage capacity, S (in): *S = (1000 / Item 6) - 10*	**10** Initial abstraction, I_a (in): *I_a = 0.2 * Item 8*

11 Precipitation for 2 yr, 24 hr storm (in):
Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

12 Pre-developed Volume (ft^3):
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*

13 Post-developed Volume (ft^3):
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*

14 Volume Reduction needed to meet HCOC Requirement, (ft^3):
*V_{HCOC} = (Item 13 * 0.95) – Item 12*

See Calculations

Form 4.2-4 HCOC Assessment for Time of Concentration (DA 1)

Compute time of concentration for pre and post developed conditions for each DA *(For projects using the Hydrology Manual complete the form below)*

Variables	Pre-developed DA1 *Use additional forms if there are more than 4 DMA*				Post-developed DA1 *Use additional forms if there are more than 4 DMA*			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*								
2 Change in elevation (ft)								
3 Slope (ft/ft), S_o *= Item 2 / Item 1*								
4 Land cover								
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*								
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*								
7 Cross-sectional area of channel (ft^2)								
8 Wetted perimeter of channel (ft)								
9 Manning's roughness of channel (n)								
10 Channel flow velocity (ft/sec) V_{fps} *= (1.49 / Item 9) * (Item 7/Item 8)^0.67 * (Item 3)^0.5*								
11 Travel time to outlet (min) T_t *= Item 6 / (Item 10 * 60)*								
12 Total time of concentration (min) T_c *= Item 5 + Item 11*								
13 Pre-developed time of concentration (min): *Minimum of Item 12 pre-developed DMA*								
14 Post-developed time of concentration (min): *Minimum of Item 12 post-developed DMA*								
15 Additional time of concentration needed to meet HCOC requirement (min): $T_{C\text{-}HCOC}$ *= (Item 13 * 0.95) – Item 14*								

See Calculations

Form 4.2-5 HCOC Assessment for Peak Runoff (DA 1)

Compute peak runoff for pre- and post-developed conditions

Variables		Pre-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*			Post-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*		
		DMA A	DMA B	DMA C	DMA A	DMA B	DMA C
1 Rainfall Intensity for storm duration equal to time of concentration *I_{peak} = 10^(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 /60)*							
2 Drainage Area of each DMA (Acres) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*							
3 Ratio of pervious area to total area *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*							
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*							
5 Maximum loss rate (in/hr) *F_m = Item 3 * Item 4* *Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*							
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*							
7 Time of concentration adjustment factor for other DMA to site discharge point *Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)*	DMA A	*n/a*			*n/a*		
	DMA B		*n/a*			*n/a*	
	DMA C			*n/a*			*n/a*

8 Pre-developed Q_p at T_c for DMA A: *Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAA/2}$] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAA/3}$]*	**9** Pre-developed Q_p at T_c for DMA B: *Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAB/1}$] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAB/3}$]*	**10** Pre-developed Q_p at T_c for DMA C: *Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAC/1}$] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAC/2}$]*

10 Peak runoff from pre-developed condition confluence analysis (cfs): *Maximum of Item 8, 9, and 10 (including additional forms as needed)*

11 Post-developed Q_p at T_c for DMA A: *Same as Item 8 for post-developed values*	**12** Post-developed Q_p at T_c for DMA B: *Same as Item 9 for post-developed values*	**13** Post-developed Q_p at T_c for DMA C: *Same as Item 10 for post-developed values*

14 Peak runoff from post-developed condition confluence analysis (cfs): *Maximum of Item 11, 12, and 13 (including additional forms as needed)*

15 Peak runoff reduction needed to meet HCOC Requirement (cfs): $Q_{p\text{-}HCOC}$ = *(Item 14 * 0.95) – Item 10*

4.3 Project Conformance Analysis

Complete the following forms for each project site DA to document that the proposed LID BMPs conform to the project DCV developed to meet performance criteria specified in the MS4 Permit (WQMP Template Section 4.2). For the LID DCV, the forms are ordered according to hierarchy of BMP selection as required by the MS4 Permit (see Section 5.3.1 in the TGD for WQMP). The forms compute the following for on-site LID BMP:

- Site Design and Hydrologic Source Controls (Form 4.3-2)
- Retention and Infiltration (Form 4.3-3)
- Harvested and Use (Form 4.3-4) or
- Biotreatment (Form 4.3-5).

At the end of each form, additional fields facilitate the determination of the extent of mitigation provided by the specific BMP category, allowing for use of the next category of BMP in the hierarchy, if necessary.

The first step in the analysis, using Section 5.3.2.1 of the TGD for WQMP, is to complete Forms 4.3-1 and 4.3-3) to determine if retention and infiltration BMPs are infeasible for the project. For each feasibility criterion in Form 4.3-1, if the answer is "Yes," provide all study findings that includes relevant calculations, maps, data sources, etc. used to make the determination of infeasibility.

Next, complete Forms 4.3-2 and 4.3-4 to determine the feasibility of applicable HSC and harvest and use BMPs, and, if their implementation is feasible, the extent of mitigation of the DCV.

If no site constraints exist that would limit the type of BMP to be implemented in a DA, evaluate the use of combinations of LID BMPs, including all applicable HSC BMPs to maximize on-site retention of the DCV. If no combination of BMP can mitigate the entire DCV, implement the single BMP type, or combination of BMP types, that maximizes on-site retention of the DCV within the minimum effective area.

If the combination of LID HSC, retention and infiltration, and harvest and use BMPs are unable to mitigate the entire DCV, then biotreatment BMPs may be implemented by the project proponent. If biotreatment BMPs are used, then they must be sized to provide sufficient capacity for effective treatment of the remainder of the volume-based performance criteria that cannot be achieved with LID BMPs (TGD for WQMP Section 5.4.4.2). **Under no circumstances shall any portion of the DCV be released from the site without effective mitigation and/or treatment**.

Form 4.3-1 Infiltration BMP Feasibility (DA 1)

Feasibility Criterion – Complete evaluation for each DA on the Project Site

[1] Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☐ No ☒
Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach)

[2] Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☐ No ☒
(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

- The location is less than 50 feet away from slopes steeper than 15 percent
- The location is less than eight feet from building foundations or an alternative setback.
- A study certified by a geotechnical professional or an available watershed study determines that stormwater infiltration would result in significantly increased risks of geotechnical hazards.

If Yes, Provide basis: (attach)

[3] Would infiltration of runoff on a Project site violate downstream water rights? Yes ☐ No ☒

If Yes, Provide basis: (attach)

[4] Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils? Yes ☐ No ☒

If Yes, Provide basis: (attach)

[5] Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)? Yes ☐ No ☒

If Yes, Provide basis: (attach)

[6] Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses? Yes ☐ No ☒
See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

[7] Any answer from Item 1 through Item 3 is "Yes": Yes ☐ No ☒
If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 8 below.

[8] Any answer from Item 4 through Item 6 is "Yes": Yes ☐ No ☒
If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Hydrologic Source Control BMP. If no, then proceed to Item 9, below.

[9] All answers to Item 1 through Item 6 are "No": Yes ☒ No ☐
Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP. Proceed to Form 4.3-2, Hydrologic Source Control BMP.

4.3.1 Site Design Hydrologic Source Control BMP

Section XI.E. of the Permit emphasizes the use of LID preventative measures; and the use of LID HSC BMPs reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable HSC shall be provided except where they are mutually exclusive with each other, or with other BMPs. Mutual exclusivity may result from overlapping BMP footprints such that either would be potentially feasible by itself, but both could not be implemented. Please note that while there are no numeric standards regarding the use of HSC, if a project cannot feasibly meet BMP sizing requirements or cannot fully address HCOCs, feasibility of all applicable HSC must be part of demonstrating that the BMP system has been designed to retain the maximum feasible portion of the DCV. Complete Form 4.3-2 to identify and calculate estimated retention volume from implementing site design HSC BMP. Refer to Section 5.4.1 in the TGD for more detailed guidance.

Form 4.3-2 Site Design Hydrologic Source Control BMPs (DA 1)

1 Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP: Yes ☐ No ☒ *If yes, complete Items 2-5; If no, proceed to Item 6*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Total impervious area draining to pervious area (ft^2)			
3 Ratio of pervious area receiving runoff to impervious area			
4 Retention volume achieved from impervious area dispersion (ft^3) *V = Item2 * Item 3 * (0.5/12), assuming retention of 0.5 inches of runoff*			
5 Sum of retention volume achieved from impervious area dispersion (ft^3): 0 *$V_{retention}$ =Sum of Item 4 for all BMPs*			
6 Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☒ *If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
7 Ponding surface area (ft^2)			
8 Ponding depth (ft)			
9 Surface area of amended soil/gravel (ft^2)			
10 Average depth of amended soil/gravel (ft)			
11 Average porosity of amended soil/gravel			
12 Retention volume achieved from on-lot infiltration (ft^3) *$V_{retention}$ = (Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)*			
13 Runoff volume retention from on-lot infiltration (ft^3): 0 *$V_{retention}$ =Sum of Item 12 for all BMPs*			

Form 4.3-2 cont. Site Design Hydrologic Source Control BMPs (DA 1)

14 Implementation of evapotranspiration BMP (green, brown, or blue roofs): Yes ☐ No ☒ *If yes, complete Items 15-20. If no, proceed to Item 21*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
15 Rooftop area planned for ET BMP (ft^2)			
16 Average wet season ET demand (in/day) *Use local values, typical ~ 0.1*			
17 Daily ET demand (ft^3/day) *Item 15 * (Item 16 / 12)*			
18 Drawdown time (hrs) *Copy Item 6 in Form 4.2-1*			
19 Retention Volume (ft^3) $V_{retention}$ *= Item 17 * (Item 18 / 24)*			
20 Runoff volume retention from evapotranspiration BMPs (ft^3): 0 $V_{retention}$ *=Sum of Item 19 for all BMPs*			
21 Implementation of Street Trees: Yes ☐ No ☒ *If yes, complete Items 22-25. If no, proceed to Item 26*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
22 Number of Street Trees			
23 Average canopy cover over impervious area (ft^2)			
24 Runoff volume retention from street trees (ft^3) $V_{retention}$ *= Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches*			
25 Runoff volume retention from street tree BMPs (ft^3): 0 $V_{retention}$ *= Sum of Item 24 for all BMPs*			
26 Implementation of residential rain barrel/cisterns: Yes ☐ No ☒ *If yes, complete Items 27-29; If no, proceed to Item 30*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
27 Number of rain barrels/cisterns			
28 Runoff volume retention from rain barrels/cisterns (ft^3) $V_{retention}$ *= Item 27 * 3*			
29 Runoff volume retention from residential rain barrels/Cisterns (ft3): 0 $V_{retention}$ *=Sum of Item 28 for all BMPs*			
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: 0 *Sum of Items 5, 13, 20, 25 and 29*			

4.3.2 Infiltration BMPs

Use Form 4.3-3 to compute on-site retention of runoff from proposed retention and infiltration BMPs. Volume retention estimates are sensitive to the percolation rate used, which determines the amount of runoff that can be infiltrated within the specified drawdown time. The infiltration safety factor reduces field measured percolation to account for potential inaccuracy associated with field measurements, declining BMP performance over time, and compaction during construction. Appendix D of the TGD for WQMP provides guidance on estimating an appropriate safety factor to use in Form 4.3-3.

If site constraints limit the use of BMPs to a single type and implementation of retention and infiltration BMPs mitigate no more than 40% of the DCV, then they are considered infeasible and the Project Proponent may evaluate the effectiveness of BMPs lower in the LID hierarchy of use (Section 5.5.1 of the TGD for WQMP)

If implementation of infiltrations BMPs is feasible as determined using Form 4.3-1, then LID infiltration BMPs shall be implemented to the MEP (section 4.1 of the TGD for WQMP).

Form 4.3-3 Infiltration LID BMP - including underground BMPs (DA 1)

1 Remaining LID DCV not met by site design HSC BMP (ft^3): 10,247.05 *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30*

BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs*	DA 1 DMA 1 BMP Type Storm Tech System	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods*	12.20		
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*	3		
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*	4.07		
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*	48		
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*	N/A		
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*	N/A		
8 Infiltrating surface area, SA_{BMP} (ft^2) *the lesser of the area needed for infiltration of full DCV or minimum space requirements from Table 5.7 of the TGD for WQMP*	4,034.69		
9 Amended soil depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*	N/A		
10 Amended soil porosity	N/A		
11 Gravel depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 of the TGD for WQMP for BMP design details*	N/A		
12 Gravel porosity	0.40		
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*	3		
14 Above Ground Retention Volume (ft^3) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*	0		
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*	16,993.51 Cf Per Calc. On Next Page		

16 Total Retention Volume from LID Infiltration BMPs: 16,993.51 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 166% *Retention% = Item 16 / Form 4.2-1 Item 7*

18 Is full LID DCV retained onsite with combination of hydrologic source control and LID retention/infiltration BMPs? Yes ☒ No ☐

If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.

User Inputs

Chamber Model:	MC-7200
Outlet Control Structure:	Yes
Project Name:	JN 3432
Engineer:	N/A
Project Location:	California
Measurement Type:	Imperial
Required Storage Volume:	16535 cubic ft.
Stone Porosity:	40%
Stone Foundation Depth:	9 in.
Stone Above Chambers:	12 in.
Average Cover Over Chambers:	24 in.
Design Constraint Dimensions:	(40 ft. x 100 ft.)

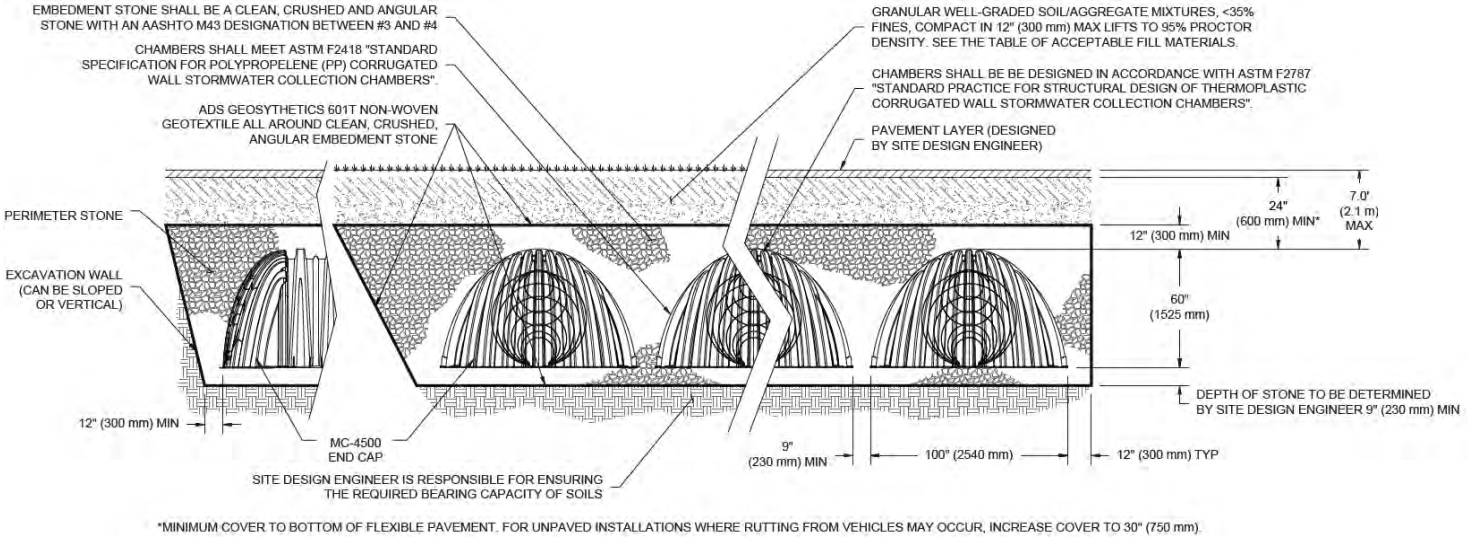
Results

System Volume and Bed Size

Installed Storage Volume:	16993.51 cubic ft.
Storage Volume Per Chamber:	175.90 cubic ft.
Number Of Chambers Required:	56
Number Of End Caps Required:	8
Chamber Rows:	4
Maximum Length:	108.02 ft.
Maximum Width:	38.18 ft.
Approx. Bed Size Required:	4034.69 square ft.

System Components

Amount Of Stone Required:	633 cubic yards
Volume Of Excavation (Not Including Fill):	1009 cubic yards
Total Non-woven Geotextile Required:	1340 square yards
Woven Geotextile Required (excluding Isolator Row):	64 square yards
Woven Geotextile Required (Isolator Row):	229 square yards
Total Woven Geotextile Required:	292 square yards
Impervious Liner Required:	0 square yards



4.3.3 Harvest and Use BMP

Harvest and use BMP may be considered if the full LID DCV cannot be met by maximizing infiltration BMPs. Use Form 4.3-4 to compute on-site retention of runoff from proposed harvest and use BMPs.

Volume retention estimates for harvest and use BMPs are sensitive to the on-site demand for captured stormwater. Since irrigation water demand is low in the wet season, when most rainfall events occur in San Bernardino County, the volume of water that can be used within a specified drawdown period is relatively low. The bottom portion of Form 4.3-4 facilitates the necessary computations to show infeasibility if a minimum incremental benefit of 40 percent of the LID DCV would not be achievable with MEP implementation of on-site harvest and use of stormwater (Section 5.5.4 of the TGD for WQMP).

Form 4.3-4 Harvest and Use BMPs (DA 1)

1 Remaining LID DCV not met by site design HSC or infiltration BMP (ft^3): 0

V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16

BMP Type(s) *Compute runoff volume retention from proposed harvest and use BMP (Select BMPs from Table 5-4 of the TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Describe cistern or runoff detention facility			
3 Storage volume for proposed detention type (ft^3) *Volume of cistern*			
4 Landscaped area planned for use of harvested stormwater (ft^2)			
5 Average wet season daily irrigation demand (in/day) Use local values, typical ~ 0.1 in/day			
6 Daily water demand (ft^3/day) *Item 4 * (Item 5 / 12)*			
7 Drawdown time (hrs) *Copy Item 6 from Form 4.2-1*			
8 Retention Volume (ft^3) *$V_{retention}$ = Minimum of (Item 3) or (Item 6 * (Item 7 / 24))*			

9 Total Retention Volume (ft^3) from Harvest and Use BMP *Sum of Item 8 for all harvest and use BMP included in plan*

10 Is the full DCV retained with a combination of LID HSC, retention and infiltration, and harvest & use BMPs? Yes ☐ No ☐

If yes, demonstrate conformance using Form 4.3-10. If no, then re-evaluate combinations of all LID BMP and optimize their implementation such that the maximum portion of the DCV is retained on-site (using a single BMP type or combination of BMP types). If the full DCV cannot be mitigated after this optimization process, proceed to Section 4.3.4.

4.3.4 Biotreatment BMP

Biotreatment BMPs may be considered if the full LID DCV cannot be met by maximizing retention and infiltration, and harvest and use BMPs. A key consideration when using biotreatment BMP is the effectiveness of the proposed BMP in addressing the pollutants of concern for the project (see Table 5-5 of the TGD for WQMP).

Use Form 4.3-5 to summarize the potential for volume based and/or flow based biotreatment options to biotreat the remaining unmet LID DCV w. Biotreatment computations are included as follows:

- Use Form 4.3-6 to compute biotreatment in small volume based biotreatment BMP (e.g. bioretention w/underdrains);
- Use Form 4.3-7 to compute biotreatment in large volume based biotreatment BMP (e.g. constructed wetlands);
- Use Form 4.3-8 to compute sizing criteria for flow-based biotreatment BMP (e.g. bioswales)

Form 4.3-5 Selection and Evaluation of Biotreatment BMP (DA 1)

1 Remaining LID DCV not met by site design HSC, infiltration, or harvest and use BMP for potential biotreatment (ft^3): 0 *Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9*	List pollutants of concern *Copy from Form 2.3-1.*	
2 Biotreatment BMP Selected *(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)*	Volume-based biotreatment *Use Forms 4.3-6 and 4.3-7 to compute treated volume*	Flow-based biotreatment *Use Form 4.3-8 to compute treated volume*
	☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention	☐ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment
3 Volume biotreated in volume based biotreatment BMP (ft^3): *Form 4.3-6 Item 15 + Form 4.3-7 Item 13*	**4** Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft^3): *Item 1 – Item 3*	**5** Remaining fraction of LID DCV for sizing flow based biotreatment BMP: % *Item 4 / Item 1*
6 Flow-based biotreatment BMP capacity provided (cfs): *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)*		
7 Metrics for MEP determination: • Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.*		

Form 4.3-6 Volume Based Biotreatment (DA 1) – Bioretention and Planter Boxes with Underdrains

Biotreatment BMP Type *(Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*			
2 Amended soil infiltration rate *Typical ~ 5.0*			
3 Amended soil infiltration safety factor *Typical ~ 2.0*			
4 Amended soil design percolation rate (in/hr) P_{design} *= Item 2 / Item 3*			
5 Ponded water drawdown time (hr) *Copy Item 6 from Form 4.2-1*			
6 Maximum ponding depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
7 Ponding Depth (ft) d_{BMP} *= Minimum of (1/12 * Item 4 * Item 5) or Item 6*			
8 Amended soil surface area (ft^2)			
9 Amended soil depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
10 Amended soil porosity, *n*			
11 Gravel depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
12 Gravel porosity, *n*			
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
14 Biotreated Volume (ft^3) $V_{biotreated}$ *= Item 8 * [(Item 7/2) + (Item 9 * Item 10) +(Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*			
15 Total biotreated volume from bioretention and/or planter box with underdrains BMP: *Sum of Item 14 for all volume-based BMPs included in this form*			

Form 4.3-7 Volume Based Biotreatment (DA 1) – Constructed Wetlands and Extended Detention

Biotreatment BMP Type *Constructed wetlands, extended wet detention, extended dry detention, or other comparable proprietary BMP. If BMP includes multiple modules (e.g. forebay and main basin), provide separate estimates for storage and pollutants treated in each module.*	DA DMA BMP Type		DA DMA BMP Type *(Use additional forms for more BMPs)*	
	Forebay	Basin	Forebay	Basin
1 Pollutants addressed with BMP forebay and basin *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*				
2 Bottom width (ft)				
3 Bottom length (ft)				
4 Bottom area (ft^2) A_{bottom} = *Item 2 * Item 3*				
5 Side slope (ft/ft)				
6 Depth of storage (ft)				
7 Water surface area (ft^2) $A_{surface}$ =*(Item 2 + (2 * Item 5 * Item 6)) * (Item 3 + (2 * Item 5 * Item 6))*				
8 Storage volume (ft^3) *For BMP with a forebay, ensure fraction of total storage is within ranges specified in BMP specific fact sheets, see Table 5-6 of the TGD for WQMP for reference to BMP design details* V =*Item 6 / 3 * [Item 4 + Item 7 + (Item 4 * Item 7)^0.5]*				
9 Drawdown Time (hrs) *Copy Item 6 from Form 2.1*				
10 Outflow rate (cfs) Q_{BMP} = *(Item* $8_{forebay}$ + *Item* 8_{basin}*) / (Item 9 * 3600)*				
11 Duration of design storm event (hrs)				
12 Biotreated Volume (ft^3) $V_{biotreated}$ = *(Item* $8_{forebay}$ + *Item* 8_{basin}*) +(Item 10 * Item 11 * 3600)*				
13 Total biotreated volume from constructed wetlands, extended dry detention, or extended wet detention : *(Sum of Item 12 for all BMP included in plan)*				

Form 4.3-8 Flow Based Biotreatment (DA 1)

Biotreatment BMP Type *Vegetated swale, vegetated filter strip, or other comparable proprietary BMP*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in TGD Table 5-5*			
2 Flow depth for water quality treatment (ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
3 Bed slope (ft/ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
4 Manning's roughness coefficient			
5 Bottom width (ft) b_w *= (Form 4.3-5 Item 6 * Item 4) / (1.49 * Item 2^1.67 * Item 3^0.5)*			
6 Side Slope (ft/ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
7 Cross sectional area (ft^2) *A = (Item 5 * Item 2) + (Item 6 * Item 2^2)*			
8 Water quality flow velocity (ft/sec) *V = Form 4.3-5 Item 6 / Item 7*			
9 Hydraulic residence time (min) *Pollutant specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
10 Length of flow based BMP (ft) *L = Item 8 * Item 9 * 60*			
11 Water surface area at water quality flow depth (ft^2) SA_{top} *= (Item 5 + (2 * Item 2 * Item 6)) * Item 10*			

4.3.5 Conformance Summary

Complete Form 4.3-9 to demonstrate how on-site LID DCV is met with proposed site design hydrologic source control, infiltration, harvest and use, and/or biotreatment BMP. The bottom line of the form is used to describe the basis for infeasibility determination for on-site LID BMP to achieve full LID DCV, and provides methods for computing remaining volume to be addressed in an alternative compliance plan. If the project has more than one outlet, then complete additional versions of this form for each outlet.

Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DA 1)

1 Total LID DCV for the Project DA-1 (ft^3): 10,247.05 *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design hydrologic source control LID BMP (ft^3): 0 *Copy Item 30 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): 16,993.51 *Copy Item 16 in Form 4.3-3*

4 On-site retention with LID harvest and use BMP (ft^3): 0 *Copy Item 9 in Form 4.3-4*

5 On-site biotreatment with volume based biotreatment BMP (ft^3): 0 *Copy Item 3 in Form 4.3-5*

6 Flow capacity provided by flow based biotreatment BMP (cfs): 0 *Copy Item 6 in Form 4.3-5*

7 LID BMP performance criteria are achieved if answer to any of the following is "Yes":

- Full retention of LID DCV with site design HSC, infiltration, or harvest and use BMP: Yes ☒ No ☐
  If yes, sum of Items 2, 3, and 4 is greater than Item 1
- Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☒
  If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized
- On-site retention and infiltration is determined to be infeasible and biotreatment BMP provide biotreatment for all pollutants of concern for full LID DCV: Yes ☐ No ☒
  If yes, Form 4.3-1 Items 7 and 8 were both checked yes

8 If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance:

- Combination of HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: ☐
  Checked yes for Form 4.3-5 Item 7, Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, V_{alt} *= (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%*
- An approved Watershed Action Plan (WAP) demonstrates that water quality and hydrologic impacts of urbanization are more effective when managed in at an off-site facility: ☐
  Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed

4.3.6 Hydromodification Control BMP

Use Form 4.3-10 to compute the remaining runoff volume retention, after LID BMP are implemented, needed to address HCOC, and the increase in time of concentration and decrease in peak runoff necessary to meet targets for protection of waterbodies with a potential HCOC. Describe hydromodification control BMP that address HCOC, which may include off-site BMP and/or in-stream controls. Section 5.6 of the TGD for WQMP provides additional details on selection and evaluation of hydromodification control BMP.

Form 4.3-10 Hydromodification Control BMPs (DA 1)

1 Volume reduction needed for HCOC performance criteria (ft^3): 15,478 *(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1*	**2** On-site retention with site design hydrologic source control, infiltration, and harvest and use LID BMP (ft^3): 16,993.51 *Sum of Form 4.3-9 Items 2, 3, and 4 Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving HCOC volume reduction*
3 Remaining volume for HCOC volume capture (ft^3): 0 *Item 1 – Item 2*	**4** Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft^3): *Existing downstream BMP may be used to demonstrate additional volume capture (if so, attach to this WQMP a hydrologic analysis showing how the additional volume would be retained during a 2-yr storm event for the regional watershed)*

5 If Item 4 is less than Item 3, incorporate in-stream controls on downstream waterbody segment to prevent impacts due to hydromodification ☐ *Attach in-stream control BMP selection and evaluation to this WQMP*

6 Is Form 4.2-2 Item 11 less than or equal to 5%: Yes ☐ No ☒

If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:

- Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site or off-site retention BMP ☐
  BMP upstream of a waterbody segment with a potential HCOC may be used to demonstrate increased time of concentration through hydrograph attenuation (if so, show that the hydraulic residence time provided in BMP for a 2-year storm event is equal or greater than the addition time of concentration requirement in Form 4.2-4 Item 15)
- Increase time of concentration by preserving pre-developed flow path and/or increase travel time by reducing slope and increasing cross-sectional area and roughness for proposed on-site conveyance facilities ☒
- Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐

7 Form 4.2-2 Item 12 less than or equal to 5%: Yes ☐ No ☒

If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:

- Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site or off-site retention BMPs ☒
  BMPs upstream of a waterbody segment with a potential HCOC may be used to demonstrate additional peak runoff reduction through hydrograph attenuation (if so, attach to this WQMP, a hydrograph analysis showing how the peak runoff would be reduced during a 2-yr storm event)
- Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐

4.4 Alternative Compliance Plan (if applicable)

Describe an alternative compliance plan (if applicable) for projects not fully able to infiltrate, harvest and use, or biotreat the DCV via on-site LID practices. A project proponent must develop an alternative compliance plan to address the remainder of the LID DCV. Depending on project type some projects may qualify for water quality credits that can be applied to reduce the DCV that must be treated prior to development of an alternative compliance plan (see Form 2.4-1, Water Quality Credits). Form 4.3-9 Item 8 includes instructions on how to apply water quality credits when computing the DCV that must be met through alternative compliance. Alternative compliance plans may include one or more of the following elements:

- On-site structural treatment control BMP - All treatment control BMP should be located as close to possible to the pollutant sources and should not be located within receiving waters;
- Off-site structural treatment control BMP - Pollutant removal should occur prior to discharge of runoff to receiving waters;
- Urban runoff fund or In-lieu program, if available

Depending upon the proposed alternative compliance plan, approval by the executive officer may or may not be required (see Section 6 of the TGD for WQMP).

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

All BMP included as part of the project WQMP are required to be maintained through regular scheduled inspection and maintenance (refer to Section 8, Post Construction BMP Requirements, in the TGD for WQMP). Fully complete Form 5-1 summarizing all BMP included in the WQMP. Attach additional forms as needed. The WQMP shall also include a detailed Operation and Maintenance Plan for all BMP and may require a Maintenance Agreement (consult the jurisdiction's LIP). If a Maintenance Agreement is required, it must also be attached to the WQMP.

Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)

BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
Stormtech System (infiltration underground basin)	Henry Oliver	Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming . For more information see stormtech isolator row O&M manual in section 6.4.	Shall be inspected monthly during the rainy season (October-May) and before and after each storm to ensure proper operation.
N1 Education for property owners	Henry Oliver	Practical informational materials will be provided by owner to employees regarding practices that contribute to protection of storm water quality. Among other things, these materials will describe the use of chemicals (including household type) that should be limited to the property, with no discharge of specified wastes via hosing or other direct discharges to gutters, catch basins, and storm drains. Property owner will provide these materials through an education program. This program must be maintained, enforced, and updated periodically by the owner. Educational materials including, but not limited to, the materials included in Section 6.4 will be made available to the employees periodically thereafter.	annually

N2 Activity restrictions	Henry Oliver	Owner shall force employees to maintain good housekeeping daily and enforce restrictions to employees, customers and guests. Such restrictions should include no washing of vehicles. Owner and employees shall not discharge any chemicals, wastewater or other prohibited discharges listed in the City and County Ordinances onto the DA and therefore the downstream receiving waters. Pesticide application shall be done by a licensed applicator. Owner or delegated manager to inspect facility for compliance with all restrictions within this WQMP daily.	daily
N3 Landscape management	Henry Oliver	The Landscape crews shall inspect the irrigation system and shall report all drainage problems to the owner. Landscape maintenance activities for this site include mowing, trimming, weeding and irrigation. For irrigation, the owner shall install automatic timers and a water efficient system to minimize runoff. Owner shall be responsible for educating and training employees on appropriate landscape maintenance or hire a qualified professional. Maintenance shall be done weekly or as needed.	Weekly at minimum.
N11 Litter control	Henry Oliver	Owner is responsible to hire a maintenance person or contact with a landscape service for litter patrol. A program shall be implemented to pick up litter and sweep and clean the entire site on a daily basis.	Entire site will be kept clean from litter and be swept daily.
N14 Catch basin inspection program	Henry Oliver	The on-site catch basins shall be inspected monthly during the rainy season (October-May) and before and after each storm to ensure proper operation. The owner shall contract with a qualified landscape contractor to inspect and clean out accumulation of trash, litter and sediment and check for evidence of illegal dumping of waste materials into on-site drains. Also inspect catch basins and cleaned as needed for standing water in addition to trash.	Shall be inspected monthly during the rainy season (October-May) and before and after each storm to ensure proper operation.
N15 Vacuum sweeping of private streets and parking lots	Henry Oliver	Street shall be swept using a vacuum assisted sweeper (is required) weekly to prevent sediment, garden waste, and trash, or other pollutants from entering on-site drains and public storm channels. Vacuum sweeping will be done by a landscape contractor or other contractor provided by the owner.	weekly

S1 Provide storm drain system stenciling and signage	Henry Oliver	Inspect stenciling for legibility and repaint as needed.	Shall be inspected annually and repainted as necessary.
S5 Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	Henry Oliver	Landscape to be depressed 1-2" below finish surface of concrete curbs and concrete sidewalks. See detail on WQMP Exhibit in section 6.1.	Weekly at minimum.
Trash enclosure	Henry Oliver	Trash enclosures are designed to divert all flows around the enclosure. A permanent awning is required over the trash enclosure area. Inspect trash enclosure for trash and leaks repair as needed. All dumpsters will have lids installed and will be inspected to ensure that the dumpsters remain covered and leak-proof. The owner shall contract with a refuse company to have the dumpsters emptied on a weekly basis, at a minimum.	Weekly at minimum.
Fueling area	Henry Oliver	Fueling areas and storage tanks shall be inspected **monthly**. Keep an ample supply of spill cleanup material on the site. Any equipment, tanks, pumps, piping and fuel dispensing equipment found to be leaking or in disrepair must be repaired or replaced immediately.	Monthly
Wash water controls	Henry Oliver	Food establishments (per State Health & Safety Code 27520) shall have either contained areas or sinks, each with sanitary sewer connections for disposal of wash waters containing kitchen and food wastes. If located outside, the contained areas or sinks shall also be structurally covered to prevent entry of stormwater. Adequate signs shall be provided and appropriately placed stating the prohibition of discharging washwater to the storm drain system.	Weekly at minimum.

Section 6 WQMP Attachments

6.1. Site Plan and Drainage Plan

Include a site plan and drainage plan sheet set containing the following minimum information:

- Project location
- Site boundary
- Land uses and land covers, as applicable
- Suitability/feasibility constraints
- Structural Source Control BMP locations
- Site Design Hydrologic Source Control BMP locations
- LID BMP details
- Drainage delineations and flow information
- Drainage connections

6.2 Electronic Data Submittal

Minimum requirements include submittal of PDF exhibits in addition to hard copies. Format must not require specialized software to open. If the local jurisdiction requires specialized electronic document formats (as described in their local Local Implementation Plan), this section will describe the contents (e.g., layering, nomenclature, geo-referencing, etc.) of these documents so that they may be interpreted efficiently and accurately.

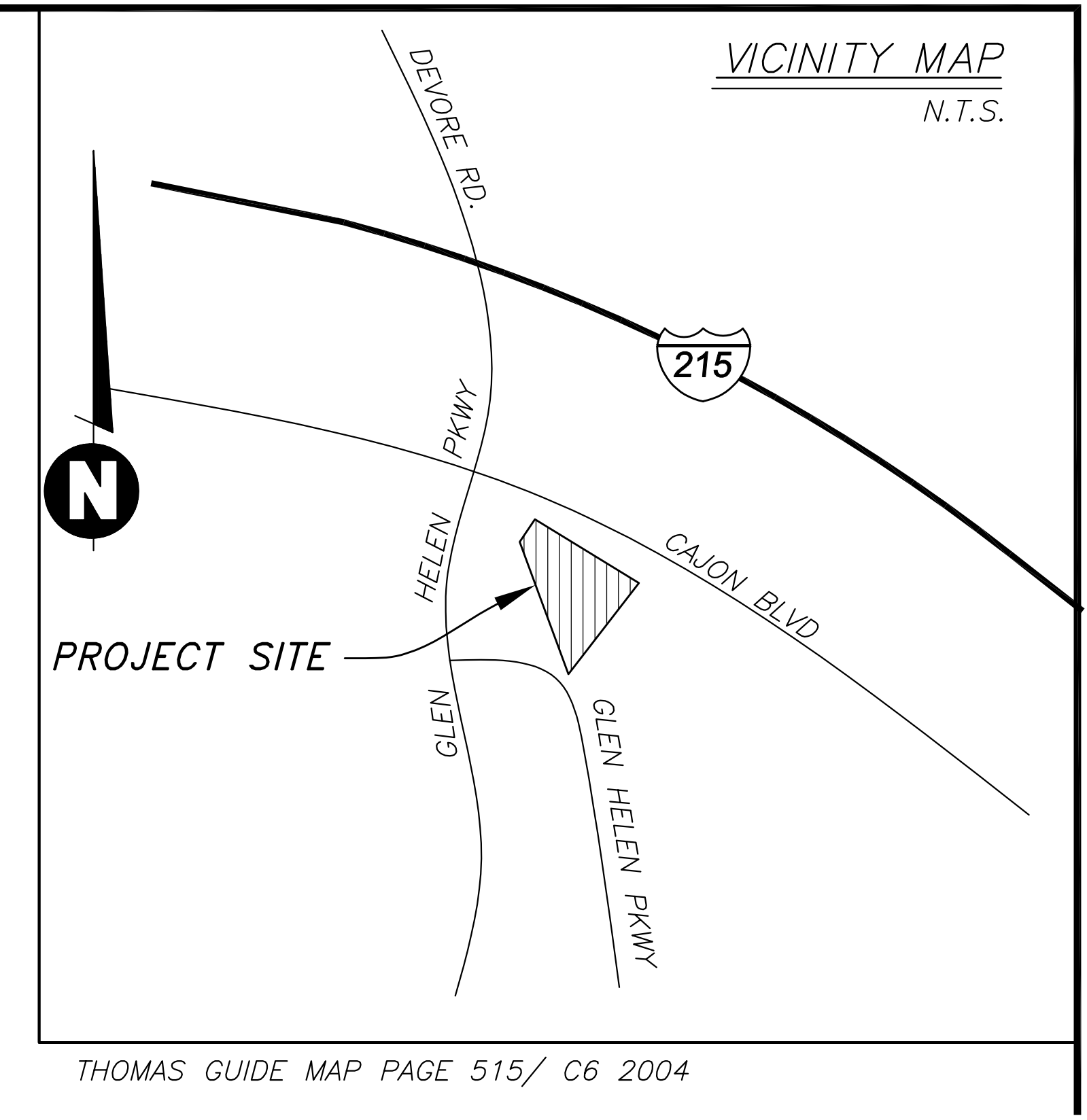
6.3 Post Construction

Attach all O&M Plans and Maintenance Agreements for BMP to the WQMP.

6.4 Other Supporting Documentation

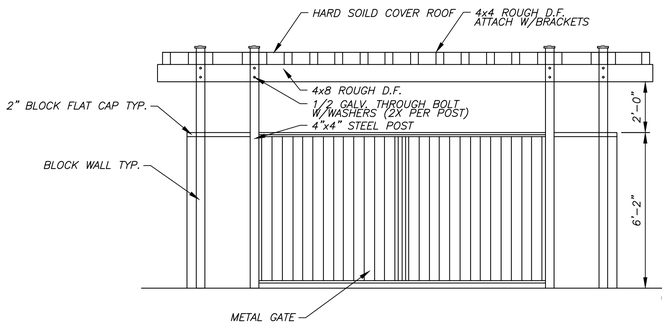
- BMP Educational Materials
- Activity Restriction – C, C&R's & Lease Agreements

6.1. Site Plan and Drainage Plan

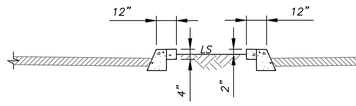


THOMAS GUIDE MAP PAGE 515/ C6 2004

WATER QUALITY MANAGEMENT PLAN
PLOT PLAN

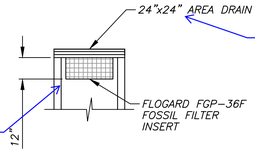


TRASH ENCLOSURE:
NTS



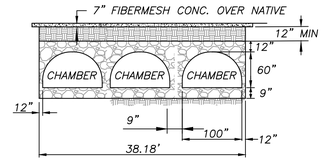
SECTION "A-A"
TYP. NTS

show pipe locations for inlet to the chambers and overflow inlet to outlet. Provide construction drawings if they will be on there.

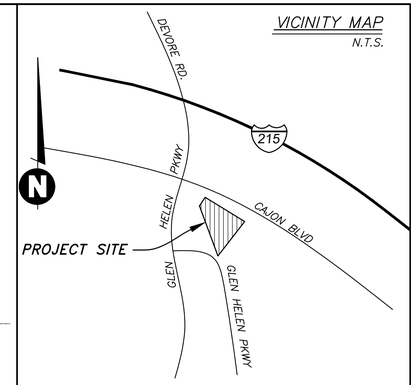


provide depth dimension

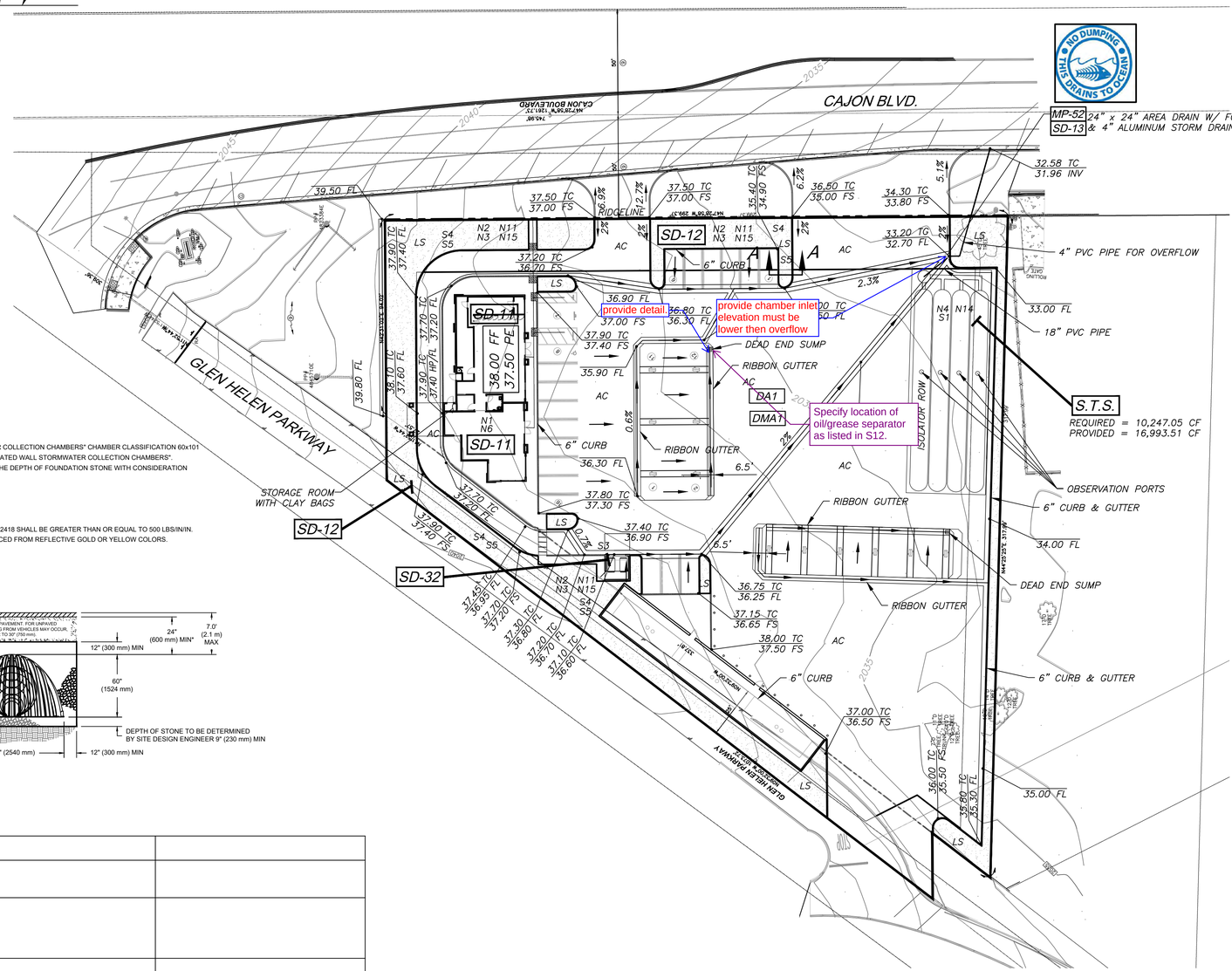
FOSSIL FILTER INSERT
NTS



STORM TECH DETAIL
N.T.S.



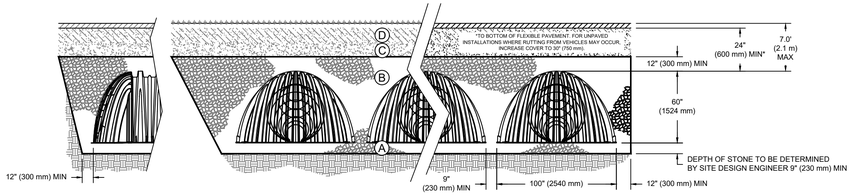
THOMAS GUIDE MAP PAGE 515/ C6 2004



REQUIRED = 10,247.05 CF
PROVIDED = 16,993.51 CF

NOTES:

1. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418-16a, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 60x101
2. MC-7200 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
4. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
5. REQUIREMENTS FOR HANDLING AND INSTALLATION:
   - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
   - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 3".
   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 500 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.



LEGEND: APPLICATION:

SD-11	ROOF RUNOFF CONTROLS
SD-12	LANDSCAPE AREA
SD-32	TRASH ENCLOSURE
S.T.S.	STORM TECH SYSTEM

OWNER/DEVELOPER:

HENRY OLIVER
4370 HALLMARK PARKWAY, STE. 101
SAN BERNARDINO, CA 92407
951-232-4378 PH.

ENGINEER:

SAKE ENGINEERS, INC.
400 S. RAMONA AVE. STE. 202
CORONA, CA 92879
(951) 279-4041 PH.

ASSESSORS PARCEL NO.:

0349-182-11

TOTAL ACREAGE:

TOTAL AREA = 69,278 SF (1.59 AC)
IMPERVIOUS AREA = 58,893 SF (1.35 AC) 85%
PERVIOUS AREA = 10,385 SF (0.24 AC) 15%

NOTE:

SYSTEM ADDRESSES WATER QUALITY AND HCOC REQUIREMENTS

MANUFACTURER INFO:

ADS ENGINEERING SERVICES
1-800-821-6710 PH.

LEGEND:

LANDSCAPING AREA

0 30 60
1 inch = 30 ft.

REGISTERED PROFESSIONAL ENGINEER SAM AKBARPOUR C053038 CIVIL STATE OF CALIFORNIA

SAKE ENGINEERS, INC. www.sakeengineers.com
ENGINEERING ● SURVEYING ● LAND DEVELOPMENT
400 S. RAMONA AVE., STE. 202
CORONA, CALIFORNIA 92879
(951) 279-4041

COUNTY OF SAN BERNARDINO
WATER QUALITY MANAGEMENT PLAN
FOR
PLOT PLAN
SITE PLAN

SHEET NO. 1 OF 1 SHEETS
FILE NO.

\\Nas-new\data\projects\CO SAN BERNARDINO\Un3432 Glen Helen Gas Station\WQMP\WQMP.dwg, WQMP, 7/18/2023 4:29:42 PM, 1:30

6.2 Electronic Data Submittal

Will be submitted at Final WQMP.

6.3 Post Construction

O&M Plans and Maintenance Agreements

RECORDING REQUESTED BY:
County of San Bernardino
Department of Public Works

AND WHEN RECORDED MAIL TO:
County of San Bernardino
Department of Public Works
825 E. Third Street, Room 117
San Bernardino, CA 92415-0835

SPACE ABOVE THIS LINE FOR RECORDER'S USE

COVENANT AND AGREEMENT REGARDING WATER QUALITY MANAGEMENT PLAN AND STORMWATER BEST MANAGEMENT PRACTICES TRANSFER, ACCESS AND MAINTENANCE

THIS PAGE ADDED TO PROVIDE ADEQUATE SPACE FOR RECORDING INFORMATION

Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

OWNER NAME: **Henry Oliver**

PROPERTY ADDRESS: **18545 Cajon Blvd.**

San Bernardino, Ca 92407

APN: **0349-182-11**

THIS AGREEMENT is made and entered into in

_____ ,California, this _____ day of

_____ , by and between

_____ , hereinafter

referred to as Owner, and the COUNTY OF SAN BERNARDINO, a political subdivision of the State of California, hereinafter referred to as "the County";

WHEREAS, the Owner owns real property ("Property") in the County of San Bernardino, State of California, more specifically described in Exhibit "A" and depicted in Exhibit "B", each of which exhibits is attached hereto and incorporated herein by this reference; and

WHEREAS, at the time of initial approval of development project known as

APN 0349-182-11 within the Property described herein, the County required the project to employ Best Management Practices, hereinafter referred to as "BMPs," to minimize pollutants in urban runoff; and

WHEREAS, the Owner has chosen to install and/or implement BMPs as described in the Water Quality Management Plan, dated _____, on file with the County and incorporated herein by this reference, hereinafter referred to as "WQMP", to minimize pollutants in urban runoff and to minimize other adverse impacts of urban runoff; and

WHEREAS, said WQMP has been certified by the Owner and reviewed and approved by the County; and

WHEREAS, the Owner is aware that periodic and continuous maintenance, including, but not necessarily limited to, filter material replacement and sediment removal, is required to assure peak performance of all BMPs in the WQMP and that, furthermore, such

maintenance activity will require compliance with all Local, State, or Federal laws and regulations, including those pertaining to confined space and waste disposal methods, in effect at the time such maintenance occurs.

NOW THEREFORE, it is mutually stipulated and agreed as follows:

1. Owner shall comply with the WQMP.

2. All maintenance or replacement of BMPs proposed as part of the WQMP are the sole responsibility of the Owner in accordance with the terms of this Agreement.

3. Owner hereby provides the County's designee complete access, of any duration, to the BMPs and their immediate vicinity at any time, upon reasonable notice, or in the event of emergency, as determined by the County Director of Public Works, no advance notice, for the purpose of inspection, sampling, testing of the BMPs, and in case of emergency, to undertake all necessary repairs or other preventative measures at owner's expense as provided in paragraph 5 below. The County shall make every effort at all times to minimize or avoid interference with Owner's use of the Property. Denial of access to any premises or facility that contains WQMP features is a breach of this Agreement and may also be a violation of the County's Pollutant Discharge Elimination System regulations, which on the effective date of this Agreement are found in County Code Sections 35.0101 et seq. If there is reasonable cause to believe that an illicit discharge or breach of this Agreement is occurring on the premises then the authorized enforcement agency may seek issuance of a search warrant from any court of competent jurisdiction in addition to other enforcement actions. Owner recognizes that the County may perform routine and regular inspections, as well as emergency inspections, of the BMPs. Owner or Owner's successors or assigns shall pay County for all costs incurred by County in the inspection, sampling, testing of the BMPs within thirty (30) calendar days of County invoice.

4. Owner shall use its best efforts diligently to maintain all BMPs in a manner assuring peak performance at all times. All reasonable precautions shall be exercised by Owner and Owner's representative or contractor in the removal and extraction of any material(s) from the BMPs and the ultimate disposal of the material(s) in a manner consistent with all relevant laws and regulations in effect at the time. As may be requested from time to time by the County, the Owner shall provide the County with documentation identifying the material(s) removed, the quantity, and disposal destination), testing construction or reconstruction.

5. In the event Owner, or its successors or assigns, fails to accomplish the necessary maintenance contemplated by this Agreement, within five (5) business days of being given written notice by the County , the County is hereby authorized to cause any maintenance necessary to be done and charge the entire cost and expense against the Property and/or to the Owner or Owner's successors or assigns, including administrative costs, attorneys fees and interest thereon at the maximum rate

authorized by the County Code from the date of the notice of expense until paid in full. Owner or Owner's successors or assigns shall pay County within thirty (30) calendar days of County invoice.

6. The County may require the owner to post security in form and for a time period satisfactory to the County to guarantee the performance of the obligations stated herein. Should the Owner fail to perform the obligations under the Agreement, the County may, in the case of a cash bond, act for the Owner using the proceeds from it, or in the case of a surety bond, require the surety(ies) to perform the obligations of this Agreement.

7. The County agrees, from time to time, within ten (10) business days after request of Owner, to execute and deliver to Owner, or Owner's designee, an estoppel certificate requested by Owner, stating that this Agreement is in full force and effect, and that Owner is not in default hereunder with regard to any maintenance or payment obligations (or specifying in detail the nature of Owner's default). Owner shall pay all costs and expenses incurred by the County in its investigation of whether to issue an estoppel certificate within thirty (30) calendar days after receipt of a County invoice and prior to the County's issuance of such certificate. Where the County cannot issue an estoppel certificate, Owner shall pay the County within thirty (30) calendar days of receipt of a County invoice.

8. Owner shall not change any BMPs identified in the WQMP without an amendment to this Agreement approved by authorized representatives of both the County and the Owner.

9. County and Owner shall comply with all applicable laws, ordinances, rules, regulations, court orders and government agency orders now or hereinafter in effect in carrying out the terms of this Agreement. If a provision of this Agreement is terminated or held to be invalid, illegal or unenforceable, the validity, legality and enforceability of the remaining provisions shall remain in full effect.

10. In addition to any remedy available to County under this Agreement, if Owner violates any term of this Agreement and does not cure the violation within the time already provided in this Agreement, or, if not provided, within thirty (30) calendar days, or within such time authorized by the County if said cure reasonably requires more than the subject time, the County may bring an action at law or in equity in a court of competent jurisdiction to enforce compliance by the Owner with the terms of this Agreement. In such action, the County may recover any damages to which the County may be entitled for the violation, enjoin the violation by temporary or permanent injunction without the necessity of proving actual damages or the inadequacy of otherwise available legal remedies, or obtain other equitable relief, including, but not limited to, the restoration of the Property and/or the BMPs identified in the WQMP to the condition in which it/they existed prior to any such violation or injury.

11. This Agreement shall be recorded in the Office of the Recorder of San Bernardino County, California, at the expense of the Owner and shall constitute notice to all successors and assigns of the title to said Property of the obligation herein set forth, and also a lien in such amount as will fully reimburse the County, including interest as herein above set forth, subject to foreclosure in event of default in payment.

12. In event of legal action occasioned by any default or action of the Owner, or its successors or assigns, then the Owner and its successors or assigns agree(s) to hold the County harmless and pay all costs incurred by the County in enforcing the terms of this Agreement, including reasonable attorney's fees and costs, and that the same shall become a part of the lien against said Property.

13. It is the intent of the parties hereto that burdens and benefits herein undertaken shall constitute covenants that run with said Property and constitute a lien there against.

14. The obligations herein undertaken shall be binding upon the heirs, successors, executors, administrators and assigns of the parties hereto. The term "Owner" shall include not only the present Owner, but also its heirs, successors, executors, administrators, and assigns. Owner shall notify any successor to title of all or part of the Property about the existence of this Agreement. Owner shall provide such notice prior to such successor obtaining an interest in all or part of the Property. Owner shall provide a copy of such notice to the County at the same time such notice is provided to the successor.

15. Time is of the essence in the performance of this Agreement.

16. Any notice to a party required or called for in this Agreement shall be served in person, or by deposit in the U.S. Mail, first class postage prepaid, to the address set forth below. Notice(s) shall be deemed effective upon receipt, or seventy-two (72) hours after deposit in the U.S. Mail, whichever is earlier. A party may change a notice address only by providing written notice thereof to the other party.

17. Owner agrees to indemnify, defend (with counsel reasonably approved by the County) and hold harmless the County and its authorized officers, employees, agents and volunteers from any and all claims, actions, losses, damages, and/or liability arising out of this Agreement from any cause whatsoever, including the acts, errors or omissions of any person and for any costs or expenses incurred by the County on account of any claim except where such indemnification is prohibited by law. This indemnification provision shall apply regardless of the existence or degree of fault of indemnitees. The Owner's indemnification obligation applies to the County's "active" as well as "passive" negligence but does not apply to the County's "sole negligence" or "willful misconduct" within the meaning of Civil Code Section 2782, or to any claims, actions, losses, damages, and/or liabilities, to the extent caused by the acts or omissions of any third party contractors undertaking any work (other than field inspections) or other maintenance on the Property on behalf of the County under this Agreement..

IF TO COUNTY :

Director of Public Works

825 E. Third Street, Room 117

San Bernardino, CA 92415-0835

IF TO OWNER:

_____

_____

_____

IN WITNESS THEREOF, the parties hereto have affixed their signatures as of the date first written above.

OWNER:

Company/Trust:_____

Signature: _____

Name: _____

Title: _____

Date: _____

OWNER:

Company/Trust:_____

Signature: _____

Name: _____

Title: _____

Date: _____

FOR: Maintenance Agreement, dated _____, for the project known as ___APN 0349-182-11__ _____ (APN)__0349-182-11_____, As described in the WQMP dated _____.

NOTARIES ON FOLLOWING PAGE

A notary acknowledgement is required for recordation.

ACCEPTED BY:

BRENDON BIGGS, M.S., P.E., Director of Public Works

Date: _____

Attachment: Notary Acknowledgement

ATTACHMENT 1
Notary Acknowledgement)

EXHIBIT A
(Legal Description)

EXHIBIT B
(Map/illustration)

6.4 Other Supporting Documentation

- BMP Educational Materials
- Infiltration Test/ Soils report

Educational Materials Included

The following is a list of educational materials included in this WQMP.

- Home & Garden
- Landscape Maintenance
- SC-60 Housekeeping Practices
- SD-11 Roof Runoff Controls
- SD-12 Efficient Irrigation
- SD-32 Trash enclosure
- Storm tech system

STORMWATER Pollution Prevention

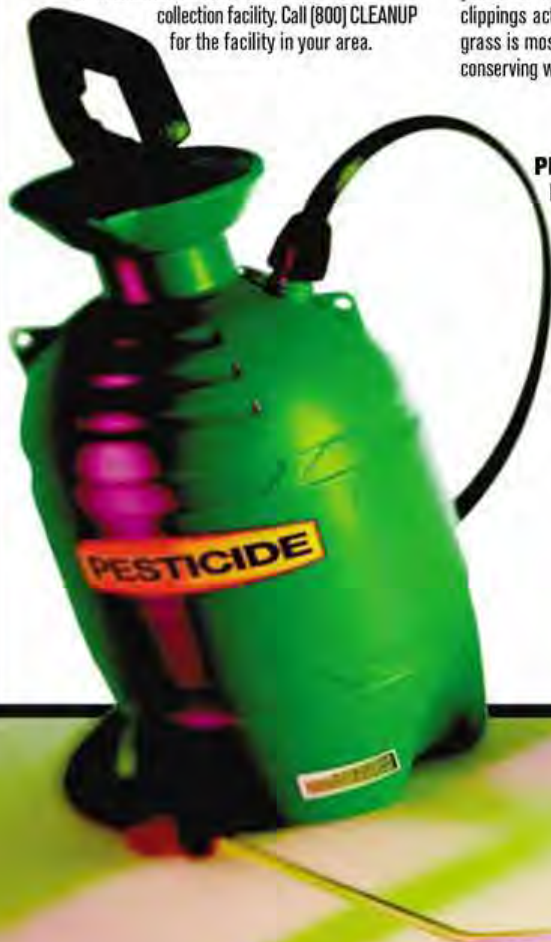
HOME & GARDEN

Yard waste and household toxics like paints and pesticides often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health.

Recycle Household Hazardous Waste
Household products like paint, pesticides, solvents and cleaners are too dangerous to dump and too toxic to trash. Take them to be recycled at a convenient household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.

Disposing of Yard Waste
Recycle leaves, grass clippings and other yard waste, instead of blowing, sweeping or hosing into the street. Try grasscycling, leaving grass clippings on your lawn instead of using a grass catcher. The clippings act as a natural fertilizer, and because grass is mostly water, it also irrigates your lawn, conserving water.

Use Fertilizers & Pesticides Safely
Fertilizers and pesticides are often carried into the storm drain system by sprinkler runoff. Try using organic or non-toxic alternatives. If you use chemical fertilizers or pesticides, avoid applying near curbs and driveways and never apply before a rain.



Planting in the Yard
Produce less yard waste and save water by planting low maintenance, drought-tolerant trees and shrubs. Using drip irrigation, soaker hoses or micro-spray systems for flower beds and vegetation can also help reduce your water bill and prevent runoff.

Use Water Wisely
Cut your water costs and prevent runoff by controlling the amount of water and direction of sprinklers. The average lawn needs about an inch of water a week, including rainfall, or 10 to 20 minutes of watering. A half-inch per week is enough for fall and spring. Sprinklers should be on long enough to allow water to soak into the ground but not so long as to cause runoff.

To report illegal dumping call

(877) WASTE18

sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION

Commercial landscape maintenance:

Yard waste, sediments and toxic lawn and garden chemicals used in commercial landscape maintenance often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates local waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution, protect public health and avoid fines or legal action.

- **Recycle Yard Waste:** Recycle leaves, grass clippings and other yard waste. Do not blow, sweep, rake or hose yard waste into the street. Let your customers know about grass cycling --the natural recycling of grass by leaving clippings on the lawn when mowing instead of using a grass catcher. Grass clippings will quickly decompose, returning valuable nutrients to the soil. You can get more information at www.ciwmb.ca.gov/Organics.
- **Use Fertilizers, Herbicides & Pesticides Safely:** Fertilizers, herbicides and pesticides are often carried into the storm drain system by sprinkler runoff. Use natural, non-toxic alternatives to traditional garden chemicals. If you must use chemical fertilizers, herbicides, or pesticides spot apply rather than blanketing entire areas, avoid applying near curbs and driveways and never apply before a rain.
- **Recycle Hazardous Waste:** Pesticides, fertilizers, herbicides and motor oil contaminate landfills and should be disposed of through a Hazardous Waste Facility. For information on proper disposal, call (909) 386-8401.
- **Use Water Wisely:** Conserve water and prevent runoff by controlling the amount of water and direction of sprinklers. Sprinklers should be on long enough to allow water to soak into the ground but not so long as to cause runoff. Periodically inspect, fix leaks and realign sprinkler heads.

- **Planting:** Plant native vegetation to reduce the need of water, fertilizers, herbicides and pesticides.
- **Prevent Erosion:** Erosion washes sediments, debris and toxic runoff into the storm drain system, polluting waterways. Prevent erosion and sediment runoff by using ground cover, berms and vegetation down-slope to capture runoff. Avoid excavation or grading during wet weather.

- **Store Materials Safely:** Keep landscaping materials and debris away from the street, gutter and storm drains. On-site stockpiles of materials should be covered with plastic sheeting to protect from rain, wind and runoff.

For more information about how you can prevent stormwater pollution:

www.sbcountystormwater.org

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	☑

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- 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)

Roof Runoff Controls SD-11

Rain Garden

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Description

Various roof runoff controls are available to address stormwater that drains off rooftops. The objective is to reduce the total volume and rate of runoff from individual lots, and retain the pollutants on site that may be picked up from roofing materials and atmospheric deposition. Roof runoff controls consist of directing the roof runoff away from paved areas and mitigating flow to the storm drain system through one of several general approaches: cisterns or rain barrels; dry wells or infiltration trenches; pop-up emitters, and foundation planting. The first three approaches require the roof runoff to be contained in a gutter and downspout system. Foundation planting provides a vegetated strip under the drip line of the roof.

Approach

Design of individual lots for single-family homes as well as lots for higher density residential and commercial structures should consider site design provisions for containing and infiltrating roof runoff or directing roof runoff to vegetative swales or buffer areas. Retained water can be reused for watering gardens, lawns, and trees. Benefits to the environment include reduced demand for potable water used for irrigation, improved stormwater quality, increased groundwater recharge, decreased runoff volume and peak flows, and decreased flooding potential.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Designing New Installations

Cisterns or Rain Barrels

One method of addressing roof runoff is to direct roof downspouts to cisterns or rain barrels. A cistern is an above ground storage vessel with either a manually operated valve or a permanently open outlet. Roof runoff is temporarily stored and then released for irrigation or infiltration between storms. The number of rain

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barrels needed is a function of the rooftop area. Some low impact developers recommend that every house have at least 2 rain barrels, with a minimum storage capacity of 1000 liters. Roof barrels serve several purposes including mitigating the first flush from the roof which has a high volume, amount of contaminants, and thermal load. Several types of rain barrels are commercially available. Consideration must be given to selecting rain barrels that are vector proof and childproof. In addition, some barrels are designed with a bypass valve that filters out grit and other contaminants and routes overflow to a soak-away pit or rain garden.

If the cistern has an operable valve, the valve can be closed to store stormwater for irrigation or infiltration between storms. This system requires continual monitoring by the resident or grounds crews, but provides greater flexibility in water storage and metering. If a cistern is provided with an operable valve and water is stored inside for long periods, the cistern must be covered to prevent mosquitoes from breeding.

A cistern system with a permanently open outlet can also provide for metering stormwater runoff. If the cistern outlet is significantly smaller than the size of the downspout inlet (say ¼ to ½ inch diameter), runoff will build up inside the cistern during storms, and will empty out slowly after peak intensities subside. This is a feasible way to mitigate the peak flow increases caused by rooftop impervious land coverage, especially for the frequent, small storms.

Dry wells and Infiltration Trenches

Roof downspouts can be directed to dry wells or infiltration trenches. A dry well is constructed by excavating a hole in the ground and filling it with an open graded aggregate, and allowing the water to fill the dry well and infiltrate after the storm event. An underground connection from the downspout conveys water into the dry well, allowing it to be stored in the voids. To minimize sedimentation from lateral soil movement, the sides and top of the stone storage matrix can be wrapped in a permeable filter fabric, though the bottom may remain open. A perforated observation pipe can be inserted vertically into the dry well to allow for inspection and maintenance.

In practice, dry wells receiving runoff from single roof downspouts have been successful over long periods because they contain very little sediment. They must be sized according to the amount of rooftop runoff received, but are typically 4 to 5 feet square, and 2 to 3 feet deep, with a minimum of 1-foot soil cover over the top (maximum depth of 10 feet).

To protect the foundation, dry wells must be set away from the building at least 10 feet. They must be installed in solids that accommodate infiltration. In poorly drained soils, dry wells have very limited feasibility.

Infiltration trenches function in a similar manner and would be particularly effective for larger roof areas. An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives stormwater runoff. These are described under Treatment Controls.

Pop-up Drainage Emitter

Roof downspouts can be directed to an underground pipe that daylights some distance from the building foundation, releasing the roof runoff through a pop-up emitter. Similar to a pop-up irrigation head, the emitter only opens when there is flow from the roof. The emitter remains flush to the ground during dry periods, for ease of lawn or landscape maintenance.

Foundation Planting

Landscape planting can be provided around the base to allow increased opportunities for stormwater infiltration and protect the soil from erosion caused by concentrated sheet flow coming off the roof. Foundation plantings can reduce the physical impact of water on the soil and provide a subsurface matrix of roots that encourage infiltration. These plantings must be sturdy enough to tolerate the heavy runoff sheet flows, and periodic soil saturation.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Supplemental Information

Examples

- City of Ottawa's Water Links Surface –Water Quality Protection Program
- City of Toronto Downspout Disconnection Program
- City of Boston, MA, Rain Barrel Demonstration Program

Other Resources

Hager, Marty Catherine, Stormwater, "Low-Impact Development", January/February 2003. www.stormh2o.com

Low Impact Urban Design Tools, Low Impact Development Design Center, Beltsville, MD. www.lid-stormwater.net

Start at the Source, Bay Area Stormwater Management Agencies Association, 1999 Edition

Efficient Irrigation SD-12

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Irrigation water provided to landscaped areas may result in excess irrigation water being conveyed into stormwater drainage systems.

Approach

Project plan designs for development and redevelopment should include application methods of irrigation water that minimize runoff of excess irrigation water into the stormwater conveyance system.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Designing New Installations

The following methods to reduce excessive irrigation runoff should be considered, and incorporated and implemented where determined applicable and feasible by the Permittee:

- Employ rain-triggered shutoff devices to prevent irrigation after precipitation.
- Design irrigation systems to each landscape area's specific water requirements.
- Include design featuring flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.
- Implement landscape plans consistent with County or City water conservation resolutions, which may include provision of water sensors, programmable irrigation times (for short cycles), etc.

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- Design timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the storm water drainage system.
- Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider design features such as:
  - Using mulches (such as wood chips or bar) in planter areas without ground cover to minimize sediment in runoff
  - Installing appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant materials where possible and/or as recommended by the landscape architect
  - Leaving a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible
  - Choosing plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth
- Employ other comparable, equally effective methods to reduce irrigation water runoff.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

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

Trash Storage Areas SD-32

Description

Trash storage areas are areas where a trash receptacle (s) are located for use as a repository for solid wastes. Stormwater runoff from areas where trash is stored or disposed of can be polluted. In addition, loose trash and debris can be easily transported by water or wind into nearby storm drain inlets, channels, and/or creeks. Waste handling operations that may be sources of stormwater pollution include dumpsters, litter control, and waste piles.

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Approach

This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff associated with trash storage and handling. Preventative measures including enclosures, containment structures, and impervious pavements to mitigate spills, should be used to reduce the likelihood of contamination.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Design requirements for waste handling areas are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Hazardous waste should be handled in accordance with legal requirements established in Title 22, California Code of Regulation.

Wastes from commercial and industrial sites are typically hauled by either public or commercial carriers that may have design or access requirements for waste storage areas. The design criteria in this fact sheet are recommendations and are not intended to be in conflict with requirements established by the waste hauler. The waste hauler should be contacted prior to the design of your site trash collection areas. Conflicts or issues should be discussed with the local agency.

Designing New Installations

Trash storage areas should be designed to consider the following structural or treatment control BMPs:

- Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This might include berming or grading the waste handling area to prevent run-on of stormwater.
- Make sure trash container areas are screened or walled to prevent off-site transport of trash.

- Use lined bins or dumpsters to reduce leaking of liquid waste.
- Provide roofs, awnings, or attached lids on all trash containers to minimize direct precipitation and prevent rainfall from entering containers.
- Pave trash storage areas with an impervious surface to mitigate spills.
- Do not locate storm drains in immediate vicinity of the trash storage area.
- Post signs on all dumpsters informing users that hazardous materials are not to be disposed of therein.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Maintenance Considerations

The integrity of structural elements that are subject to damage (i.e., screens, covers, and signs) must be maintained by the owner/operator. Maintenance agreements between the local agency and the owner/operator may be required. Some agencies will require maintenance deed restrictions to be recorded of the property title. If required by the local agency, maintenance agreements or deed restrictions must be executed by the owner/operator before improvement plans are approved.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

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

StormTech®

Detention • Retention • Recharge

Subsurface Stormwater Management℠

Isolator™ Row O&M Manual

StormTech® Chamber System for Stormwater Management

1.0 The Isolator™ Row

1.1 INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patent pending technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

1.2 THE ISOLATOR™ ROW

The Isolator Row is a row of StormTech chambers, either SC-740 or SC-310 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

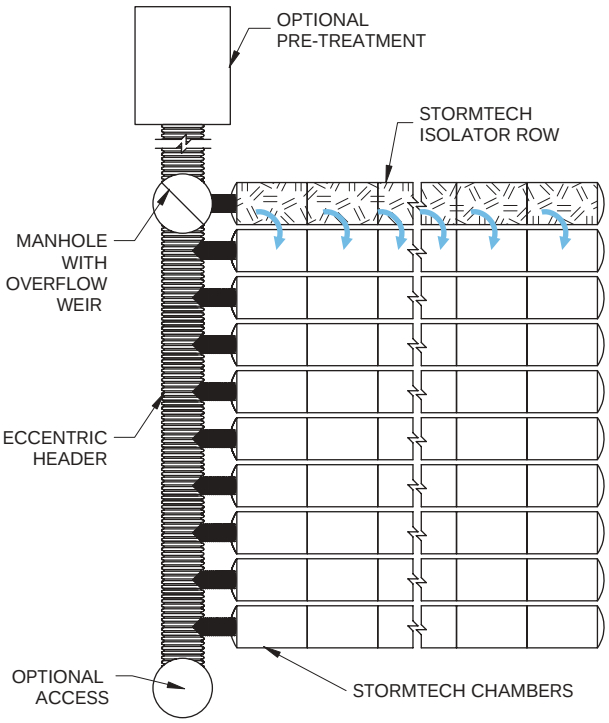
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

StormTech Isolator Row with Overflow Spillway
(not to scale)



2.0 Isolator Row Inspection/Maintenance

2.1 INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

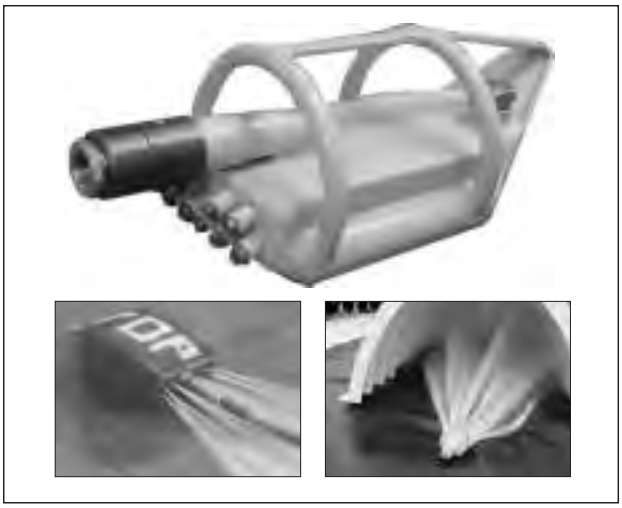
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

2.2 MAINTENANCE

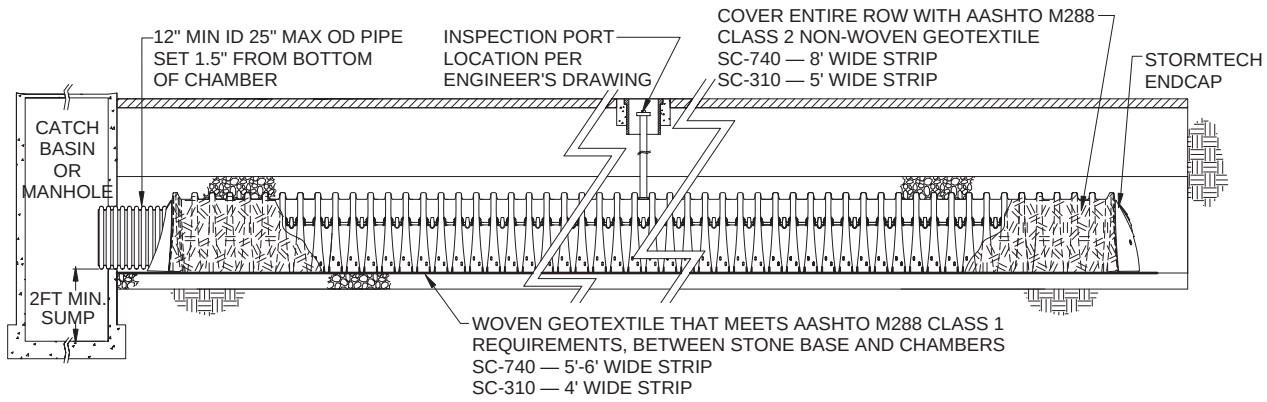
The Isolator Row was designed to reduce the cost of periodic maintenance. By “isolating” sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.



Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45” are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)



3.0 Isolator Row Step By Step Maintenance Procedures

Step 1) Inspect Isolator Row for sediment

A) Inspection ports (if present)

i. Remove lid from floor box frame

ii. Remove cap from inspection riser

iii. Using a flashlight and stadia rod, measure depth of sediment and record results on maintenance log.

iv. If sediment is at, or above, 3 inch depth proceed to Step 2. If not proceed to step 3.

B) All Isolator Rows

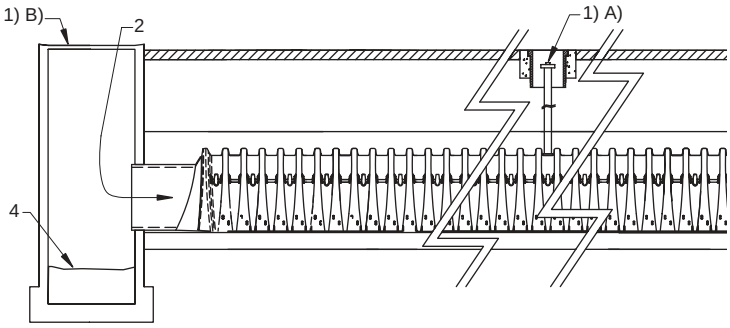
i. Remove cover from manhole at upstream end of Isolator Row

ii. Using a flashlight, inspect down Isolator Row through outlet pipe

1. Mirrors on poles or cameras may be used to avoid a confined space entry
2. Follow OSHA regulations for confined space entry if entering manhole

iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches) proceed to Step 2. If not proceed to Step 3.

StormTech Isolator Row (not to scale)



Step 2) Clean out Isolator Row using the JetVac process

A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable

B) Apply multiple passes of JetVac until backflush water is clean

C) Vacuum manhole sump as required

Step 3) Replace all caps, lids and covers, record observations and actions

Step 4) Inspect & clean catch basins and manholes upstream of the StormTech system

Sample Maintenance Log

Date	Stadia Rod Readings		Sediment Depth (1) - (2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/01	6.3 ft.	none		New installation. Fixed point is CI frame at grade	djm
9/24/01		6.2	0.1 ft.	Some grit felt	sm
6/20/03		5.8	0.5 ft.	Mucky feel, debris visible in manhole and in Isolator row, maintenance due	rv
7/7/03	6.3 ft.		0	System jetted and vacuumed	djm

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GEOTECHNICAL ENGINEERING REPORT

PROPOSED FUELING STATION AND MARKET

CAJON BLVD, GLEN HELEN, CA

APN: 0349-182-11-0000

Prepared for

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January 30, 2022

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APPENDICES

1.0 INTRODUCTION

Geo-Cal, Inc. (**GCI**) has prepared this Geotechnical Engineering Report for a new gas station proposed to be located on the southwest side of Cajon Blvd opposite Park Ave in the Glen Helen area of San Bernardino County, California (**Figure 1**). The Site APN is 0349-182-11-0000. The Site coordinates are Latitude 34.219, Longitude -117.402.

1.1 Project Considerations

Based on information provided to this office, it is our understanding that the Project will include construction of a convenience store and a QSR with a drive thru, two fueling stations, one with 6 MPD's for truck fueling and a second with 6 MPD's for fueling regular vehicles, two steel canopies, three aboveground storage tanks (20,000-gallon capacity, each) and associated piping, traffic access and parking pavements, walkways, landscaping, and signage.

Structures of wood or metal frame, reinforced masonry, or similar type construction with slab-on-grade were anticipated. Based upon the type of construction, foundation loads are not anticipated to exceed 1,500 pounds per linear foot for continuous footings and 20 kips for individual spread footings. Drilled pier type foundations are anticipated for the fuel canopy and pole sign(s).

At the time of this investigation, the project grading plans were not yet completed. Conventional cut and fill site grading has been assumed with the maximum depth of both the proposed cut and fill to be less than five feet. Because aboveground storage tanks are proposed, the 15 to 20 feet deep excavation normally assumed for underground storage tanks was not anticipated.

The above assumptions were used as the basis for the exploration, testing, and analysis programs, and for the recommendations contained in this Report. If the anticipated foundation loading or other Site improvements vary significantly from those stated herein, then the recommendations should be reconfirmed prior to completing Project plans.

1.2 Purpose and Scope of Services

The purpose of **GCI**'s services was to explore and evaluate the subsurface soil conditions at the Site in order to provide preliminary geotechnical engineering conclusions and recommendations relative to the proposed development. **GCI**'s scope of services included a geotechnical Site reconnaissance, drilling and sampling of five test borings (35 ft max), laboratory testing including corrosivity, geotechnical engineering analyses of the boring and test data, seismic design values, and a discussion of findings and recommendations in this Report. Percolation testing for BMP infiltration was conducted in two of the borings.

This Report provides geotechnical recommendations for design and construction of the proposed development, including Site preparation and grading criteria, foundation design and lateral earth pressures, estimated settlements, expansive soils, soil corrosivity, preliminary on-site pavement structural section design, and BMP infiltration.

2.0 SITE DESCRIPTION

The subject Site consists of a 1.4 acre vacant lot, approximately trapezoidal in shape, as shown on the Site Satellite Photo attached as **Figure 2**. At the time of this investigation, topography of the Site was near planar with a slight slope to the south east. The surface of the Site was disturbed and irregular with cobbles and boulders. The elevation near the center of the Site was about 2,040 feet. Vegetation included a slight growth of weeds across the Site and 3 trees along the south east property line. A minor amount of scattered trash and debris were seen at the Site.

3.0 FIELD INVESTIGATION

As part of the field investigation, a geotechnical field reconnaissance of the Site and surrounding areas was performed by the project engineer. The general configuration of the Site, Site topography and drainage characteristics, and surface conditions were noted and photographs were taken.

Subsurface exploration consisted of drilling and sampling five exploratory hollow-stem auger test borings to a maximum depth of 35 feet below the existing ground surface with a Mobil B-61 drill rig equipped with an automatic hammer for soil sampling. The approximate locations of the test borings are shown on **Figure 2**.

Bulk (disturbed) samples of the subsurface soils were obtained from spoil generated during drilling for classification and testing purposes. They represent mixtures of soils within the noted depth intervals.

Standard Penetration Test (SPT) samplers were utilized at 5-foot intervals to the full depth of the borings to provide appropriate SPT data for geotechnical evaluations. The samplers were driven by an automatic lift 140-pound hammer falling 30 inches (ASTM D 1586). The raw number of blows required to drive the sampler 18 inches was noted in six-inch increments, or portion thereof, and recorded on the boring logs.

The materials and conditions encountered were visually/manually classified (USCS) and evaluated by the project engineer. The soil samples were logged and placed in labeled sealed containers for transportation to the laboratories for testing and further evaluation.

The bore holes were backfilled with drill spoils, except for the percolation test borings, where the gravel packed pipe was left in place.

Logs of the exploratory borings are included in **Appendix A**. They represent **GCI**'s interpretation of the field logs prepared for each location by the project engineer, along with an interpretation of soil conditions between samples. While the noted stratification lines represent approximate boundaries between soil types, the actual transitions may be gradual.

4.0 LABORATORY TESTING

Included in the laboratory testing program were field moisture content determinations of all samples (ASTM D 2937). The results are included on the boring logs in **Appendix A**.

Sieve analyses were conducted on selected samples for classification purposes. A maximum dry density-optimum moisture content test (ASTM D 1557) was performed on a selected bulk sample to evaluate the compaction characteristics of the upper soils encountered. The graphs of the laboratory test results are included in **Appendix B**.

A selected sample of soil was delivered to HDR for soil corrosivity testing including soluble sulfates (CTM 417) and chlorides (CTM 422), minimum resistivity (CTM 643), pH, and for various additional cations and anions. The corrosivity test results are included in **Appendix C**.

5.0 SUBSURFACE SOIL CONDITIONS

Data from the exploratory borings indicate that the soil profile at the Site generally consists of alluvial wash deposits to the maximum depth of 35 feet attained with a disturbed surface. The soils encountered were generally classified as fine to coarse grained poorly graded Sand (SP) with variable gravel/rock fragments up to 1.25" with some poorly graded Sand with silt (SP-SM). **Based on observations and the drill rig response to drilling, the potential for cobbles and boulders exist throughout the Site.**

The SPT data at the 5-foot sample interval indicate that the soils encountered were generally in place in a "loose" state. At the 10-foot sample interval "medium dense" conditions were indicated becoming "dense" and "very dense" with depth.

Compressible soil conditions or soils prone to hydro-consolidation when inundated with water and subjected to surcharge loading were not encountered below the 5-foot sample interval.

All the materials encountered at the Site were granular non-plastic and non-expansive.

The soil corrosivity test results indicate that the soils tested exhibit a "negligible" anticipated exposure to sulfate attack of concrete.

Refusal to further drilling was experienced (bouncing on a boulder) at 9 feet in PB-2.

Bedrock was not encountered.

No ground water or evidence of previous shallow groundwater (mottles) was encountered within any of the exploratory borings to the maximum depth of 35 feet attained.

For seismic design, the appropriate Site soil profile classification is D, "stiff soil", according to the California Building Code (CBC). The ASCE 7-16 seismic design values for the Site are included in **Appendix D.**

6.0 GEOLOGY AND GROUNDWATER

As shown on the attached Geologic Map (**Figure 3**), the site is underlain by Very young wash deposits (Q_{w2}) explained to be unconsolidated, mixed sand, gravel, pebble, cobble, and boulder deposits that form slightly elevated, low terraces within, or along active margins of, active washes (USGS Open-File Report 2006-1217).

No groundwater or evidence of previous shallow groundwater (mottles) was encountered within any of the exploratory borings to the maximum depth of 35 feet attained. Well data provided from Devore Water Company Well No.4, located about 300 feet southwest of the Site, indicated a depth to groundwater of about 150 feet bgs on November 9, 2021. Groundwater is not anticipated to rise within 65 feet of the ground surface.

7.0 LIQUEFACTION AND OTHER GEOLOGIC HAZARDS

Geologic hazards that may affect the proposed development include seismic shaking and other earthquake-related hazards. A Geologic Hazard Map for the area is attached as **Figure 4**.

The Site is not located within a currently delineated CGS Special Studies Zone (formerly known as Alquist-Priolo fault hazard zone). No known or suspected active faults were identified on or near the Site. Therefore, the potential for active fault rupture is considered to be very low.

Potential secondary seismic hazards related to ground shaking include liquefaction, water storage facility failure, ground deformation, areal subsidence, seismically-induced landslides or slope failure, rockfalls, tsunamis, and seiches.

Due to the inland location of the Site, hazards from tsunamis are not of concern. No water storage reservoirs or facilities are located near the Site; therefore, hazards from seiches or storage facility failure are not present.

Because there are no slopes at or near the Site and because there are no slopes proposed, there are no slope stability related hazards.

The Site is not located within a mapped liquefaction hazard zone. Well data provided from Devore Water Company indicated a depth to groundwater of about 150 feet bgs. Therefore, the potential for liquefaction is considered to be low.

Because the Site is located near major active faults and underlain by very young wash deposits, **the potential for seismic settlement was evaluated**.

The differential seismic settlement potential of the improved Site would be greatly minimized by the recommended removal and recompaction of at least the upper five feet of existing soils across essentially the entire Site.

Based on inspection of the SPT data, below about 15 feet the soils were indicated to be sufficiently dense to preclude significant seismic settlements.

Therefore, a thickness of about 5 to 10 feet of medium dense competent natural wash deposits would remain beneath the compacted fill with a limited potential for seismic settlements. Because the amount of settlement tends to be proportional to the thickness, **it appears reasonable to assume that differential seismic settlements up to one inch across 30 feet may occur over the lifetime of the project and the proposed structures should be designed accordingly.**

Because settlement of sand due to foundation loading occurs almost immediately, with the majority occurring during construction, it is our opinion that the estimated static settlements do not need to be combined with the seismic.

8.0 SITE INFILTRATION

Two boring percolation tests were performed in order to provide infiltration rate recommendations for storm water BMP design. The percolation test borings were drilled with 8-inch diameter hollow stem augers to anticipated BMP depths of 5 and 9 feet bgs. The holes were fitted with 3-inch diameter perforated pipe, gravel packed to the surface and filled with water to presoak.

Based on the measured water drop over two 25-minute time intervals, the sandy soil criteria was met and the testing proceeded with water drop measurements at 10-minute intervals for an additional hour.

Both percolation test borings indicated relatively fast infiltration test rates (PB-1 at 5.5 ft was 13.0 in/hr and PB-2 at 9 ft was 12.2 in/hr).

By applying a factor of safety of 3, the design infiltration rates are 4.34 in/hr and 4.07 in/hr for PB-1 and PB-2, respectively.

The percolation test data and calculated results are included in **Appendix E**.

9.0 DISCUSSION AND CONCLUSIONS

Based upon the results of the field and laboratory investigations, it is the opinion of **GCI** that the proposed development is feasible from a geotechnical standpoint, provided the recommendations contained in this Report are followed during design and construction.

9.1 Initial Site Preparation

Because of the disturbed surface conditions observed at the Site and the loose conditions encountered at the 5-ft sample interval of our borings**, a minimum mandatory removal and recompaction of the upper 5 feet of existing soils should be performed across the entire Site** with possible exceptions for shallow infiltration areas. The minimum mandatory removal should help to identify any buried structures and areas of deeper fill or disturbance associated with past land use. By virtue of the minimum mandatory removal and recompaction of the upper 5 feet of existing soils, a continuous compacted fill surface across the Site will provide uniform support for the proposed improvements and excavations.

Based on the considerable amount of oversize material (cobble over 6-inches and boulders) observed at the surface, it follows that significant quantities of oversize material can be encountered in the Site excavations, and, as such, should be considered throughout planning, design, and construction.

9.2 Foundations and Settlement

If the Site is prepared and graded as recommended, conventional spread foundations may be utilized in conjunction with a compacted fill matt to support the proposed structures. The building pad areas will be overexcavated and recompacted to provide to provide at least 36 inches of properly compacted and tested fill beneath footings.

Foundations for the proposed fuel canopy, pole signs, and UST's should be deep enough to bear in competent natural soils observed and approved by the geotechnical consultant. However, excavation difficulties, such as caving, should be anticipated due to the cohesionless nature of the natural sand and gravel wash deposits that likely contain larger clasts (cobbles and boulders).

If the site is properly prepared and the preliminary recommendations for foundation design and construction are followed, we would anticipate maximum settlements on the order of 1/2 inch. Differential settlement may be assumed to be fifty percent of the total settlement.

Based on the recommended minimum removal and recompaction of at least the upper five feet of existing soils across essentially the entire Site, as well as the complete removal and recompaction of any deeper loose soils encountered and because the SPT data of the materials tested below about 15 feet are sufficiently dense to preclude significant seismic settlements, **differential seismic settlements are anticipated to be within acceptable tolerable limits (less than 1 inch across 30 feet)**.

9.3 Infiltration

Based upon the materials and conditions encountered at the Site and the results of the two boring percolation tests, it is the opinion of **GCI** that infiltration BMPs are geotechnically feasible for the Site with a recommended design infiltration rate 4.0 in/hr.

10.0 RECOMMENDATIONS

The following recommendations and applicable portions of the CBC as well as any local ordinances should be followed during Site preparation, design, and construction of the proposed commercial development. An on-Site pre-grade meeting with the developer/owner, contractor, inspector, design civil, and the geotechnical consultant should occur prior to beginning site preparation.

10.1 Site Preparation and Grading

All vegetation, undocumented fill, trash piles, pavements, abandoned underground utilities (if any), and other debris should be removed from the Site. Underground utilities (water, sewer, storm drain, electric, gas, cable, etc.) may be present within or adjacent to the proposed construction area. These utilities should be identified and relocated as required prior to performing excavations for any Site grading or foundation excavations. Depressions resulting from such removals should have debris and loose soils removed and filled with suitable soils placed as recommended below.

Any underground structures, such as septic tanks or seepage pits, should be removed in their entirety, including any brick lining and any liquids or sediment remaining at the bottom of the pits. The void resulting from removal of the seepage pits should be backfilled with a lean 2 sack concrete slurry mix to within 5 feet of proposed final grade or proposed footing elevations. The final 5 feet should consist of compacted fill as described below.

To provide more uniform bearing conditions for the proposed structure foundations and slab-on-grade construction, **GCI** recommends the following:

Undocumented fill should be carefully examined by the geotechnical consultant to determine if the material is suitable for re-use as engineered fill. Materials with significant organics, debris, clay or soluble sulfate contents should be deemed “unsuitable” by the geotechnical consultant and all such materials should be removed from the Site to prevent them from being incorporated in the fill.

A **minimum mandatory removal and recompaction** of the upper 5 feet of existing soils is recommended across the entire Site with exceptions for shallow infiltration areas.

Prior to any fill placement, the geotechnical consultant should be notified to observe and approve the open bottom of the removal excavation.

Once approved, the bottom should be **scarified** (ripped) 6 inches, brought to near optimum moisture content, and be compacted to at least 90 percent relative compaction (ASTM D 1557).

The excavated soils may be reused as compacted fill provided they are processed to remove any deleterious or **oversize** (6"max) materials.

Based on the considerable amount of oversize material (cobble over 6-inches and boulders) observed at the surface, it follows that significant quantities of oversize material can be encountered in the Site excavations, and, as such, should be considered during planning, design, and construction.

Fill materials should be mixed and moisture treated to near optimum moisture content and be uniformly compacted to at least **90% relative compaction** (ASTM D 1557). To help compaction, fill should be spread in horizontal 8-inch thick loose lifts or less. Observation and compaction testing shall be performed by the geotechnical consultant to verify compaction and moisture content.

Import soils should be equal to, or better than, the on-Site soils in strength, expansion, compressibility, and soil chemistry characteristics. In general, import material should be free of organic matter and deleterious substances, have 100% passing a two inch sieve, 60% to 100% passing a #4 sieve, no more than 20% passing a #200 sieve, an Expansion Index less than 20, a Liquid Limit less than 35 and a Plasticity Index less than 12. Import soils shall be observed, (tested if needed), and approved by the geotechnical consultant prior to their use.

Backfill around or adjacent to confined areas (i.e. interior utility trench excavations, etc.) may be performed with a lean sand/cement slurry (minimum two sacks of cement per cubic yard) or may be performed using "self-compacting" pea gravel subject to approval by the geotechnical consultant.

Shrinkage due to excavation and compaction of the upper Site soils is estimated to be between approximately 10 to15 percent. In addition, subsidence on the order of 0.1 foot may occur due to densification of the underlying natural soils. **Losses from the removal of oversize cobbles (6" max) and boulders**, and Site clearing operations should also be considered when estimating earthwork quantities.

10.2 Excavations

Standard construction techniques should be sufficient for Site excavations. All excavations should be made in accordance with applicable regulations (including CAL/OSHA). The Site soil conditions of the existing compacted fill are classified as Type "C" according to CAL/OSHA. Project safety is the responsibility of the contractor. **GCI** will not be responsible for project safety.

Cohesionless (non-cemented) sands with the tendency to cave or flow were encountered and should be considered with means of mitigation prior to excavation.

Open excavations may be cut vertically to a maximum depth of no more than four feet. Excavations extending between four and ten feet deep in compacted fill should be shored or sloped back from the base of the excavation to at least a 1.5 horizontal to 1 vertical (1.5H:1V) slope or flatter. If excavations dry out, sloughing may occur. No excavation should be made within a 1:1 line projected outward from the toe of any existing footing or structure.

During the time excavations are open, no heavy grading equipment or other surcharge loads should be allowed within a horizontal distance from the top of any slope equal to the depth of the excavation. Adequate measures should be taken to protect any structural foundations, pavements, or utilities adjacent to any excavations.

10.3 Utility Trenches

Standard construction techniques should be sufficient for utility trench excavations made in the compacted fill associated with the recommended minimum mandatory removal and recompaction of the top 5 feet of existing soil.

Deeper trenches, made in the underlying natural wash deposits which were found to be **cohesionless (non-cemented) sands and gravels (with possible cobbles and boulders) that tend to cave, run, or flow and, as such, should be considered with means of mitigation prior to excavation.**

It is recommended that utility trench backfill be mixed and moisture conditioned to near optimum moisture content, and be uniformly compacted to at least **90%**relative compaction (ASTM D1557).

In AC pavement areas, the top 6 inches of trench backfill and all base material shall be brought to near optimum moisture content and compacted to at least 95% relative compaction.

To help obtain compaction, trench backfill should be placed in horizontal 6-inch loose lifts or less. Thinner lifts should be utilized with hand operated equipment. Jetting of utility trench backfill is not recommended.

Backfill operations should be observed and compaction tested by the geotechnical consultant to verify conformance with these recommendations.

10.4 Foundation Preparation

Foundations for the proposed building structures shall be supported by a minimum 3-foot thickness of compacted soils prepared as recommended in this Report. In areas where the

minimum mandatory removal and recompaction of the upper 5 feet of existing soil does not meet the minimum compacted fill matt thickness, the building pad areas shall be further subexcavated to provide at least 3 feet of compacted fill beneath footings to a lateral over-excavation distance of 5 feet beyond footing lines, where possible.

Foundations for the proposed canopy, pole signs, and UST's should be deep enough to bear in competent undisturbed natural wash deposits observed and approved by the geotechnical consultant. Cohesionless (non-cemented) sands with the tendency to cave or flow were encountered and, as such, the need for mitigation measures should be anticipated for deep foundation excavations. Excavation/drilling difficulties associated with possible cobbles and boulders should also be considered.

Excavations for foundations should be cleaned of all loose soils and debris prior to placement of concrete.

All foundation excavations shall be observed and approved in writing by the geotechnical consultant prior to steel placement.

10.5 Foundation Design

The proposed building structures may be safely supported by conventional shallow foundations, either continuous wall footings and/or individual spread footings bearing on a minimum of 36 inches of properly compacted and tested fill.

Foundations for the proposed fuel canopy, pole signs, and UST's should be deep enough to bear in competent observed and approved natural soils.

Footings should be at least a minimum of 12 inches wide and should bear at a minimum depth of at least 18 inches below lowest adjacent final subgrade level. For the minimum width and depth, footings may be designed for a **maximum allowable bearing pressure of 2,000** pounds per square foot (psf) for dead plus sustained live loads. The allowable bearing capacity may be increased by 250 psf for each additional foot of width and by 500 psf for each additional foot of depth to a maximum safe soil bearing pressure of 4,000 psf for dead plus live loads. These values may be increased by 1/3 when transient loads (such as wind and seismic forces) are included.

Resistance to lateral loading will be provided by passive earth pressure and friction acting along the foundation base. For foundations bearing against compacted fill, a passive earth pressure of 350 psf per foot of depth may be utilized. A base friction coefficient of 0.35 may be used with dead loads. Base friction and passive resistance may be combined without reduction.

For footings designed and constructed as recommended, we would anticipate a maximum static settlement on the order of 1/2 inch. Differential settlement can be assumed to be approximately half the total settlement.

10.6 Slab-on-Grade Construction

Interior and exterior building concrete slab-on-grade construction should be supported by compacted soils prepared as recommended in this Report. The minimum thickness of concrete floor slab supported directly on the ground shall not be less than 6 inches.

It is recommended that all interior and exterior building concrete slab-on-grade construction be reinforced with at least #4 bars on 16-inch centers, each way. Reinforcement should be placed at mid-depth of the slab. The floor slabs should be quarter-sawn and isolated from stem wall foundations with a minimum 3/8-inch thick felt expansion joint.

Nominal eight-inch (8") thick (minimum) concrete slabs should be provided for **traffic aprons, island slabs, and driveways** and reinforced and isolated in the same manner as building floors. In addition, a grade beam at least 12 inches in width and at least 18 inches below the lowest adjacent soil grade should be provided across the traffic entrances.

Actual reinforcement requirements will be dependent on the governing building code, and requirements of the structural engineer.

A modulus of subgrade reaction ("k" value) of 350 psi/inch may be assumed for design of slab-on-grade provided the subgrade soils are prepared and compacted as recommended in this Report.

In areas of moisture sensitive floor coverings, an appropriate **vapor retarder** should be installed in order to minimize vapor transmission from the subgrade soil to the slab. The vapor retarder should be centered within a 4-inch thick sand layer. The vapor retarder should be evaluated for holes and/or punctures, and the edges overlapped and taped, prior to placement of sand. Any holes or punctures observed should be properly repaired. The 2 inches of sand cover should be lightly moistened and densified just prior to placing the concrete.

Relatively impervious floor coverings (i.e. vinyl, linoleum, etc.) that cover concrete slab-on-grade may block the passage of moisture vapor through the concrete slab, which could result in damage to the floor covering. It is suggested that after the concrete slab has sufficiently cured, the concrete slab surface be sealed with a commercial sealant prior to placing the floor covering. The compatibility and recommendations for placing of the concrete sealer, mastic, and floor covering should be verified by the floor covering manufacturer prior to sealing the concrete or placing of the floor covering. Cracks that develop in concrete slab-on-grade should be filled and sealed prior to placing floor coverings. Frequent control joints should be incorporated into the slab construction, particularly in the areas of re-entrant corners, to help control cracking.

10.7 Lateral Earth Pressures, Shoring, and Retaining Walls

Resistance to lateral loading will be provided by passive earth pressure and friction acting along the foundation base. For footings bearing against compacted fill, a passive earth pressure of 350 psf per foot of depth may be utilized. A base friction coefficient of 0.35 may be used with dead loads. Base friction and passive resistance may be combined without reduction.

For preliminary retaining wall and shoring design, an "active" equivalent fluid pressure of 35pcf may be assumed for cantilever (unrestrained) conditions and an "at-rest" lateral equivalent fluid pressure of 55 pcf may be assumed for braced conditions.

These values should be verified prior to construction when the actual materials and conditions have been determined and are applicable only to properly drained level backfill with no additional surcharge loading.

Because the cohesionless sands (with gravel, cobble and possible boulders) encountered tend to cave, the need for shoring should be considered for the UST excavation. Shoring may be designed assuming no cohesion (C=0 psf) and a friction angle of 33 degrees to model the shear strength of the natural wash deposits.

Surcharge may be treated as additional height of backfill by assuming 1 additional foot for each 125 psf of areal surcharge.

Foundation concrete should be placed in neat excavations with vertical sides, or the concrete should be formed and the excavations properly backfilled as recommended.

10.8 Expansive Soil

Because all the materials encountered at the Site were granular non-plastic and considered to be non-expansive, design and construction measures specifically to mitigate the effects of expansive soils are not anticipated at this time.

Additional evaluation of soils for expansion potential should be conducted by the geotechnical consultant during construction.

10.9 Preliminary AC Pavement Sections

For preliminary planning purposes, the following asphalt concrete (AC) structural section designs were calculated based on an assumed R-value of 50 and assumed Traffic Indexes (T.I.'s) of 4 for automobile areas and 6.5 for the truck areas:

Auto Areas: 0.25' (3") AC over 0.33' (4") AB

Truck Areas: 0.33' (4") AC over 0.50' (6") AB

The aggregate base (AB) should have an R-value of at least 78. The AB and the top 6 inches of soil subgrade should be compacted to at least 95% relative compaction (ASTM D 1557).

The pavement structural section designs are predicated upon proper site preparation and compaction of utility trenches as recommended with the **upper 6 inches of subgrade soils and all base materials being compacted to at least 95 percent of maximum dry density** (ASTM D 1557).

The actual pavement sections should be determined during construction and based on R-value testing of the actual subgrade soil.

10.10 Soil Corrosivity

A selected sample of near-surface soil was delivered to HDR for a suite of Caltrans soil corrosivity tests including soluble sulfates and chlorides, and resistivity.

The **soluble sulfate** results (5.1 ppm) indicate a "**negligible**" anticipated exposure to sulfate attack of concrete of which no special design or construction measures, such as special cement types or water to cement ratios, are needed.

The results of the **soluble chlorides** (8.5 ppm) are categorized as "**not corrosive**" to ferrous materials.

The **minimum resistivity** results (18,800 ohm-cm) are categorized as "**not corrosive**" to normal grade steel.

A **pH** of 7.8 "**not corrosive**" was determined for the soil tested.

The soil corrosivity test results are provided in **Appendix C** and should be distributed to the design team for their interpretations pertaining to the corrosivity or reactivity of various construction materials with the soils.

Additional testing can be conducted during construction on the actual soils to be in contact with the item or material of concern, especially if fill is imported.

10.11 Infiltration

Based on the boring percolation infiltration test rates and using a Factor of Safety of 3, a design infiltration rate of 4.0 in/hr is recommended.

The final BMP design should be reviewed by the geotechnical consultant.

The geotechnical consultant should be notified for observation of the open BMP excavation in order to verify soil conditions and provide additional recommendations, if needed.

Foundations should be set back at least 8 feet from the BMP limits.

Equipment should be kept away from shallow infiltration BMP areas during grading.

11.0 LIMITATIONS AND CONSTRAINTS

The conclusions and recommendations submitted in this Report relative to the proposed development are based, in part, upon the data obtained from Site observations during the field exploration operations, and past experience. The nature and extent of variations between the borings may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this Report.

In the event of any change in the assumed nature or design of the proposed Project as planned, the conclusions and recommendations contained in this Report shall not be considered valid unless the changes are reviewed and the conclusions of this Report modified or verified in writing. This Report is issued with the understanding that it is the responsibility of **Henry Olivier**, or of his representatives, to insure that the information and recommendations contained in this Report are called to the attention of the architects and engineers for the Project and incorporated into the plan. It is also the responsibility of **Henry Olivier**, or of his representatives, to insure that the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

As the geotechnical engineers for this Project, **GCI** strives to provide its services in accordance with generally accepted geotechnical engineering practices in this community at this time. No warranty or guarantee is expressed or implied. This Report was prepared for the exclusive use of **Henry Olivier** and his authorized agents.

It is recommended that **GCI** 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 specifications. If **GCI** is not accorded the privilege of making this recommended review, it can assume no responsibility for misinterpretation of the recommendations. The scope of current services for this Report did not include any environmental assessment or investigation for the presence or absence of wetlands, or hazardous or toxic materials in the soil, surface water, groundwater or air, on or below or around the Site.

The statements contained in this Report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or the broadening of knowledge. Accordingly, the conclusions of this Report may be invalidated, wholly or partially, by changes outside of **GCI**'s control, and should therefore be reviewed after one year.

This Report was 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 conformance with the recommendations of this Report. Maintaining **GCI** as the geotechnical engineering consultant from beginning to end of this Project will help provide continuity of services.

The recommended services include consultation as required during the final design stages of the Project; review of grading and/or building plans; observation and testing during Site preparation, grading, placement of engineered fill, and backfill of utility trenches; and consultation as required during construction.

13.0 CLOSURE

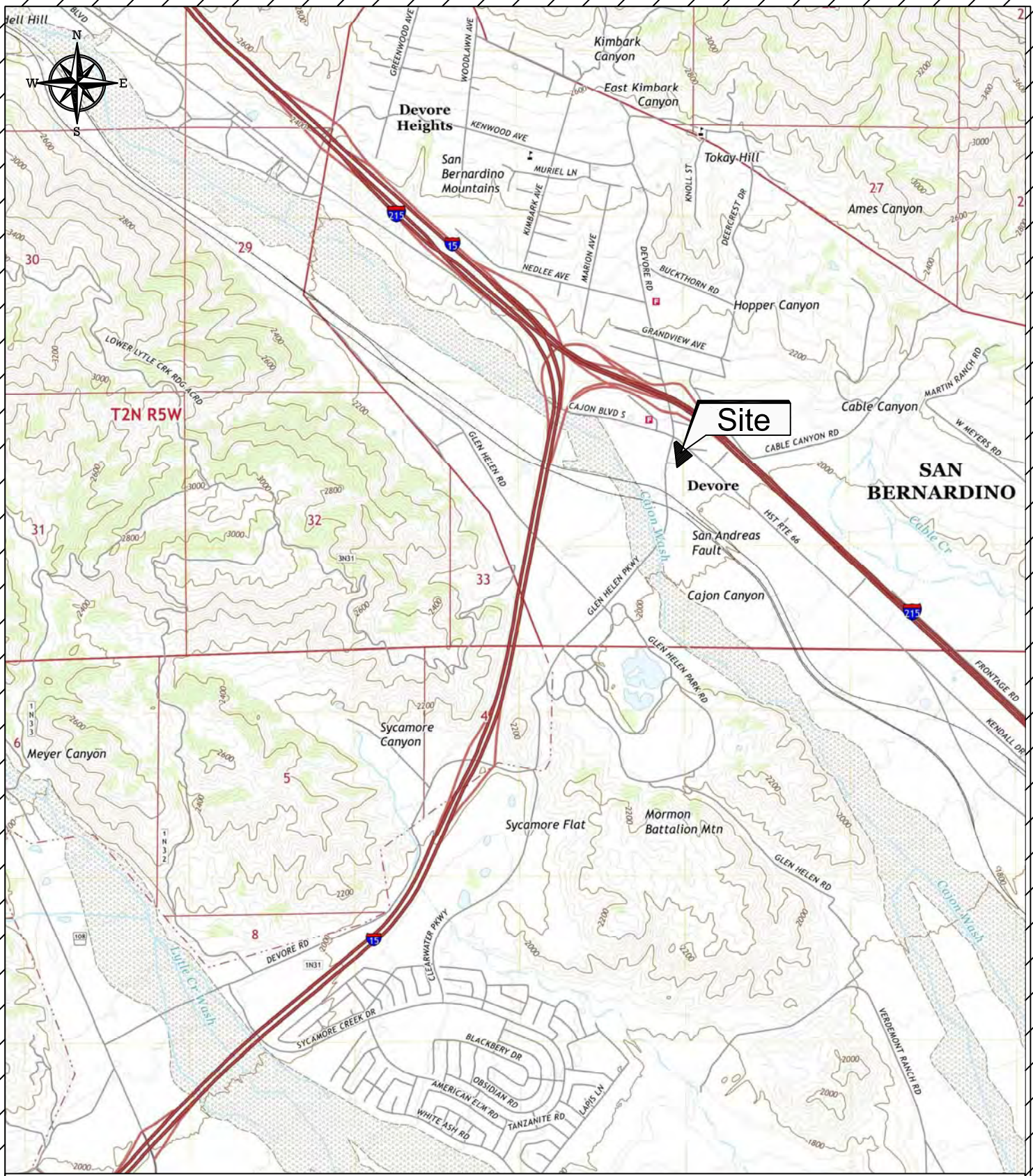
Geo-Cal, Inc. appreciates this opportunity to provide geotechnical engineering services. If there are any questions regarding the information contained in this Report, or if additional geotechnical engineering services are needed, please do not hesitate to contact this office.

Respectfully submitted,

Geo-Cal, Inc.

Todd R. Wyland, RCE 60618
Project Engineer

FIGURES



USGS 7.5 minute Topographic Map Devore Quadrangle

GEO-CAL, INC.
Environmental & Geotechnical Engineering
4370 Hallmark Prkwy. Ste #101
San Bernardino CA 92407

Figure 1
Site Location Map

APN:0349-182-11
Glen Helen, CA

LEGEND:

Site

GEO-CAL, INC.
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4370 Hallmark Prkwy. Ste #101
San Bernardino CA 92407

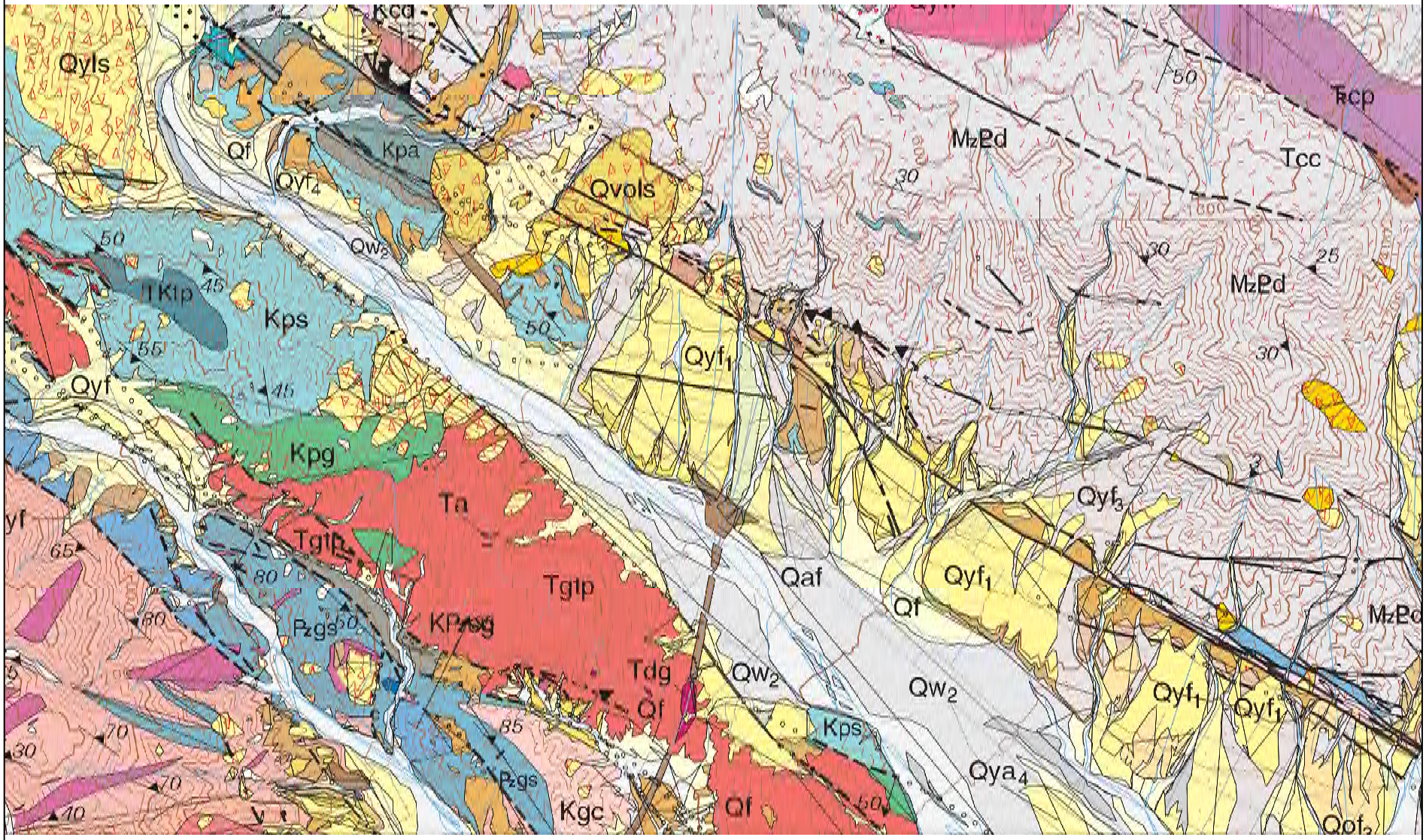
Figure 2
Site Plan Showing Boring Locations

APN:0349-182-11
Glen Helen, CA

Legend: (Locations are approx.)

PB-1 Percolation Boring Location

B-3 Exploratory Location



Reference: USGS Open-File Report 2006-1217

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Figure 3
Geologic Map

APN:0349-182-11
Glen Helen, CA

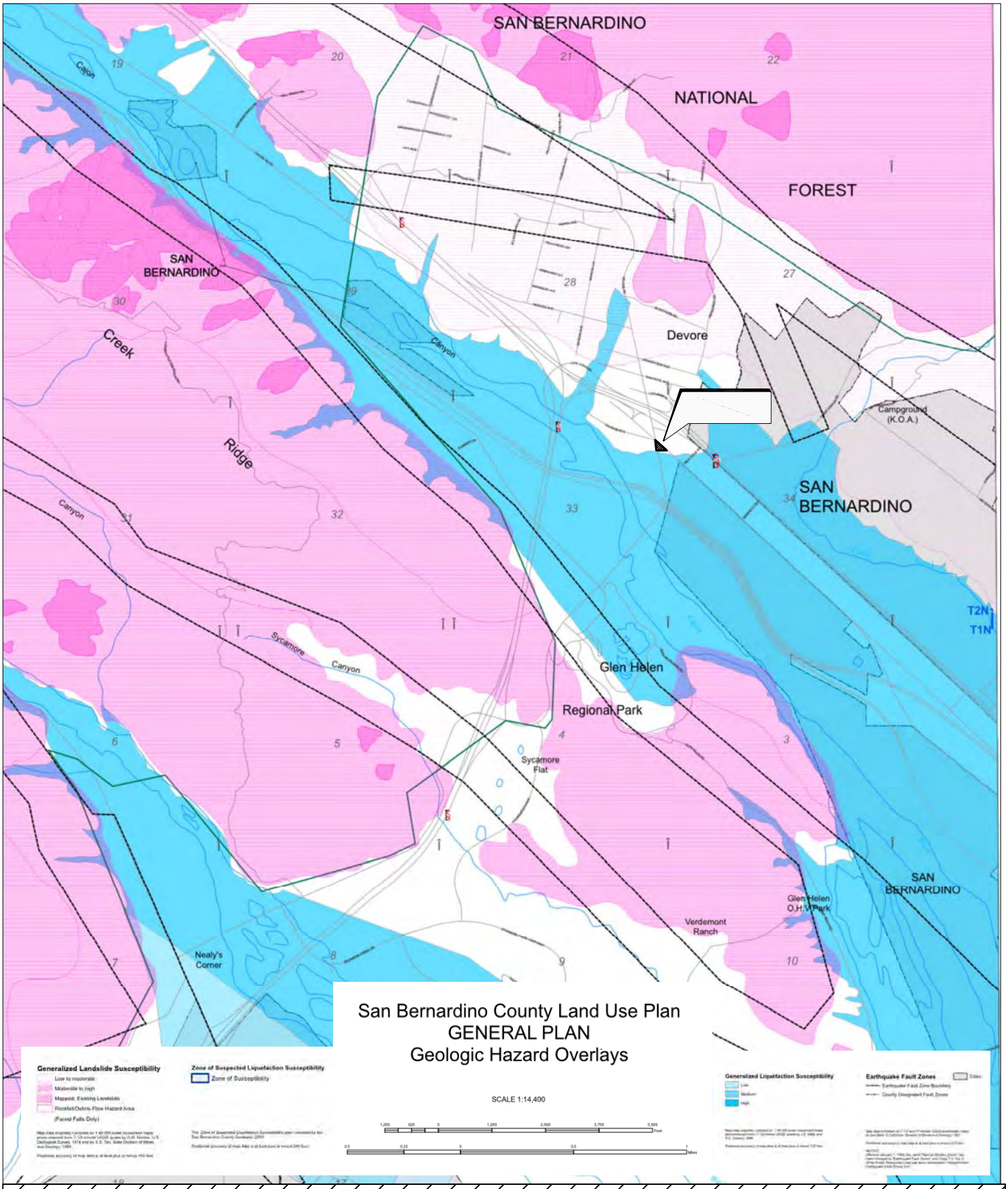

Figure 3
Area Geologic Hazard Map

APN:0349-182-11
Glen Helen, CA

LEGEND:

Site

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San Bernardino CA 92407

APPENDIX A

EXPLORATORY LOGS
(6 PAGES)

Geo-Cal, inc.
Environmental & Geotechnical Engineering
4370 Hallmark Parkway, Suite 101
San Bernardino, CA 92407
(909) 880-1146 FAX (909) 880-1557 email: info@geo-cal.com

LOG OF BORING B-1

Project:
Proposed Gas Station
APN:0349-182-11-0000
Cajon Blvd, Glen Helen, CA

Date: 10-15-2021
Drilled By: Cal-Pac
Equipment: Mobil B-61
Hole Size: 8" HSA
Logged By: Todd Wyland, RCE

Total Depth: 16.5 ft
Groundwater Depth: Not Encountered

*Automatic Hammer
140 lbs 30-Inch Drop

**
SA=Sieve Analysis
MDC=(ASTM D 1557)
COR= Caltrans Corossivity

Depth in Feet	Sample ID	Sample Type R=Ring S=SPT, B=Bulk	Blow Count*/6"	Moisture Content (%)	Dry Density (pcf)	Lab Tests **	Graphic	Description
0	1A (0'-5')	B		1.6				Disturbed Native: (SP-SM)Sand, fine to medium, trace coarse, with Silt and gravel to 1", brown
5	1-1	S	3	1.5				Very young wash deposits-Qw2: (SP) Sand, fine to medium, trace coarse with gravel to 1.5", gray brown, medium dense.
	1B (5'-10')		7 19	1.3				
10	1-2	S	8 11 8	2.2				Same as Above
15	1-3	S	18 25 16	1.4				(SP) Sand, fine to coarse with gravel/rock fragments to 1.25', gray, dense
20								End of Boring Total Depth 16.5' No Refusal No Bedrock No Groundwater Disturbed native to about 3ft. Borehole backfilled with drill spoils
25								
30								

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LOG OF BORING B-2

Project:
Proposed Gas Station
APN:0349-182-11-0000
Cajon Blvd, Glen Helen, CA

Date: 10-15-2021
Drilled By: Cal-Pac
Equipment: Mobil B-61
Hole Size: 8" HSA
Logged By: Todd Wyland, RCE

Total Depth: 35.25 ft
Groundwater Depth: Not Encountered

*Automatic Hammer
140 lbs 30-Inch Drop

**
SA=Sieve Analysis
MDC=(ASTM D 1557)
COR= Caltrans Corossivity

Depth in Feet	Sample ID	Sample Type R=Ring S=SPT, B=Bulk	Blow Count*/6"	Moisture Content (%)	Dry Density (pcf)	Lab Tests **	Graphic	Description
0	2A (0'-5')	B		1.6				Disturbed Native: (SP)Sand, fine to coarse, with gravel to 1/2", brown.
5	2-1	S	5 4 4	1.8				Very young wash deposits-Qw2: (SP-SM) Sand, fine to medium with coarse, silt and gravel to 1.25', brown, loose
10	2-2	S	9 15 12	2.2				Same as Above, medium dense
	2B (10'-15')	B		2.1				
15	2-3	S	11 14 14	2.3				(SP) Sand, fine to coarse with gravel to 3/4", gray, dense.
20	2-4	S	26 29 32	2.4				(SP) Sand, fine to coarse with gravel to 1", gray, very dense.
25	2-5	S	38 50/6"	3.0				(SP) Sand, fine to coarse with gravel to 1", gray, very dense.
30								

Cont. Next Page-------->

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LOG OF BORING 2

Project:
Proposed Gas Station
APN:0349-182-11-0000
Cajon Blvd, Glen Helen, CA

Date: 10-15-2021
Drilled By: Cal-Pac
Equipment: Mobil B-61
Hole Size: 8" HSA
Logged By: Todd Wyland, RCE

Total Depth: 35.25 ft
Groundwater Depth: Not Encountered

*Automatic Hammer
140 lbs 30-Inch Drop

**
SA=Sieve Analysis
MDC=(ASTM D 1557)
COR= Caltrans Corossivity

Depth in Feet	Sample ID	Sample Type R=Ring S=SPT, B=Bulk	Blow Count*/6"	Moisture Content (%)	Dry Density (pcf)	Lab Tests **	Graphic	Description
30	2-6	S	50/6"	2.4				(SW) Sand, fine to coarse, angular, gravel to 1/2", gray, very dense
35	2-7	S	50/3"	2.2				Cobble or boulder? Recovered as white rock chips about 1.25" in diameter, very dense
40								End of Boring Total Depth 35.25' No Refusal No Bedrock No Groundwater Disturbed native to about 3'.
45								
50								
55								Borehole: backfilled with drill spoils
60								

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San Bernardino, CA 92407
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LOG OF BORING B-3

Project:
Proposed Gas Station
APN:0349-182-11-0000
Cajon Blvd, Glen Helen, CA

Date: 10-15-2021
Drilled By: Cal-Pac
Equipment: Mobil B-61
Hole Size: 8" HSA
Logged By: Todd Wyland, RCE

Total Depth: 16.5 ft
Groundwater Depth: Not Encountered

*Automatic Hammer
140 lbs 30-Inch Drop

**
SA=Sieve Analysis
MDC=(ASTM D 1557)
COR= Caltrans Corossivity

Depth in Feet	Sample ID	Sample Type R=Ring S=SPT, B=Bulk	Blow Count*/6"	Moisture Content (%)	Dry Density (pcf)	Lab Tests **	Graphic	Description
0	3A (0'-5')	B		1.9		COR SA MDC		Disturbed Native: (SP) Sand, fine to coarse with gravel to 3/4", brown, 3% fines.
5	3-1	S	3 3 5	2.9				Very young wash deposits-Qw2: (SP-SM) Sand, fine to medium, traces coarse and gravel/rock fragments to 1.25", brown, loose
10	3-2	S	12 7 18	2.6				(SP) Sand, fine to medium, with coarse and gravel /rock fragments to 1.25", gray, medium dense
15	3-3	S	22 23 24	1.4				(SP) Sand, fine to coarse with granitic rock fragments to 1.25", gray, dense
20								End of Boring Total Depth 16.5' No Refusal No Bedrock No Groundwater Hole backfilled with drill spoils
25								
30								

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LOG OF BORING PB-1

Project:
Proposed Gas Station
APN:0349-182-11-0000
Cajon Blvd, Glen Helen, CA

Date: 10-15-2021
Drilled By: Cal-Pac
Equipment: Mobil B-61
Hole Size: 8" HSA
Logged By: Todd Wyland, RCE

Total Depth: 5.5 ft
Groundwater Depth: Not Encountered

*Automatic Hammer
140 lbs 30-Inch Drop

**
SA=Sieve Analysis
MDC=(ASTM D 1557)
COR= Caltrans Corossivity

Depth in Feet	Sample ID	Sample Type R=Ring S=SPT, B=Bulk	Blow Count*/6"	Moisture Content (%)	Dry Density (pcf)	Lab Tests **	Graphic	Description
0	PB1A (0'-5')	B		0.6				Very young wash deposits-Qw2: (SP) Sand, fine to coarse with gravel to 3/4", brown.
5	PB1-1	S	20 50/1"	2.3		SA		(SP-SM) Sand with Silt, fine to coarse with gravel to 3/8", brown, medium dense, 9% fines.
10								End of Boring Total Depth 5.5' No Refusal No Bedrock No Groundwater No Fill 3"-dig perc pipe packed with 3/4" gravel to surface
15								
20								
25								
30								

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LOG OF BORING PB-2

Project:
Proposed Gas Station
APN:0349-182-11-0000
Cajon Blvd, Glen Helen, CA

Date: 10-15-2021
Drilled By: Cal-Pac
Equipment: Mobil B-61
Hole Size: 8" HSA
Logged By: Todd Wyland, RCE

Total Depth: 9 ft
Groundwater Depth: Not Encountered

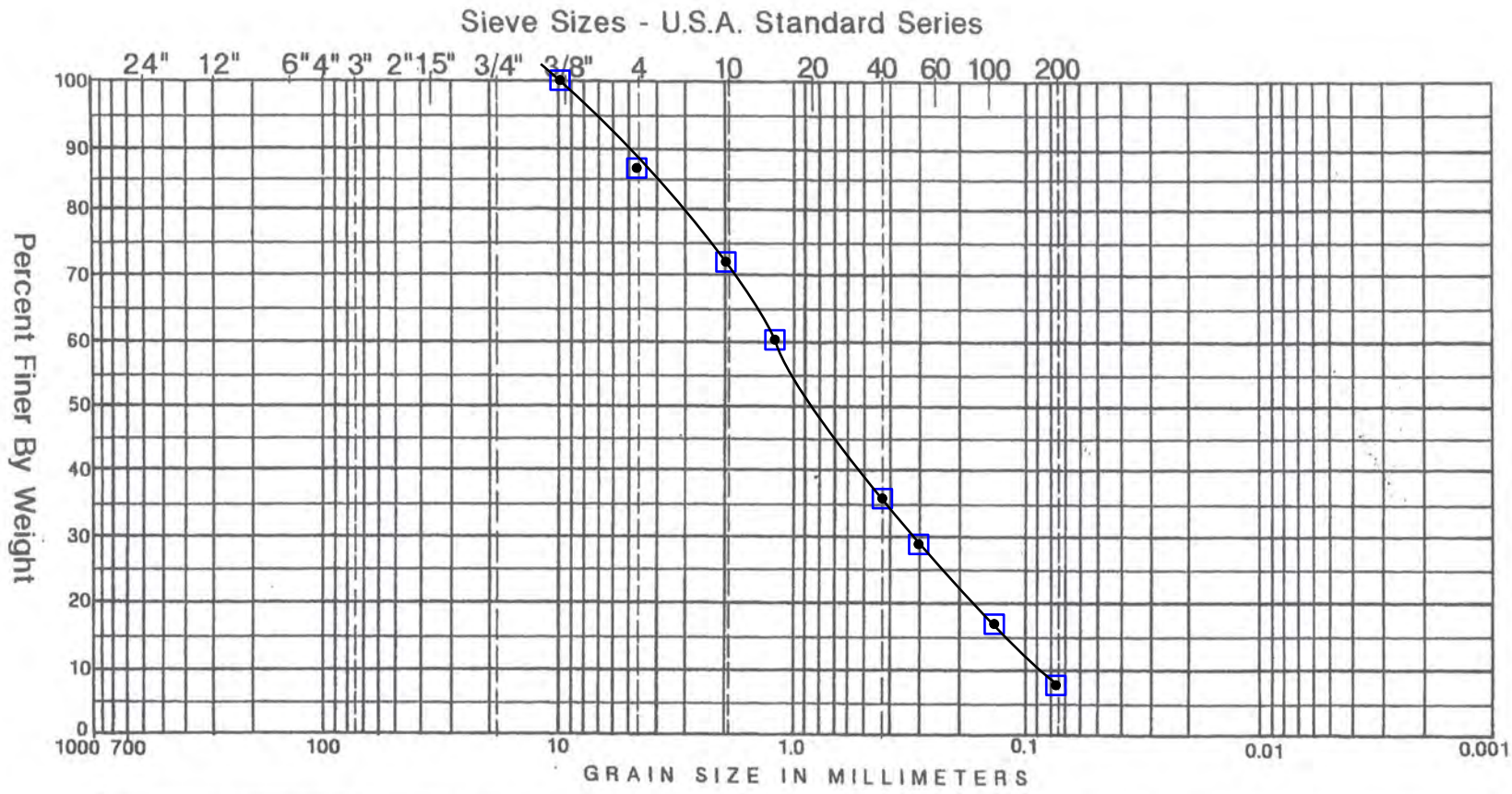
*Automatic Hammer
140 lbs 30-Inch Drop

**
SA=Sieve Analysis
MDC=(ASTM D 1557)
COR= Caltrans Corossivity

Depth in Feet	Sample ID	Sample Type R=Ring S=SPT, B=Bulk	Blow Count*/6"	Moisture Content (%)	Dry Density (pcf)	Lab Tests **	Graphic	Description
0	PB2A	B		1.8				Very young wash deposits-Qw2: (SP) Sand, fine to medium, trace coarse, gravel to 1.5", brown
5	PB2-1	S	7 3 4					(SP) Sand, fine to coarse with gravel to 3/8", graybrown, loose, 2% fines
	PB2B (5'-9')	B		2.3		SA		Boulder? at 9 ft.
10								End of Boring Total Depth 9' Refusal/ Bouncing on Rock at 9' No Bedrock No Groundwater Disturbed Surface 3"-dia. Perc Pipe Packed with 3/4" gravel to surface
15								
20								
25								
30								

APPENDIX B

LABORATORY GRAPHS
(4 PAGES)



Cobbles & Boulders	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Boring	Depth	Classification
⊡	PB-1	5 ft.	(SP-SM) Poorly graded Sand with Silt, fine to coarse with gravel to 3/8", 9% fines.

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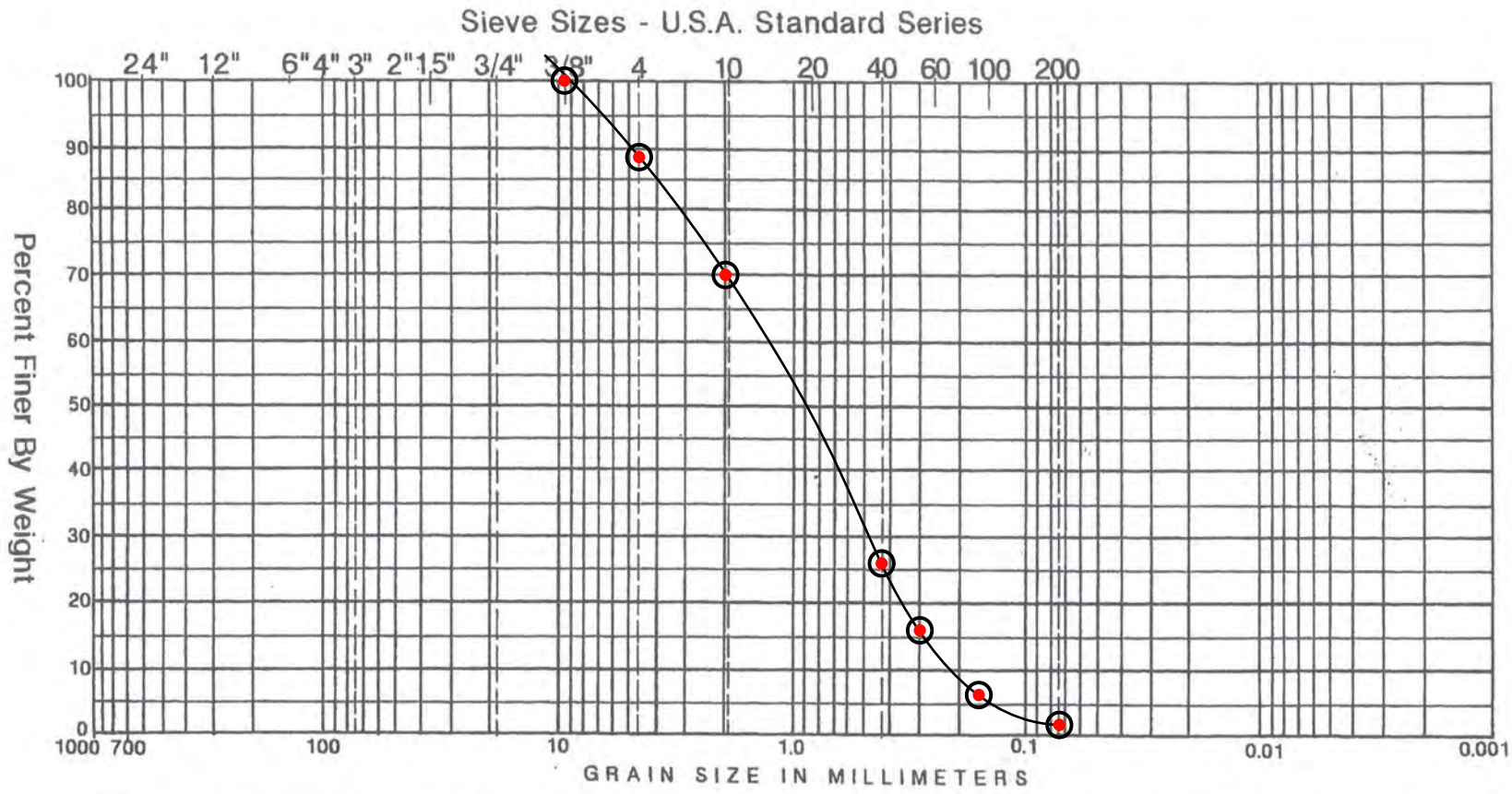
Gradation Curves

APN: 0349-182-11-0000
Glen Helen, CA



Cobbles & Boulders	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Boring	Depth	Classification
⊙	PB-2	5-9" ft.	(SP) Poorly graded Sand, fine to coarse with gravel to 3/8", 2% fines.

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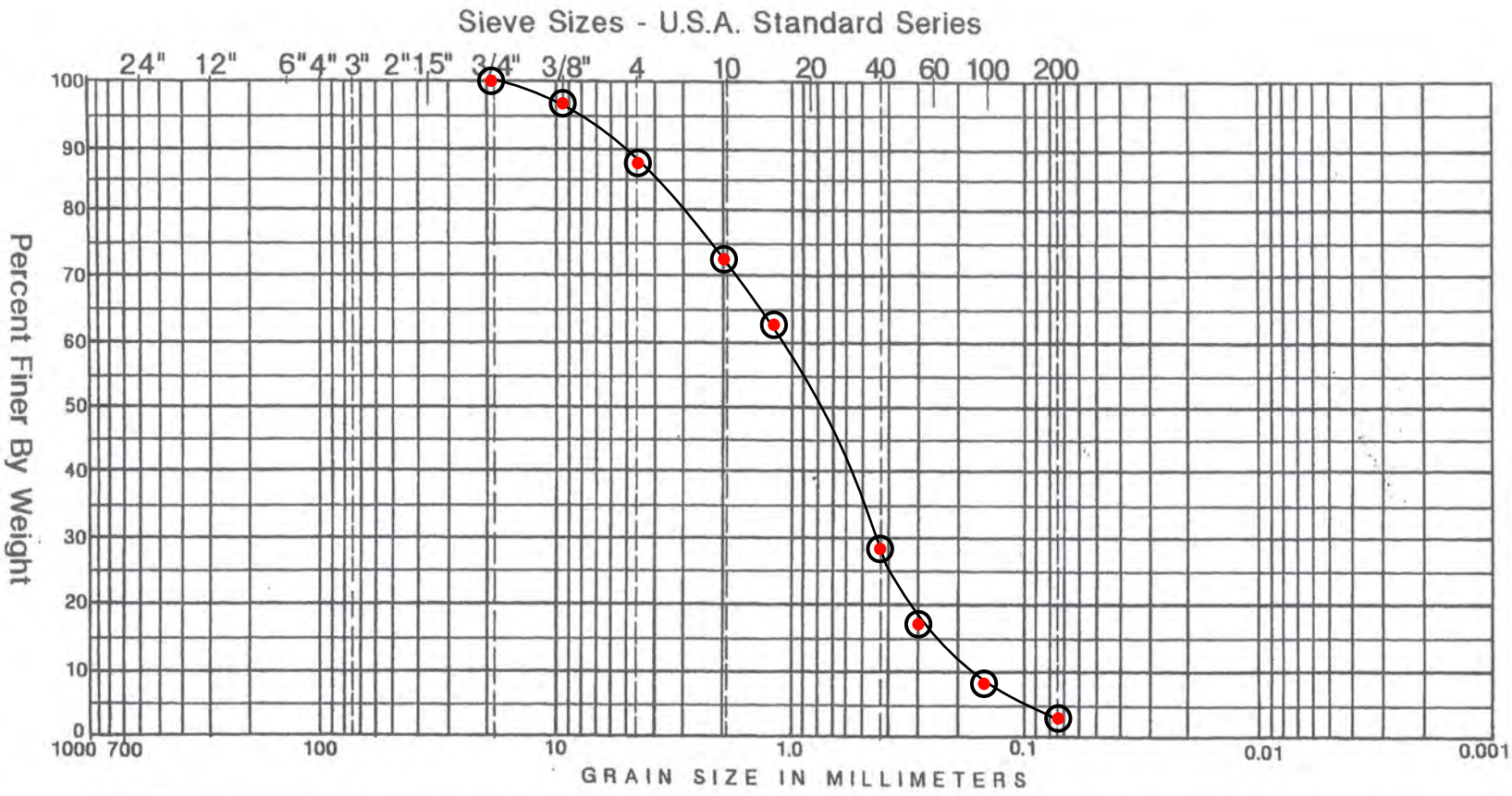
Environmental & Geotechnical Engineering

Gradation Curves

APN: 0349-182-11-0000
Glen Helen, CA



Cobbles & Boulders	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Boring	Depth	Classification
⊙	B-3	0'-5'	(SP) POORLY GRADED SAND, FINE TO COARSE WITH GRAVEL TO 3/4", 3% FINES

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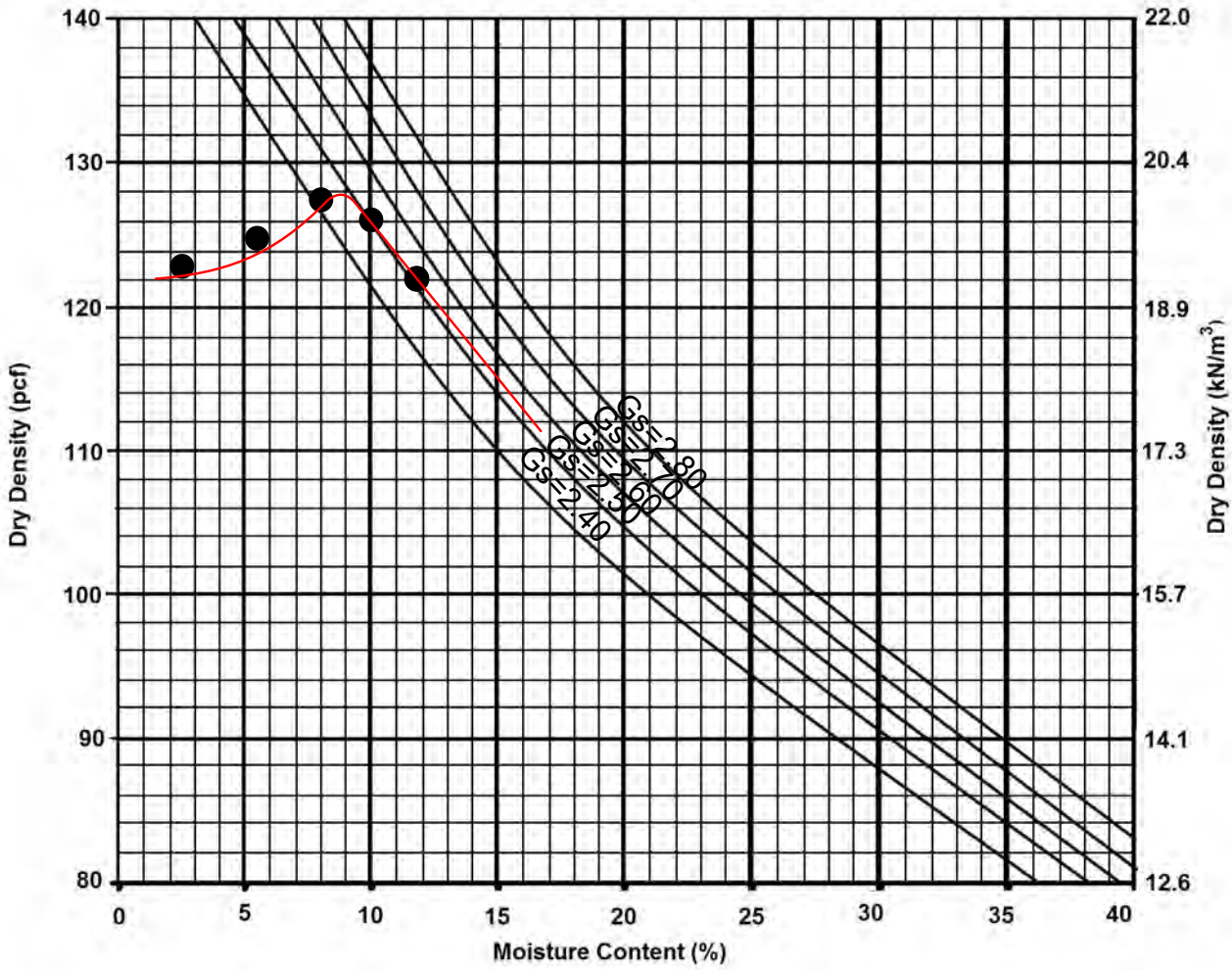
Environmental & Geotechnical Engineering

Gradation Curves

APN: 0349-182-11-0000
Glen Helen, CA

MOISTURE DENSITY CURVE



Boring	Depth (ft)	Classification	γ_{max} (pcf)	w_{opt} (%)
3	0'-5'	(SP) Sand, fine to coarse with gravel to 3/4"	128	9.0

MOISTURE DENSITY CURVE (MDC) ASTM D 1557

Project: Proposed Gas Station

Location: Cajon Blvd, Glen Helen, CA

Geo-Cal, inc.
Environmental & Geotechnical Engineering

APPENDIX C

HDR CORROSIVITY TEST RESULTS
(1 PAGE)

TRANSMITTAL LETTER

DATE: October 25, 2021

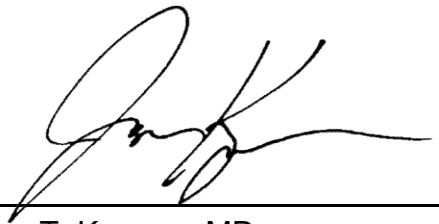
ATTENTION: **Todd Wyland**

TO: Geo-Cal, Inc.
4370 Hallmark Parkway, #101
San Bernardino, CA 92407

SUBJECT: Laboratory Test Data

HDR Lab #21-1018LAB

COMMENTS: Enclosed are the results for the subject project.



James T. Keegan, MD
Corrosion and Lab Services Section Manager

431 West Baseline Road · Claremont, CA 91711
Phone: 909.962.5485 · Fax: 909.626.3316

Table 1 - Laboratory Tests on Soil Samples

Geo-Cal, Inc.

HDR Lab #21-1018LAB
25-Oct-21

Sample ID			B-3 @ 0-5'
Resistivity		**Units**	
as-received		ohm-cm	72,000
minimum		ohm-cm	18,800
pH			7.8
Electrical Conductivity		mS/cm	0.04
Chemical Analyses			
Cations			
calcium	Ca^{2+}	mg/kg	28
magnesium	Mg^{2+}	mg/kg	ND
sodium	Na^{1+}	mg/kg	5.5
potassium	K^{1+}	mg/kg	6.8
ammonium	NH_4^{1+}	mg/kg	ND
Anions			
carbonate	CO_3^{2-}	mg/kg	ND
bicarbonate	HCO_3^{1-}	mg/kg	149
fluoride	F^{1-}	mg/kg	0.9
chloride	Cl^{1-}	mg/kg	8.5
sulfate	SO_4^{2-}	mg/kg	5.1
nitrate	NO_3^{1-}	mg/kg	4.6
phosphate	PO_4^{3-}	mg/kg	ND
Other Tests			
sulfide	S^{2-}	qual	na
Redox		mV	na

Minimum resistivity and pH per CTM 643, Chloride per CTM 422, Sulfate per CTM 417

Electrical conductivity in millisiemens/cm and chemical analyses were made on a 1:5 soil-to-water extract.

mg/kg = milligrams per kilogram (parts per million) of dry soil.

Redox = oxidation-reduction potential in millivolts

ND = not detected

na = not analyzed

APPENDIX D

USGS SEISMIC DESIGN VALUES
(1 PAGE)

Cajon Blvd, Glen Helen

Latitude, Longitude: 34.219425, -117.401645

Date	11/20/2021, 12:47:22 AM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	D - Stiff Soil

Type	Value	Description
S_S	2.369	MCE_R ground motion. (for 0.2 second period)
S_1	0.999	MCE_R ground motion. (for 1.0s period)
S_{MS}	2.369	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	1.579	Numeric seismic design value at 0.2 second SA
S_{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category
F_a	1	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	1.014	MCE_G peak ground acceleration
F_{PGA}	1.1	Site amplification factor at PGA
PGA_M	1.116	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	3.149	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	3.511	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.369	Factored deterministic acceleration value. (0.2 second)
S1RT	1.302	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	1.478	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.999	Factored deterministic acceleration value. (1.0 second)
PGAd	1.014	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.897	Mapped value of the risk coefficient at short periods
C_{R1}	0.881	Mapped value of the risk coefficient at a period of 1 s

DISCLAIMER

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APPENDIX E

PERCOLATION TEST DATA
(2 PAGES)

Geo-Cal, inc.
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Percolation Test Data Sheet

Project:	Glen Helen	Project No:	Henry Olivier	Date:	10-15-21
Test Hole No:	PB-1	Tested By:	Todd Wyland, RCE		
Depth of Test Hole, D_T:	66″	USCS Soil Classification:	(SP-SM) 9% fines		
Test Hole Dimensions (inches)			Length	Width	
Diameter (if round)=	8″	Sides (if rectangular)=			

Sandy Soil Criteria Test*

Trial No.	Start Time	Stop Time	Time Interval, (min.)	Initial Depth to Water (in.)	Final Depth to Water (in.)	Change in Water Level (in.)	Greater than or Equal to 6"? (y/n)
1	12:25	12:50	25	0	Empty	66	Yes
2	12:52	1:17	25	0	Empty	66	Yes

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Other wise, pre-soak (fill) overnight. Obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25".

Trial No.	Start Time	Stop Time	Δt Time Interval (min.)	D_o Initial Depth to Water (in.)	D_f Final Depth to Water (in.)	ΔD Change in Water Level (in.)	Percolation Rate (min./in.)
1	1:20	1:30	10	0	34.75	34.75	0.29
2	1:30	1:40	10	34.75	66.0	31.25	0.32
3	1:43	1:53	10	0	22.0	22.0	0.45
4	1:53	2:03	10	22.0	39.5	17.5	0.57
5	2:03	2:13	10	39.5	52.0	12.5	0.81
6	2:13	2:23	10	52.0	63.25	11.25	0.89
7							
8							
9							
10							
11							
12							
13							
14							
15							

COMMENTS:

$$I_t = \frac{\Delta H \cdot 60 \cdot r}{\Delta t\,(r + 2H_{avg})} = 13.0\ ^{in}/_{hr}$$

FS=3

$I_{Design} = 4.34\ ^{in}/_{hr}$

$>0.5\ ^{in}/_{hr}$ OK

Geo-Cal, inc.
Environmental & Geotechnical Engineering

Percolation Test Data Sheet

Project:	Glen Helen	Project No:	Henry Olivier	Date:	10-15-21
Test Hole No:	PB-2	Tested By:	Todd Wyland, RCE		
Depth of Test Hole, D_T:	108″	USCS Soil Classification:	(SP) 2% fines		
Test Hole Dimensions (inches)				Length	Width
Diameter (if round)=	8″	Sides (if rectangular)=			

Sandy Soil Criteria Test*

Trial No.	Start Time	Stop Time	Time Interval, (min.)	Initial Depth to Water (in.)	Final Depth to Water (in.)	Change in Water Level (in.)	Greater than or Equal to 6"? (y/n)
1	1:15	1:40	25	0	Empty	108	Yes
2	1:43	2:08	25	0	Empty	108	Yes

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Other wise, pre-soak (fill) overnight. Obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25".

Trial No.	Start Time	Stop Time	Δt Time Interval (min.)	D_o Initial Depth to Water (in.)	D_f Final Depth to Water (in.)	ΔD Change in Water Level (in.)	Percolation Rate (min./in.)
1	2:10	2:20	10	0	58.0	58.0	0.17'7"
2	2:20	2:30	10	580	93.5	35.5	0.28
3	2:33	2:43	10	0	28.25	28.25	0.35
4	2:43	2:53	10	28.25	53.75	25.5	0.39
5	2:53	3:03	10	53.75	77.00	23.25	0.43
6	3:03	3:13	10	77.0	99.25	22.25	0.45
7							
8							
9							
10							
11							
12							
13							
14							
15							

COMMENTS:

$$I_t = \frac{\triangle H \cdot 60 \cdot r}{\triangle t\,(r+2H_{avg})} = 12.2\ ^{in}/_{hr}$$

FS=3

$I_{Design} = 4.07\ ^{in}/_{hr}$

$>0.5\ ^{in}/_{hr}$ OK