Preliminary

Water Quality Management Plan

For:

Highland and Palm Avenue

Residential Development

Prepared for:

Warmington Residential

3090 Pullman Street

Costa Mesa, CA 92626

Phone:

Prepared by:

Allard Engineering

16866 Seville Avenue

Fontana, CA 92335

Phone (909) 356-1815

rallard@allardeng.com

Preparation Date:

Entitlement Approval Date:

Project Owner's Certification

This Water Quality Management Plan (WQMP) has been prepared for Warmington Residential, by Allard Engineering. 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):		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 : 0285-211-21 & 0285-211-23

Owner's Signature			
Owner Name:			
Title	President		
Company	Warmington Residential		
Address	3090 Pullman Street, Costa Mesa, CA 92626		
Email			
Telephone #	(714) 557-5511		
Signature		Date	

Preparer's Certification

Project Data			
Permit/Application Number(s):		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 : 0285-211-21 & 0285-211-23

"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: RAYMOND ALLARD		PE Stamp Below
Title	PRESIDENT	
Company	Allard Engineering	
Address	16866 Seville Avenue	
Email	rallard@allardeng.com	
Telephone #	(909) 356-1815	
Signature		
Date		

Table of Contents

Forms

Section 1 Discretionary Permit(s)

Form 1-1 Project Information					
Project Name	Highland & Palm Avenue Residential Development				
Project Owner Contact Name:	Warmington Residential				
Mailing Address:	3090 Pullman Street, Costa Mesa, CA 92626	E-mail Address:		Telephone:	714-557-5511
Permit/Application Number(s):		Tract/Parcel Map Number(s):	APN : 0285-211-21 & 0285-211-23		
Additional Information/ Comments:	N/A				
Description of Project:	The project which located at the northwest corner of Highland Avenue and Palm Avenue comprises the site area of approximately 15.2 acre of the proposed 137 units of single-family residential development located in the City of San Bernardino, County of San Bernardino, State of California. The site located at the corner of northwest of Highland Avenue and Palm Avenue and north of Freeway I-210. In current condition the property consists of a small residential use buildings, driveway, paved area, landscaping and mostly barren undeveloped open area. In the existing condition, the entire property drains via sheet flow to the northwest direction towards Highland Avenue and drains to street gutter in Highland Ave. Highland Ave street gutter drains to existing storm drain system which ultimately drains to Baldridge Creek Channel (Conc Channel, EHM) (SBBCFCD Flood Control Channel). The storm water ultimately conveyed to the Santa Ana River (Conc Lined, EHM) Channel via Upper Warm Creek Channel (EHM) and Twin Creek Channel (COE). The entire site (DA`-1) is preliminary designed as single drainage management area: DMA-1 (15.2 acres). The project is proposing redevelopment of the site to build 137 units of single-family residential lot, private driveways, private streets, walkways, planters, and landscape areas. The proposed drainage includes below surface infiltration chamber system 1 through 5 (Contech), on-surface retention/infiltration basin (Basin-1), grate inlets with Filter Inserts for pre-treatment, swales, and storm water piping. The proposed Contech inf. chamber systems and the retention/infiltration basin will retain and infiltrate water quality volume and detain the water volume from 2-yr 24-hr storm event for WQ HCOC mitigation and outflow via pipe to drains to Master Storm Drain System. For larger storm event (upto 100-yr) , the water will overflow the proposed retention/infiltration basin via overflow riser grate and pipe to drains to Master Storm Drain System in Highland Ave which ultimately drains to the Baldridge Creek (Concrete Channel Segment) to the southwest corner of the site. WQ HCOC mitigation will be meet by detaining the water volume generates in developed condition (2yr, 24hr storm event) as well as attenuation of runoff flow utilizing the proposed Contech Chamber Systems and the Ret/Inf Basin to mitigate the runoff flow rate to existing				

	condition.
Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	

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 ft² or more of impervious surface on an already developed site	☐ New development involving the creation of 10,000 ft² 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 ft² or more
☐ Hillside developments of 5,000 ft² 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 ft² 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 ft² or more exposed to storm water	☐ Retail gasoline outlets that are either 5,000 ft² 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):	662,112 sf	[3] Number of Dwelling Units:	137	[4] SIC Code:	1522

[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)*

The proposed roads will be a part of a private new development and the proposed development area will be non-adjoining to the existing public roads. Therefore transportation project guidance does not apply to this project.

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 of WQMP stormwater facilities:

Warmington Residential will be responsible to build the site and the maintenance of the post-developed BMPs.

Address:

Warmington Residential

3090 Pullman Street

Costa Mesa, CA 92626

Phone Number:

714-557-5511

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 ☐	Bacteria and viruses are a potential pollutant for Residential tract developments. Due to the nature of the development the site will be treated using site and source and treatment control BMPs. Bacteria and virus can also be detected in pavement runoff, therefore, the site has incorporated treatment control throughout. All paved and hardened surfaces will flow through the proposed grate inlet pre-treatment units prior to discharge into the proposed Infiltration Basin as part of Low Impact Design (LID). Impacted Water Body: Baldridge Creek, Santa Ana River Reach 3.
Nutrients/Noxious Aquatic Plants	E ☒	N ☐	This residential tract site includes landscaping area which will be the potential generation of this type of pollutants. Impacted Water Body: None
Sediment / Total suspended solids / pH	E ☒	N ☐	This residential tract site includes landscaping area which will be the potential generation of this type of pollutants.
Metals	E ☒	N ☐	Generates from residential tract site Impacted Water Body: Santa Ana River Reach 3.
Oil and Grease	E ☒	N ☐	Generates from Commercial/Industrial project
Trash/Debris	E ☒	N ☐	Debris/trash is a potential pollutant for residential tract site . The site will intercept debris into the proposed infiltration basin. Also trash/debris from paved surfaces will be intercepted in the proposed catch basin with filtration devices as part of the source and treatment control BMPs. Impacted Water Body: None
Pesticides / Herbicides	E ☒	N ☐	Generates from Landscape area. Impacted Water Body: None
Organic Compounds	E ☒	N ☐	This site includes landscaping area and the usage of solvents which will be the potential generation of this type of pollutants. Impacted Water Body: None
Other: Nutrients	E ☒	N ☐	Include nitrogen and phosphorus from usages of fertilizers in the proposed landscape area. Impacted Water Body: None
Oxygen Demanding Compounds	E ☒	N ☐	This site includes landscaping area which will be the potential generation of this type of pollutants. Impacted Water Body: None
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

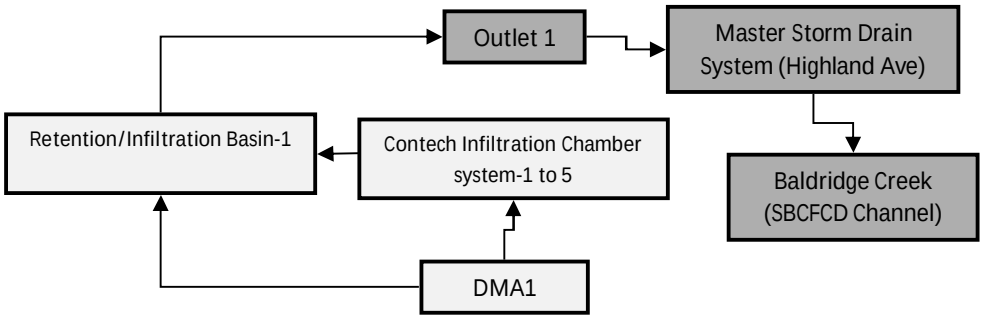
Describe the project site conditions that will facilitate the selection of BMP through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and 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: 34.13657° N	Longitude: - 117.21083° W	Thomas Bros Map page PAGE ___ GRID _ _

[1] San Bernardino County climatic region: ☒ Valley ☐ Mountain

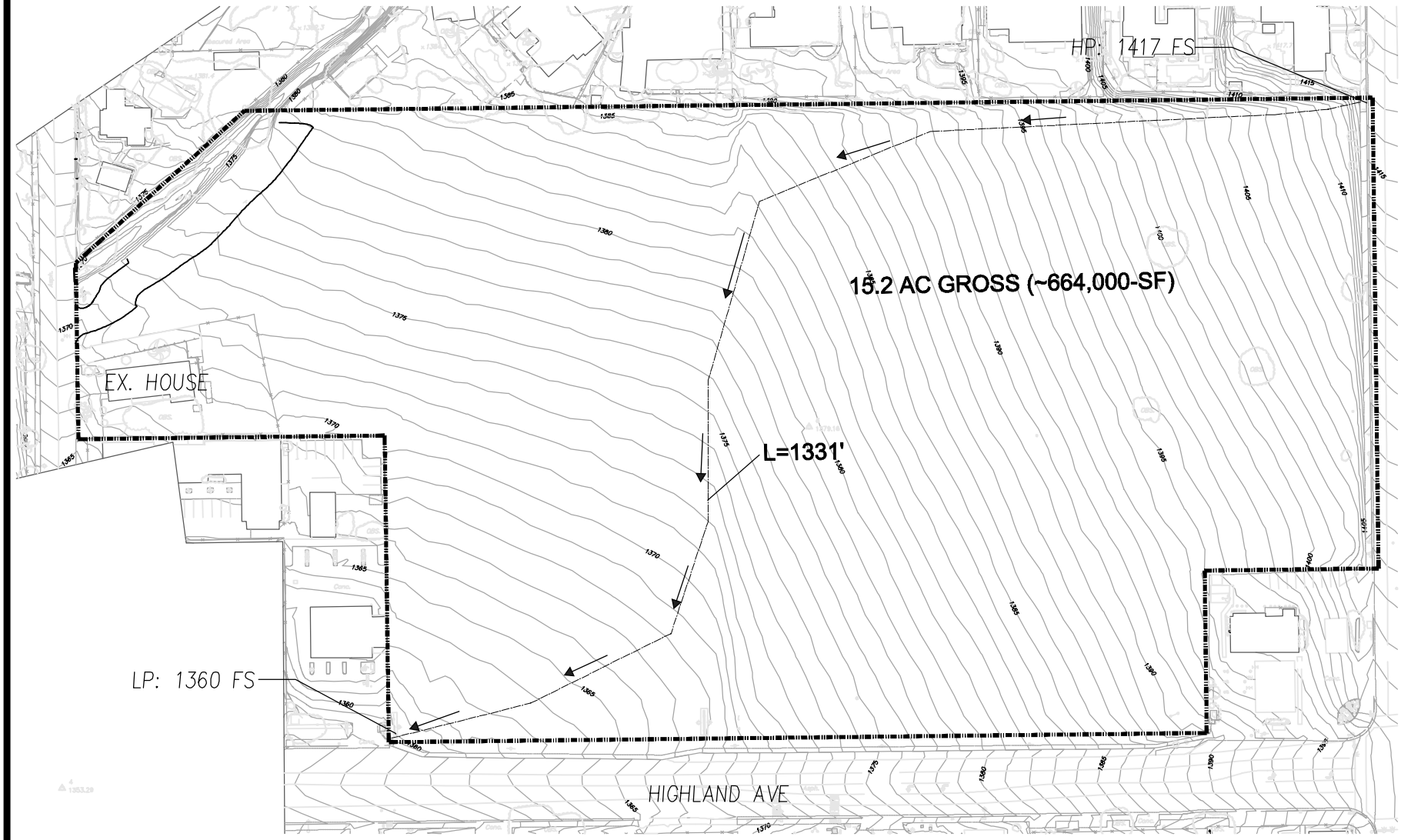
[2] Does the site have more than one drainage area (DA): Yes☐ No☒ *If no, proceed to Form 3-2. If yes, then use this form to show a conceptual schematic describing DMAs and hydrologic feature connecting DMAs to the site outlet(s). An example is provided below that can be modified for proposed project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



Conveyance	
DMA1, DMA2 to Outlet 1	The entire site (DA`-1) is preliminary designed as single drainage management area: DMA-1 (15.2 acres). The project is proposing redevelopment of the site to build 137 units of single-family residential lot, private driveways, private streets, walkways, planters, and landscape areas. The proposed drainage includes below surface infiltration chamber system 1 through 5 (Contech), on-surface retention/infiltration basin (Basin-1), grate inlets with Filter Inserts for pre-treatment, swales, and storm water piping. The proposed Contech inf. chamber systems and the retention/infiltration basin will retain and infiltrate water quality volume and detain the water volume from 2-yr 24-hr storm event for WQ HCOC mitigation and outflow via pipe to drains to Master Storm Drain System. For larger storm event (upto 100-yr) , the water will overflow the proposed retention/infiltration basin via overflow riser grate and pipe to drains to Master Storm Drain System in Highland Ave which ultimately drains to the

	Baldridge Creek (Concrete Channel Segment) to the southwest corner of the site. WQ HCOC mitigation will be meet by detaining the water volume generates in developed condition (2yr, 24hr storm event) as well as attenuation of runoff flow utilizing the proposed Contech Chamber Systems and the Ret/Inf Basin to mitigate the runoff flow rate to existing condition.

Form 3-2 Existing Hydrologic Characteristics for Drainage Areas				
For Drainage Areas 1-3 sub-watershed DMA, provide the following characteristics	DMA1			
1 DMA drainage area (ft^2)	662,115 sf			
2 Existing site impervious area (ft^2)	8712 sf			
3 Antecedent moisture condition *For desert areas, use* *http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	III			
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	A			
5 Longest flowpath length (ft)	1331			
6 Longest flowpath slope (ft/ft)	4.3%			
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Urban, Barren			
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*	Good			



PLOT DATE: October 12, 2021 ashafiq

Prepared By:
ALLARD ENGINEERING
Civil Engineering - Land Surveying - Land Planning
16866 Seville Avenue
Fontana, California 92335
(909) 356-1815 Fax (909) 356-1795

SCALE: 1"= 140'

APN: 0285-211-21 & 0285-211-23

COUNTY OF SAN BERNARDINO

EXISTING CONDITION SITE EXHIBIT

Filename: I:\Warmington Homes\Palm Avenue San Bernardino\DWG's\ENTITLEMENT\EXHIBIT\WQMP\PRELEM WQMP EXHIBIT 10-7-21.dwg

Form 3-3 Watershed Description for Drainage Area DA1/DA2	
Receiving waters *Refer to Watershed Mapping Tool -* *http://sbcounty.permitrack.com/WAP* *See 'Drainage Facilities" link at this website*	Master Storm Drain Sysstem (Highland Ave) Baldridge Creek Channel (SBCFCD Flood Control Channel)(EHM) Upper Warm Creek Channel (EHM) Twin Creek Channel (COE, enhanced) Santa Ana River Reach 3
Applicable TMDLs *Refer to Local Implementation Plan*	Baldridge Creek Channel: NONE Upper Warm Creek Channel: Chlorpyrifos "Pesticides" Twin Creek Channel: NONE Santa Ana River Reach 3: Pathogens "Bacterial Indicator TMLDs for Middle Santa Ana River Watershed Waterbodies (Bill Rice) Nitrate : Santa Ana River Reach 3 Nitrate TMDL (Hope Smythe) Prado Flood Control basin Pathogens "Bacterial Indicator TMLDs for Middle Santa Ana River Watershed Waterbodies (Bill Rice) Santa Ana River Reach 2 NONE Santa Ana River Reach 1 NONE Tidal Prism, Santa Ana River NONE
303(d) listed impairments *Refer to Local Implementation Plan and Watershed Mapping Tool –* *http://sbcounty.permitrack.com/WAP and State Water Resources Control Board website – http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/index.shtml*	Expected pollutants of concern include organic compounds and trash/debris. Potential pollutants of concern include bacteria vitus, nutrients, pesticides, sediments, and oxygen demanding substances. There is no evidence to suggest that any other pollutants will be produced from the project site other than these. 303(d) listed impairment: Lytle Creek: Patheogens Santa Ana River Reach 3: Copper, Lead, Pathogens Prado Flood Control Basin: Pathogens and Nutrients Santa Ana River Reach 2: Pathogens Santa Ana River Reach 1 and Tidal prism Santa Ana River : NONE
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool –* *http://sbcounty.permitrack.com/WAP*	NONE
Unlined Downstream Water Bodies *Refer to Watershed Mapping Tool –* *http://sbcounty.permitrack.com/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

WQMP Project Report

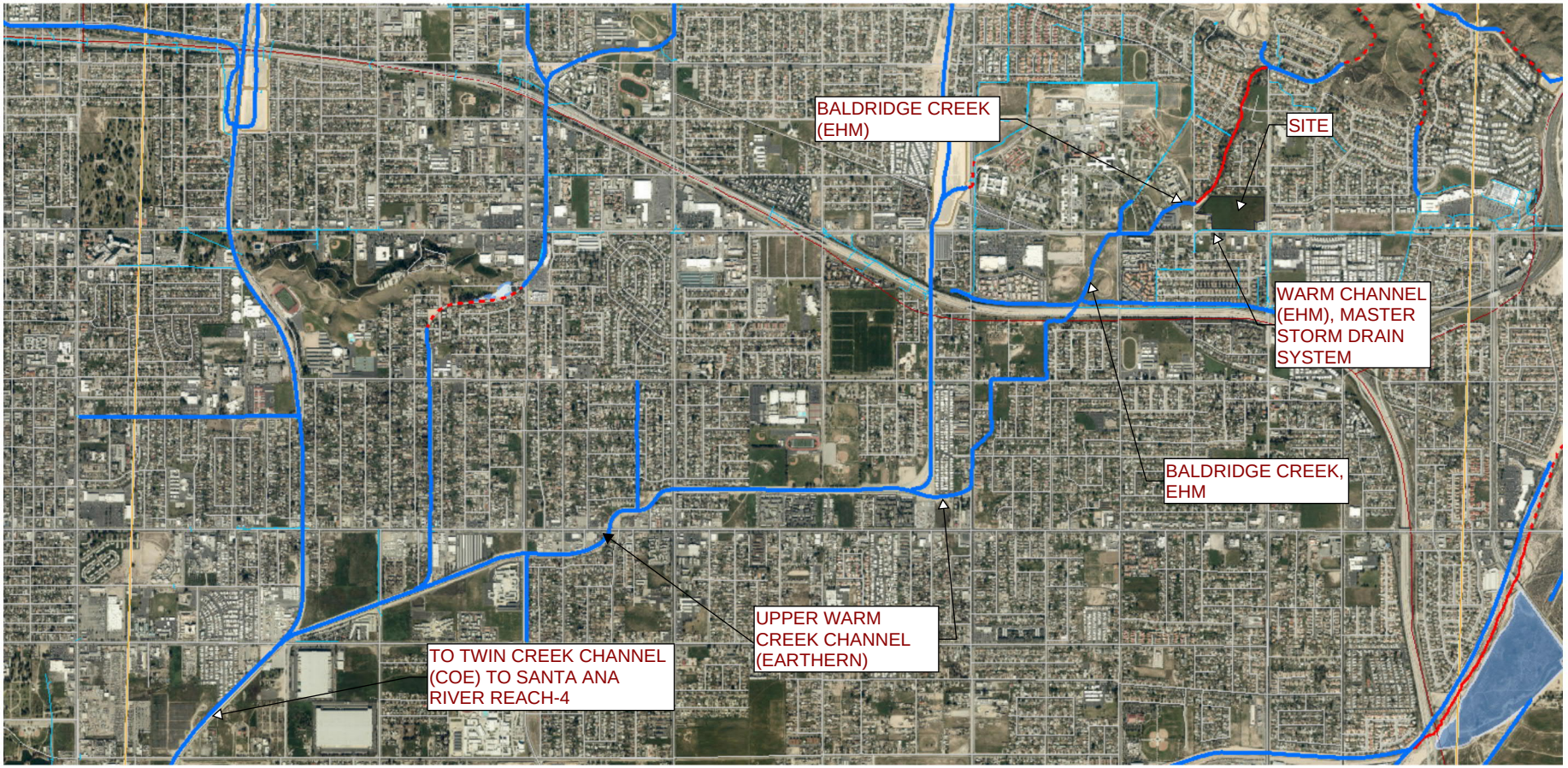
County of San Bernardino Stormwater Program

Santa Ana River Watershed Geodatabase

Thursday, July 22, 2021

Note: The information provided in this report and on the Stormwater Geodatabase for the County of San Bernardino Stormwater Program is intended to provide basic guidance in the preparation of the applicant's Water Quality Management Plan (WQMP) and should not be relied upon without independent verification.

Project Site Parcel Number(s):	028521123, 028521124, 028521105, 028521125, 028521122, 028521114, 028521121
Project Site Acreage:	15.186
HCOC Exempt Area:	No
Closest Receiving Waters: (Applicant to verify based on local drainage facilities and topography.)	**System Number** - 701 **Facility Name** - Baldridge Creek **Owner** - SBCFCD
Closest channel segment's susceptibility to Hydromodification:	High
Highest downstream hydromodification susceptibility:	High
Is this drainage segment subject to TMDLs?	No
Are there downstream drainage segments subject to TMDLs?	No
Is this drainage segment a 303d listed stream?	No
Are there 303d listed streams downstream?	Yes
Are there unlined downstream waterbodies?	No
Project Site Onsite Soil Group(s):	A, B
Environmentally Sensitive Areas within 200':	None
Groundwater Depth (FT):	-386
Parcels with potential septic tanks within 1000':	No
Known Groundwater Contamination Plumes within 1000':	No
Studies and Reports Related to Project Site:	CSDP #6 Existing Facilities and Capacities CSDP No. 6 Volume II CSDP No. 6 Deficiency Analysis CSDP No. 6 Deficiency Analysis CSDP No. 6 Existing Facilities CSDP No. 6 Proposed Master Planned Facilities CSDP No. 6 Volume I CSDP No. 7 Storm Drain Systems CSDP No. 7 Storm Drain Systems CSDP No. 7 Storm Drain Systems CSDP No. 7 Storm Drain Hydraulic Design Data SBVMWD High Groundwater / Pressure Zone Area



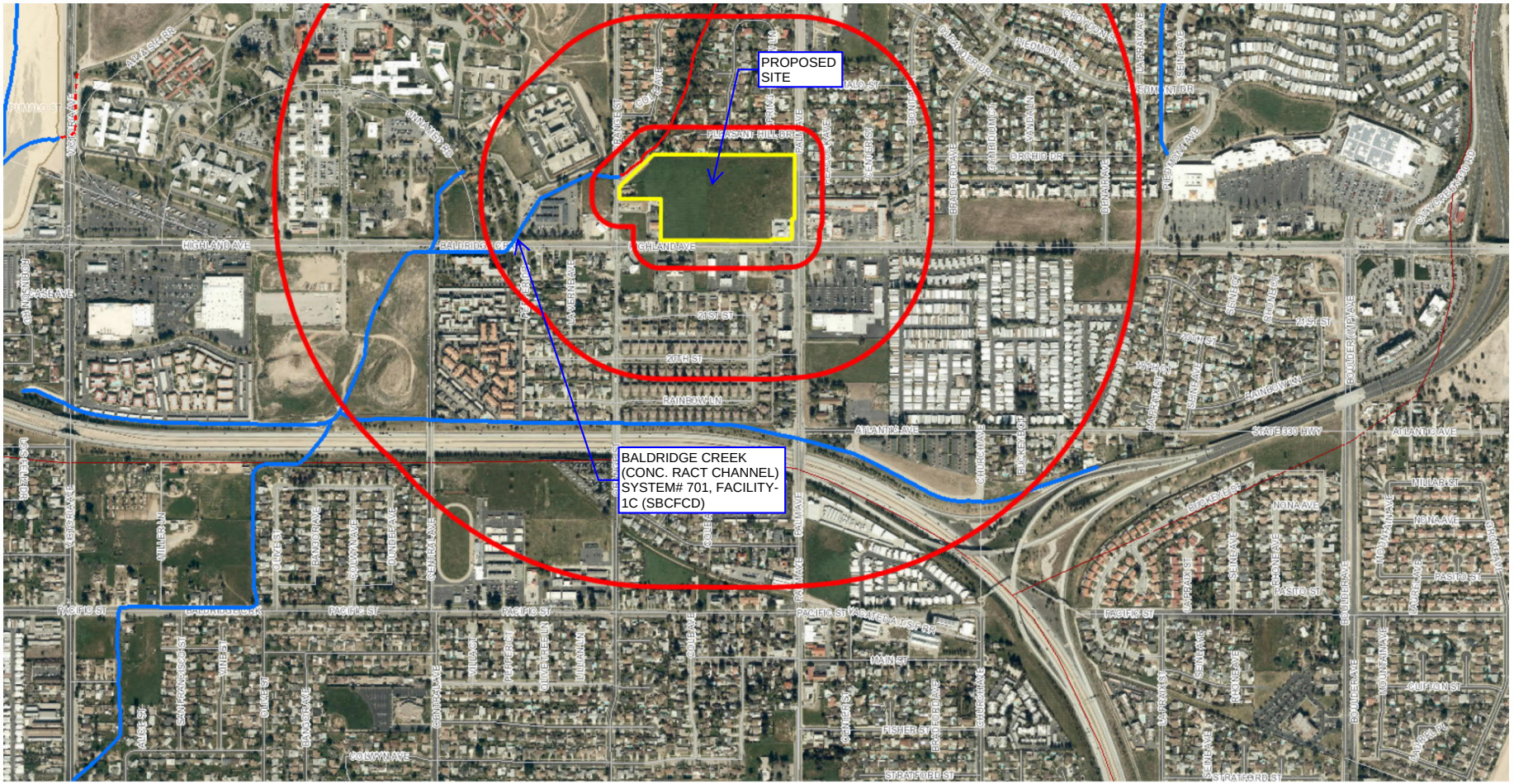
1 Miles

RBF CONSULTING GIS

Site Address: permitrack.sbcounty.gov/wap

County of San Bernardino
Stormwater Facility Mapping

Stormwater Map



0.2 Miles

RBF CONSULTING GIS

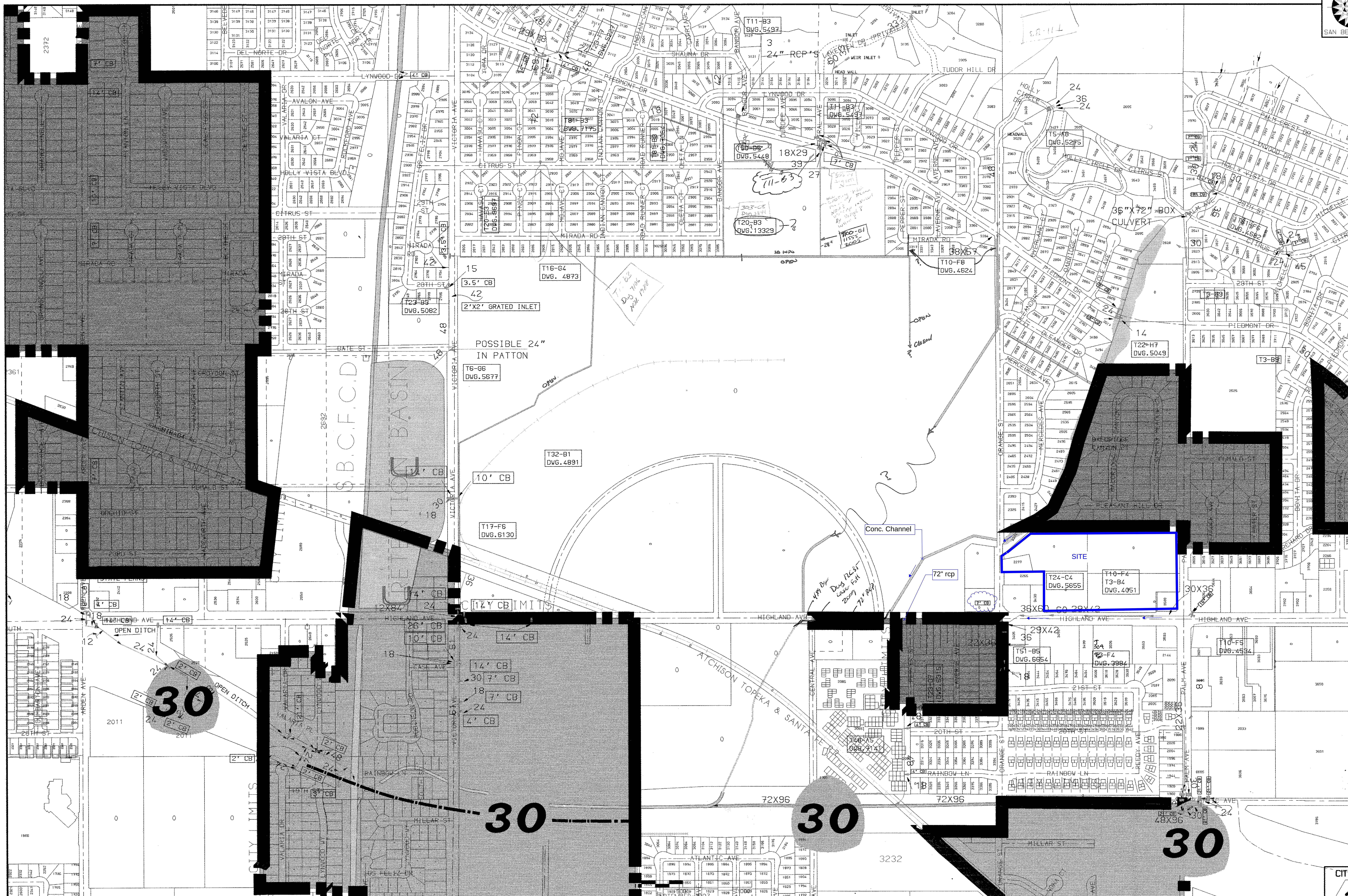
Site Address: permitrack.sbcounty.gov/wap

County of San Bernardino
Stormwater Facility Mapping

Stormwater Map

STATUS:DRAFT

SEE MAP 31



SEE MAP 47

24" 24 INCH PIPE — CATCH BASIN — NON-CITY PIPE

STATUS:DRAFT

REPRODUCTIONS AND/OR ALTERATIONS OF THIS MAP CAN BE OBTAINED FROM THE GIS COORDINATOR OF THE MIS DIVISION OF THE ADMINISTRATIVE DEPARTMENT OF THE CITY OF SAN BERNARDINO

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STORM DRAIN LOCATION MAPS

CITY MAP 39

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	☒	☐	Practical education materials will be provided to property owners and Maintenance staffs covering various water quality issues that will need to be addressed on their specific site. These materials will include general practices that contribute to the protection of storm water quality and BMP's that eliminate or reduce pollution during property improvements. The developer will request these materials in writing at least 30 days prior to intended distribution and will then be responsible for publication and distribution.
N2	Activity Restrictions	☒	☐	At minimum Pesticide applications will be performed by an applicator certified by the California Department of Pesticide Regulation. Vehicle washing will be prohibited.
N3	Landscape Management BMPs	☒	☐	According to the California Stormwater Quality Associations Stormwater Best Management Practice Handbook, landscape planning is implemented to reduce groundwater and storm water contamination. This will be accomplished through an debris basins, infiltration basins, and landscape areas.
N4	BMP Maintenance	☒	☐	See section 5, Table 5.1 for details on BMP maintenance
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	No hazardous waster onsite
N6	Local Water Quality Ordinances	☒	☐	Comply with any applicable local water quality ordinances complying through this WQMP
N7	Spill Contingency Plan	☒	☐	Applicable "absorbent" materials shall be kept onsite in case of oils spills in parking lot.
N8	Underground Storage Tank Compliance	☐	☒	No underground storage tank on the site.

Form 4.1-1 Non-Structural Source Control BMPs				
N9	Hazardous Materials Disclosure Compliance	☐	☒	No Hazardous waste stored onsite.

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	☒	☐	Compliance with Article 80 of the Uniform Fire Code enforced by the fire protection agency. No fire hazardous waste is stored on site.
N11	Litter/Debris Control Program	☒	☐	Owners of individual lots will implement trash management and litter control procedures. At a minimum the site will be inspected weekly and trash picked up as necessary.
N12	Employee Training	☒	☐	Gardenaers and other maintenance staff will have training regarding the location and maintenance of the BMP.
N13	Housekeeping of Loading Docks	☐	☒	No Loading docks proposed.
N14	Catch Basin Inspection Program	☒	☐	Catch basins will be inspected a minimum of once every three months during the dry season and a minimum of once every two months during the rainy season.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	Private driveways/private streets and onsite pavement will be vacume sweep by the owner. At a minimum all paved areas shall be swept, in late summer or early fall. Prior to the start of the rainy season or equivalent, as govern by the governing jurisdiction.

N16	Other Non-structural Measures for Public Agency Projects	☐	☒	Not a public agency project.
N17	Comply with all other applicable NPDES permits	☒	☐	Construction is not over an acre so no general construction permit is required however this WQMP is in compliance with NPDES permit requirements.

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 will be placed above storm drain inlets to warn the public of prohibitions against waste disposal. The sign will be "NO DUMPING – THIS DRAINS TO OCEAN".
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	No material storages areas in the project
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	-Trash storage area will be roofed & paved to contain leaks & spills to minimize direct precipitation & exposure according to the design requirements of CASQA source control BMP SD-32 (Trash Enclosures).
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (State wide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☒	☐	Rain sensors will be incorporated into the onsite sprinkler system so that no unnecessary watering of landscaped areas occurs after storm events.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	New landscaped areas will be constructed at a minimum of 1 inch below existing paved areas
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☒	☐	Slopes and Channel will be protected with rip-rap and vegetated swale (see plans for location) per San Bernardino County Standard.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	No dock, Not applicable
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	No Bays, Not applicable
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No Vehicle Wash at the site, Not applicable
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	No outdoor Processing, Not applicable

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, Not applicable
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	No Fueling, Not applicable
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	No Hillside Landscaping, Not applicable
S14	Wash water control for food preparation areas	☐	☒	No food Preparation, Not applicable
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	No Community Car Wash, Not applicable

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: We will build more landscaping, planter areas in addition to the infiltration basin for infiltration.
Maximize natural infiltration capacity: Yes ☒ No ☐ Explanation: Runoff from a portion of impervious surfaces (Driveways, building roof etc) will first drain to the proposed landscaped areas/planters for bio-filtration and incidental infiltration before entering the proposed swale/grate inlets so that infiltration is maximized. Runoff will also be intercepted by the proposed infiltration basin/Contech Chamber System for retention and infiltration.
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: The site currently drains Southwest on surface and drains to Highland Avenue and/or existing inlet structure by in Highland Avenue to Baldridge Creek. Post developed flow will also drain southwest to the Baldridge Creek via the proposed drainage system to Master Storm Drain System in Highland Ave. This is consistent with existing and flow patterns.
Disconnect impervious areas: Yes ☒ No ☐ Explanation: Impervious areas will drain into landscaped areas and numerous planter areas..
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation: There are no environmentally sensitive areas with in the proposed sub-division and existing vegetation will be kept as much as possible in the open dirt area.
Re-vegetate disturbed areas: Yes ☒ No ☐ Explanation: Part of the disturbed areas will be revegeated, see landscape plan.
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: There will be no compaction in infiltration basin basin area during compaction.
Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes ☒ No ☐ Explanation: Utilized graded vegetated swale. Also Runoff will also be intercepted by the proposed infiltration basin/Contech Chamber System and existing landscaped areas/planters within project site

Stake off areas that will be used for landscaping to minimize compaction during construction: Yes ☒ No ☐

Explanation: No compaction will be performed within the proposed area of infiltrationbasin and the landscape/planter areas.

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 (DMA1)

1 Project area (DMA-1) (ft^2): 662,112	2 Imperviousness after applying preventative site design practices (Imp%): 65%	3 Runoff Coefficient (Rc): 0.45 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.564 *http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.8353 (Using C1=1.4807) *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): 40,637 (Using C2=1.963) *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*		

Target Captured Volume
Watershed DA 1

1) Calculate the "Watershed Imperviousness Ratio", I which is equal to the percent of impervious area in the BMP Drainage Area divided by 100

Imperviousness(i)= **0.65**

Total Acreage(A) = **15.20** **662,112** SF

2) Calculate the composite Runoff Coefficient C_{bmp} for the drainage area

$Rc = 0.858i^3-0.78i^2+0.774i+0.04$

Rc 0.45

3) Determine which Regression Coefficient to use by region the project is located in

Valley	1.481
Mountain	1.909
Desert	1.237

Regression coefficient for this project is: 1.481

4) Determine the area averaged "6 hour Mean Storm Rainfall" , P_6

2 yr 1 Hr Rainfall Depth per NOAA Atlas 14= **0.564** inches

P_6 = 2 yr 1 hr Rainfall x Regression coefficient

P_6 = 0.8353 inches

5) Determine Regression Constant (a) for 48 hour drawdown

a for 24 hour = 1.582
a for 48 hour = 1.963

a = 1.963

6) Calculate the Maximized Detention Volume, P_0

P_0 = C x a x P6

Po(inches) = 0.7365

7) Calculate the Target Capture Volume, V_0, in acre feet

$V_0 = (P_0 * A)/12$

V_0 = 0.93 acre-feet
V_0 = 40,637 CF

NOAA Atlas 14, Volume 6, Version 2
Location name: Highland, California, USA*
Latitude: 34.1366°, Longitude: -117.2108°
Elevation: 1378.45 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	**0.112** (0.093-0.137)	**0.147** (0.122-0.179)	**0.195** (0.162-0.238)	**0.236** (0.194-0.290)	**0.294** (0.233-0.374)	**0.342** (0.265-0.444)	**0.392** (0.297-0.523)	**0.447** (0.329-0.613)	**0.525** (0.371-0.752)	**0.590** (0.402-0.875)
10-min	**0.161** (0.134-0.196)	**0.211** (0.175-0.257)	**0.280** (0.232-0.341)	**0.338** (0.278-0.416)	**0.422** (0.335-0.537)	**0.489** (0.380-0.637)	**0.562** (0.426-0.749)	**0.640** (0.471-0.878)	**0.753** (0.531-1.08)	**0.846** (0.576-1.25)
15-min	**0.195** (0.162-0.237)	**0.255** (0.212-0.311)	**0.338** (0.280-0.413)	**0.409** (0.336-0.503)	**0.510** (0.405-0.649)	**0.592** (0.460-0.770)	**0.679** (0.515-0.906)	**0.774** (0.570-1.06)	**0.910** (0.642-1.30)	**1.02** (0.697-1.52)
30-min	**0.293** (0.243-0.356)	**0.384** (0.319-0.467)	**0.508** (0.421-0.620)	**0.615** (0.505-0.756)	**0.767** (0.608-0.976)	**0.890** (0.691-1.16)	**1.02** (0.774-1.36)	**1.16** (0.857-1.60)	**1.37** (0.965-1.96)	**1.54** (1.05-2.28)
60-min	**0.430** (0.358-0.523)	**0.564** (0.468-0.686)	**0.747** (0.618-0.911)	**0.903** (0.741-1.11)	**1.13** (0.893-1.43)	**1.31** (1.01-1.70)	**1.50** (1.14-2.00)	**1.71** (1.26-2.35)	**2.01** (1.42-2.88)	**2.26** (1.54-3.35)
2-hr	**0.619** (0.515-0.752)	**0.795** (0.660-0.967)	**1.03** (0.853-1.26)	**1.23** (1.01-1.51)	**1.50** (1.19-1.91)	**1.72** (1.34-2.24)	**1.95** (1.48-2.60)	**2.19** (1.61-3.00)	**2.52** (1.78-3.61)	**2.79** (1.90-4.14)
3-hr	**0.760** (0.632-0.923)	**0.968** (0.804-1.18)	**1.25** (1.03-1.52)	**1.48** (1.21-1.82)	**1.79** (1.42-2.28)	**2.04** (1.59-2.66)	**2.30** (1.74-3.06)	**2.57** (1.89-3.52)	**2.94** (2.07-4.21)	**3.23** (2.20-4.79)
6-hr	**1.06** (0.884-1.29)	**1.35** (1.12-1.64)	**1.73** (1.43-2.11)	**2.03** (1.67-2.50)	**2.45** (1.95-3.12)	**2.78** (2.16-3.61)	**3.11** (2.36-4.15)	**3.45** (2.54-4.74)	**3.92** (2.77-5.61)	**4.28** (2.92-6.35)
12-hr	**1.41** (1.17-1.71)	**1.81** (1.50-2.20)	**2.33** (1.93-2.84)	**2.75** (2.26-3.38)	**3.32** (2.64-4.23)	**3.76** (2.92-4.89)	**4.20** (3.18-5.60)	**4.65** (3.42-6.38)	**5.26** (3.71-7.53)	**5.73** (3.90-8.49)
24-hr	**1.90** (1.68-2.18)	**2.48** (2.19-2.86)	**3.24** (2.86-3.75)	**3.86** (3.37-4.50)	**4.68** (3.97-5.64)	**5.31** (4.41-6.53)	**5.95** (4.82-7.49)	**6.60** (5.20-8.54)	**7.47** (5.65-10.1)	**8.15** (5.96-11.4)
2-day	**2.34** (2.07-2.69)	**3.09** (2.74-3.57)	**4.08** (3.60-4.72)	**4.89** (4.28-5.70)	**5.99** (5.07-7.22)	**6.84** (5.67-8.41)	**7.70** (6.24-9.70)	**8.59** (6.77-11.1)	**9.80** (7.41-13.2)	**10.7** (7.85-15.0)
3-day	**2.54** (2.25-2.93)	**3.39** (3.00-3.91)	**4.51** (3.98-5.22)	**5.43** (4.75-6.33)	**6.70** (5.67-8.07)	**7.68** (6.38-9.45)	**8.69** (7.04-11.0)	**9.74** (7.68-12.6)	**11.2** (8.46-15.1)	**12.3** (9.01-17.2)
4-day	**2.73** (2.42-3.15)	**3.67** (3.24-4.23)	**4.91** (4.33-5.68)	**5.94** (5.20-6.92)	**7.36** (6.23-8.86)	**8.46** (7.02-10.4)	**9.61** (7.78-12.1)	**10.8** (8.51-14.0)	**12.4** (9.41-16.8)	**13.7** (10.0-19.2)

7-day	**3.11** (2.76-3.59)	**4.24** (3.75-4.89)	**5.75** (5.07-6.65)	**7.00** (6.12-8.16)	**8.73** (7.40-10.5)	**10.1** (8.38-12.4)	**11.5** (9.32-14.5)	**13.0** (10.2-16.8)	**15.0** (11.4-20.3)	**16.6** (12.2-23.2)
10-day	**3.37** (2.99-3.89)	**4.64** (4.10-5.35)	**6.33** (5.59-7.33)	**7.74** (6.78-9.03)	**9.71** (8.22-11.7)	**11.2** (9.33-13.8)	**12.8** (10.4-16.2)	**14.5** (11.4-18.8)	**16.9** (12.8-22.7)	**18.7** (13.7-26.1)
20-day	**4.16** (3.68-4.79)	**5.79** (5.12-6.68)	**7.98** (7.04-9.23)	**9.81** (8.59-11.4)	**12.4** (10.5-14.9)	**14.4** (11.9-17.7)	**16.5** (13.4-20.8)	**18.7** (14.8-24.2)	**21.8** (16.5-29.4)	**24.3** (17.8-33.9)
30-day	**4.90** (4.34-5.65)	**6.82** (6.03-7.87)	**9.40** (8.30-10.9)	**11.6** (10.1-13.5)	**14.6** (12.4-17.6)	**17.0** (14.1-20.9)	**19.5** (15.8-24.6)	**22.1** (17.5-28.7)	**25.8** (19.6-34.8)	**28.8** (21.1-40.2)
45-day	**5.90** (5.22-6.79)	**8.12** (7.18-9.37)	**11.1** (9.82-12.9)	**13.7** (11.9-15.9)	**17.2** (14.6-20.7)	**20.0** (16.6-24.6)	**22.9** (18.6-28.9)	**26.0** (20.5-33.7)	**30.4** (23.0-41.0)	**33.9** (24.8-47.3)
60-day	**6.93** (6.14-7.99)	**9.42** (8.33-10.9)	**12.8** (11.3-14.8)	**15.6** (13.7-18.2)	**19.6** (16.6-23.6)	**22.8** (18.9-28.0)	**26.1** (21.1-32.8)	**29.6** (23.3-38.3)	**34.5** (26.1-46.5)	**38.4** (28.1-53.5)

[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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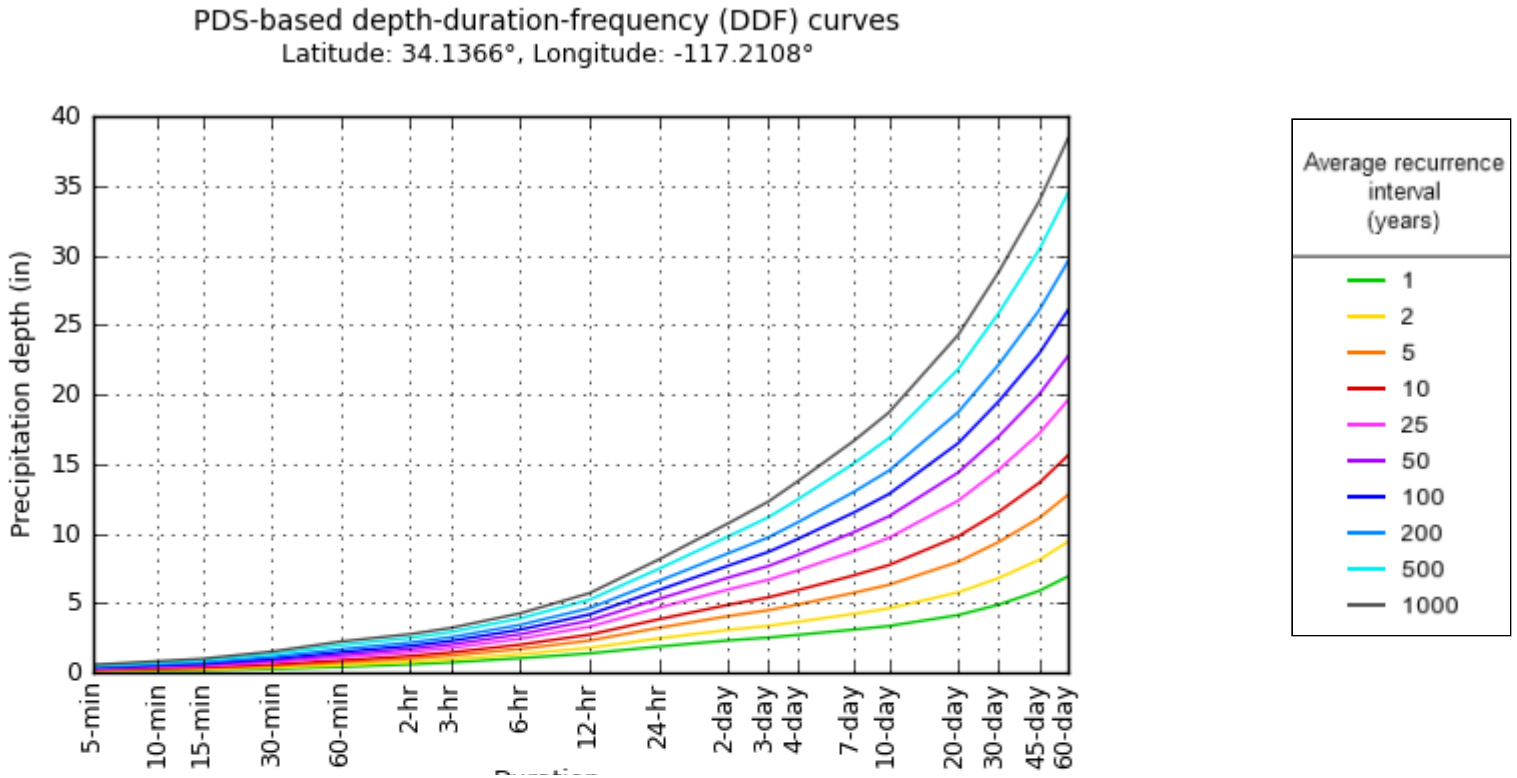
PF graphical



ACTUAL IMPERVIOUS COVER

Land Use (1)	Range-Percent	Recommended Value For Average Conditions-Percent (2)
Natural or Agriculture	0 - 0	0
Public Park	10 - 25	15
School	30 - 50	40
Single Family Residential: (3)		
2.5 acre lots	5 - 15	10
1 acre lots	10 - 25	20
2 dwellings/acre	20 - 40	30
3-4 dwellings/acre	30 - 50	40
5-7 dwellings/acre	35 - 55	50
8-10 dwellings/acre	50 - 70	60
More than 10 dwellings/acre	65 - 90	80
Multiple Family Residential:		
Condominiums	45 - 70	65
Apartments	65 - 90	80
Mobile Home Park	60 - 85	75
Commercial, Downtown Business or Industrial	80 - 100	90

Notes:

1. Land use should be based on ultimate development of the watershed. Long range master plans for the County and incorporated cities should be reviewed to insure reasonable land use assumptions.

2. Recommended values are based on average conditions which may not apply to a particular study area. The percentage impervious may vary greatly even on comparable sized lots due to differences in dwelling size, improvements, etc. Landscape practices should also be considered as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. A field investigation of a study area shall always be made, and a review of aerial photos, where available, may assist in estimating the percentage of impervious cover in developed areas.

3. For typical equestrian subdivisions increase impervious area 5 percent over the values recommended in the table above.

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

ACTUAL IMPERVIOUS COVER
FOR
DEVELOPED AREAS

Figure C-4

Form 4.2-2 Summary of HCOC Assessment

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

Go to: http://sbcounty.permitrack.com/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] 21780 *Form 4.2-3 Item 12*	[2] 16.25 *Form 4.2-4 Item 13*	[3] 7.3 *Form 4.2-5 Item 10*
Post-developed	[4] 79399 *Form 4.2-3 Item 13*	[5] 16.45 *Form 4.2-4 Item 14*	[6] 13.8 *Form 4.2-5 Item 14*
Difference	[7] *57,619* *Item 4 – Item 1*	[8] *Item 5 – Item 2*	[9] *6.5* *Item 6 – Item 3*
Difference (as % of pre-developed)	[10] 264% *Item 7 / Item 1*	[11] 1.2% *Item 8 / Item 2*	[12] 89% *Item 9 / Item 3*

Per *http://sbcounty.permitrack.com/WAP* the project site is not located within the HCOC exempt area.

The project site is tabled to drain to the existing Master Storm Drain System in Highland Avenue. The site is proposing full retention/infiltration of the WQ water volume and detention of the of water volume in developed condition in excess of water volume in existing condition for 2-yr, 24-hr storm event and discharge water in a mitigated flow rate to the Master Plan Storm Drain System in Highland Avenue. Being tabled to drain to Master Storm Drain System, detention of water volume increase in developed condition for 2-yr 24-hr storm event and by attenuation of the peak flow in the basin/chamber system, the site will eliminate WQ HCOC. Refer to the following pages for the HCOC mitigation analysis calculation.

HCOC Calculation (2-yr 24 hr Storm Event)

Water Volume in Developed Condition: 1.8227 ac-ft ~ 79,397 cu-ft
Qpeak (2yr storm) in Developed Condition: 13.8 cfs

Water Volume in Existing Condition: 0.500 ac-ft ~ 21,780 cu-ft
Qpeak (2yr storm) in Existing Condition: 7.3 cfs

Detention Volume Required: 57,619 cu-ft (79,397 - 21,780)
Detention Vol provided by 5 unit Contech Chamber System (Via retention/Infiltration): 31,500 cu-ft
(See capacity calc hereon)
Detention Vol provided by Retention/Infiltration Basin (4.5' water depth): 39,204 cu-ft
(See capacity calc hereon)
Total Detention Volume Provided: 70,704 cu-ft > 57,619 cu-ft required.

```
************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
        (c) Copyright 1983-2016 Advanced Engineering Software (aes)
            Ver. 23.0  Release Date: 07/01/2016  License ID 1400

                          Analysis prepared by:



 ************************* DESCRIPTION OF STUDY *************************
* HIGHLAND/PALM AVE RESIDENTIAL                                         *
* 2-YEAR STORM EVENT                                                    *
* DEVELOPED CONDITION                                                   *
 ************************************************************************

  FILE NAME: PALM.DAT
  TIME/DATE OF STUDY: 15:06 10/08/2021
========================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
========================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.7000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.5640

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
========================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =  2005.00
  ELEVATION DATA: UPSTREAM(FEET) =   1415.00  DOWNSTREAM(FEET) =   1366.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.448
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.395
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
        LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      A       15.20      0.98     0.400    32   16.45
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
```

```
  SUBAREA RUNOFF(CFS) =     13.75
  TOTAL AREA(ACRES) =     15.20   PEAK FLOW RATE(CFS) =     13.75
================================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       15.2  TC(MIN.) =     16.45
  EFFECTIVE AREA(ACRES) =     15.20  AREA-AVERAGED Fm(INCH/HR)=  0.39
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap = 0.400
  PEAK FLOW RATE(CFS)   =      13.75
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

```
************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
        (c) Copyright 1983-2016 Advanced Engineering Software (aes)
            Ver. 23.0  Release Date: 07/01/2016  License ID 1400

                          Analysis prepared by:



 ************************* DESCRIPTION OF STUDY *************************
* HIGHLAND/PALM AVE RESIDENTIAL                                         *
* 2-YEAR STORM EVENT                                                    *
* EXISTING CONDITION                                                    *
 ************************************************************************

  FILE NAME: PALM.DAT
  TIME/DATE OF STUDY: 15:00 10/08/2021
========================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
========================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.7000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.5640

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
========================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =  1331.00
  ELEVATION DATA: UPSTREAM(FEET) =   1417.00  DOWNSTREAM(FEET) =   1360.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.250
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.407
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
        LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  ".4 DWELLING/ACRE"         A       15.20      0.98     0.900    32   16.25
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.900
```

```
  SUBAREA RUNOFF(CFS) =      7.25
  TOTAL AREA(ACRES) =     15.20   PEAK FLOW RATE(CFS) =      7.25
================================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       15.2  TC(MIN.) =     16.25
  EFFECTIVE AREA(ACRES) =     15.20  AREA-AVERAGED Fm(INCH/HR)=  0.88
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap = 0.900
  PEAK FLOW RATE(CFS)   =       7.25
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

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

Study date 10/08/21

++

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

Program License Serial Number 6484

UH METHOD
2YR 24HR DURATION STORM
DEVELOPED CONDITION

Storm Event Year = 2

Antecedent Moisture Condition = 2

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		
15.20	1	0.56
Rainfall data for year 2		
15.20	6	1.35
Rainfall data for year 2		
15.20	24	2.48

++

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

SCS curve No.(AMCII)	SCS curve NO.(AMC 2)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
32.0	32.0	15.20	1.000	0.978	0.400	0.391

Area-averaged adjusted loss rate Fm (In/Hr) = 0.391

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

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC2)	S	Pervious Yield Fr
6.08	0.400	32.0	32.0	12.40	0.000
9.12	0.600	98.0	98.0	0.20	0.908

Area-averaged catchment yield fraction, Y = 0.545
Area-averaged low loss fraction, Yb = 0.455
Direct entry of lag time by user
++

Watershed area = 15.20(Ac.)
Catchment Lag time = 0.219 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 38.0518
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.391(In/Hr)
Average low loss rate fraction (Yb) = 0.455 (decimal)
VALLEY DEVELOPED S-Graph Selected
Computed peak 5-minute rainfall = 0.268(In)
Computed peak 30-minute rainfall = 0.458(In)
Specified peak 1-hour rainfall = 0.564(In)
Computed peak 3-hour rainfall = 0.963(In)
Specified peak 6-hour rainfall = 1.350(In)
Specified peak 24-hour rainfall = 2.480(In)

Rainfall depth area reduction factors:
Using a total area of 15.20(Ac.) (Ref: fig. E-4)

5-minute factor = 0.999 Adjusted rainfall = 0.267(In)
30-minute factor = 0.999 Adjusted rainfall = 0.458(In)
1-hour factor = 0.999 Adjusted rainfall = 0.564(In)
3-hour factor = 1.000 Adjusted rainfall = 0.963(In)
6-hour factor = 1.000 Adjusted rainfall = 1.350(In)
24-hour factor = 1.000 Adjusted rainfall = 2.480(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 = 183.82 (CFS))	
1	2.799	5.146
2	17.778	27.535
3	45.354	50.691
4	74.454	53.493
5	89.282	27.258
6	95.700	11.797
7	98.186	4.570
8	98.937	1.381
9	99.620	1.256
10	100.000	0.698

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.2674	0.2674
2	0.3292	0.0618
3	0.3718	0.0426
4	0.4054	0.0335
5	0.4334	0.0281
6	0.4578	0.0244
7	0.4795	0.0217
8	0.4990	0.0196
9	0.5170	0.0179
10	0.5336	0.0166
11	0.5491	0.0155
12	0.5636	0.0145
13	0.5860	0.0224
14	0.6076	0.0216
15	0.6284	0.0208
16	0.6485	0.0201
17	0.6679	0.0195
18	0.6868	0.0189
19	0.7052	0.0184
20	0.7230	0.0179
21	0.7405	0.0174
22	0.7574	0.0170
23	0.7740	0.0166
24	0.7903	0.0162

25	0.8062	0.0159
26	0.8217	0.0156
27	0.8370	0.0153
28	0.8520	0.0150
29	0.8667	0.0147
30	0.8811	0.0144
31	0.8953	0.0142
32	0.9093	0.0140
33	0.9231	0.0137
34	0.9366	0.0135
35	0.9499	0.0133
36	0.9631	0.0131
37	0.9760	0.0129
38	0.9888	0.0128
39	1.0014	0.0126
40	1.0138	0.0124
41	1.0261	0.0123
42	1.0382	0.0121
43	1.0501	0.0120
44	1.0620	0.0118
45	1.0737	0.0117
46	1.0852	0.0116
47	1.0967	0.0114
48	1.1080	0.0113
49	1.1191	0.0112
50	1.1302	0.0111
51	1.1412	0.0110
52	1.1520	0.0108
53	1.1628	0.0107
54	1.1734	0.0106
55	1.1839	0.0105
56	1.1944	0.0104
57	1.2047	0.0103
58	1.2150	0.0103
59	1.2251	0.0102
60	1.2352	0.0101
61	1.2452	0.0100
62	1.2551	0.0099
63	1.2649	0.0098
64	1.2747	0.0097
65	1.2843	0.0097
66	1.2939	0.0096
67	1.3034	0.0095
68	1.3129	0.0094
69	1.3222	0.0094
70	1.3315	0.0093
71	1.3408	0.0092
72	1.3499	0.0092
73	1.3581	0.0082
74	1.3663	0.0081
75	1.3743	0.0081
76	1.3823	0.0080
77	1.3903	0.0080
78	1.3982	0.0079
79	1.4060	0.0078
80	1.4138	0.0078
81	1.4215	0.0077
82	1.4292	0.0077
83	1.4368	0.0076
84	1.4444	0.0076
85	1.4519	0.0075
86	1.4594	0.0075
87	1.4668	0.0074
88	1.4742	0.0074
89	1.4815	0.0073
90	1.4888	0.0073
91	1.4960	0.0072
92	1.5032	0.0072
93	1.5103	0.0071
94	1.5174	0.0071
95	1.5245	0.0071

96	1.5315	0.0070
97	1.5385	0.0070
98	1.5454	0.0069
99	1.5523	0.0069
100	1.5592	0.0069
101	1.5660	0.0068
102	1.5728	0.0068
103	1.5796	0.0067
104	1.5863	0.0067
105	1.5929	0.0067
106	1.5996	0.0066
107	1.6062	0.0066
108	1.6127	0.0066
109	1.6193	0.0065
110	1.6258	0.0065
111	1.6322	0.0065
112	1.6387	0.0064
113	1.6451	0.0064
114	1.6515	0.0064
115	1.6578	0.0063
116	1.6641	0.0063
117	1.6704	0.0063
118	1.6766	0.0062
119	1.6829	0.0062
120	1.6890	0.0062
121	1.6952	0.0062
122	1.7013	0.0061
123	1.7074	0.0061
124	1.7135	0.0061
125	1.7196	0.0060
126	1.7256	0.0060
127	1.7316	0.0060
128	1.7375	0.0060
129	1.7435	0.0059
130	1.7494	0.0059
131	1.7553	0.0059
132	1.7612	0.0059
133	1.7670	0.0058
134	1.7728	0.0058
135	1.7786	0.0058
136	1.7844	0.0058
137	1.7901	0.0057
138	1.7958	0.0057
139	1.8015	0.0057
140	1.8072	0.0057
141	1.8129	0.0057
142	1.8185	0.0056
143	1.8241	0.0056
144	1.8297	0.0056
145	1.8353	0.0056
146	1.8408	0.0055
147	1.8463	0.0055
148	1.8518	0.0055
149	1.8573	0.0055
150	1.8628	0.0055
151	1.8682	0.0054
152	1.8736	0.0054
153	1.8790	0.0054
154	1.8844	0.0054
155	1.8897	0.0054
156	1.8951	0.0053
157	1.9004	0.0053
158	1.9057	0.0053
159	1.9110	0.0053
160	1.9163	0.0053
161	1.9215	0.0052
162	1.9267	0.0052
163	1.9319	0.0052
164	1.9371	0.0052
165	1.9423	0.0052
166	1.9475	0.0052

167	1.9526	0.0051
168	1.9577	0.0051
169	1.9628	0.0051
170	1.9679	0.0051
171	1.9730	0.0051
172	1.9780	0.0051
173	1.9831	0.0050
174	1.9881	0.0050
175	1.9931	0.0050
176	1.9981	0.0050
177	2.0030	0.0050
178	2.0080	0.0050
179	2.0129	0.0049
180	2.0179	0.0049
181	2.0228	0.0049
182	2.0277	0.0049
183	2.0326	0.0049
184	2.0374	0.0049
185	2.0423	0.0049
186	2.0471	0.0048
187	2.0519	0.0048
188	2.0567	0.0048
189	2.0615	0.0048
190	2.0663	0.0048
191	2.0711	0.0048
192	2.0758	0.0048
193	2.0806	0.0047
194	2.0853	0.0047
195	2.0900	0.0047
196	2.0947	0.0047
197	2.0994	0.0047
198	2.1040	0.0047
199	2.1087	0.0047
200	2.1133	0.0046
201	2.1180	0.0046
202	2.1226	0.0046
203	2.1272	0.0046
204	2.1318	0.0046
205	2.1364	0.0046
206	2.1409	0.0046
207	2.1455	0.0046
208	2.1500	0.0045
209	2.1545	0.0045
210	2.1591	0.0045
211	2.1636	0.0045
212	2.1681	0.0045
213	2.1725	0.0045
214	2.1770	0.0045
215	2.1815	0.0045
216	2.1859	0.0044
217	2.1903	0.0044
218	2.1948	0.0044
219	2.1992	0.0044
220	2.2036	0.0044
221	2.2080	0.0044
222	2.2123	0.0044
223	2.2167	0.0044
224	2.2211	0.0044
225	2.2254	0.0043
226	2.2297	0.0043
227	2.2341	0.0043
228	2.2384	0.0043
229	2.2427	0.0043
230	2.2470	0.0043
231	2.2512	0.0043
232	2.2555	0.0043
233	2.2598	0.0043
234	2.2640	0.0042
235	2.2683	0.0042
236	2.2725	0.0042
237	2.2767	0.0042

238	2.2809	0.0042
239	2.2851	0.0042
240	2.2893	0.0042
241	2.2935	0.0042
242	2.2977	0.0042
243	2.3018	0.0042
244	2.3060	0.0042
245	2.3101	0.0041
246	2.3143	0.0041
247	2.3184	0.0041
248	2.3225	0.0041
249	2.3266	0.0041
250	2.3307	0.0041
251	2.3348	0.0041
252	2.3388	0.0041
253	2.3429	0.0041
254	2.3470	0.0041
255	2.3510	0.0040
256	2.3551	0.0040
257	2.3591	0.0040
258	2.3631	0.0040
259	2.3671	0.0040
260	2.3711	0.0040
261	2.3751	0.0040
262	2.3791	0.0040
263	2.3831	0.0040
264	2.3871	0.0040
265	2.3910	0.0040
266	2.3950	0.0040
267	2.3989	0.0039
268	2.4029	0.0039
269	2.4068	0.0039
270	2.4107	0.0039
271	2.4146	0.0039
272	2.4185	0.0039
273	2.4224	0.0039
274	2.4263	0.0039
275	2.4302	0.0039
276	2.4341	0.0039
277	2.4379	0.0039
278	2.4418	0.0039
279	2.4457	0.0038
280	2.4495	0.0038
281	2.4533	0.0038
282	2.4572	0.0038
283	2.4610	0.0038
284	2.4648	0.0038
285	2.4686	0.0038
286	2.4724	0.0038
287	2.4762	0.0038
288	2.4800	0.0038

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0038	0.0017	0.0021
2	0.0038	0.0017	0.0021
3	0.0038	0.0017	0.0021
4	0.0038	0.0017	0.0021
5	0.0038	0.0017	0.0021
6	0.0038	0.0017	0.0021
7	0.0038	0.0018	0.0021
8	0.0039	0.0018	0.0021
9	0.0039	0.0018	0.0021
10	0.0039	0.0018	0.0021
11	0.0039	0.0018	0.0021
12	0.0039	0.0018	0.0021
13	0.0039	0.0018	0.0021
14	0.0039	0.0018	0.0021
15	0.0039	0.0018	0.0021

16	0.0040	0.0018	0.0022
17	0.0040	0.0018	0.0022
18	0.0040	0.0018	0.0022
19	0.0040	0.0018	0.0022
20	0.0040	0.0018	0.0022
21	0.0040	0.0018	0.0022
22	0.0040	0.0018	0.0022
23	0.0040	0.0018	0.0022
24	0.0041	0.0018	0.0022
25	0.0041	0.0019	0.0022
26	0.0041	0.0019	0.0022
27	0.0041	0.0019	0.0022
28	0.0041	0.0019	0.0022
29	0.0041	0.0019	0.0023
30	0.0041	0.0019	0.0023
31	0.0042	0.0019	0.0023
32	0.0042	0.0019	0.0023
33	0.0042	0.0019	0.0023
34	0.0042	0.0019	0.0023
35	0.0042	0.0019	0.0023
36	0.0042	0.0019	0.0023
37	0.0042	0.0019	0.0023
38	0.0043	0.0019	0.0023
39	0.0043	0.0019	0.0023
40	0.0043	0.0020	0.0023
41	0.0043	0.0020	0.0023
42	0.0043	0.0020	0.0024
43	0.0043	0.0020	0.0024
44	0.0044	0.0020	0.0024
45	0.0044	0.0020	0.0024
46	0.0044	0.0020	0.0024
47	0.0044	0.0020	0.0024
48	0.0044	0.0020	0.0024
49	0.0044	0.0020	0.0024
50	0.0045	0.0020	0.0024
51	0.0045	0.0020	0.0024
52	0.0045	0.0020	0.0024
53	0.0045	0.0021	0.0025
54	0.0045	0.0021	0.0025
55	0.0046	0.0021	0.0025
56	0.0046	0.0021	0.0025
57	0.0046	0.0021	0.0025
58	0.0046	0.0021	0.0025
59	0.0046	0.0021	0.0025
60	0.0046	0.0021	0.0025
61	0.0047	0.0021	0.0025
62	0.0047	0.0021	0.0025
63	0.0047	0.0021	0.0026
64	0.0047	0.0022	0.0026
65	0.0048	0.0022	0.0026
66	0.0048	0.0022	0.0026
67	0.0048	0.0022	0.0026
68	0.0048	0.0022	0.0026
69	0.0048	0.0022	0.0026
70	0.0049	0.0022	0.0026
71	0.0049	0.0022	0.0027
72	0.0049	0.0022	0.0027
73	0.0049	0.0022	0.0027
74	0.0049	0.0023	0.0027
75	0.0050	0.0023	0.0027
76	0.0050	0.0023	0.0027
77	0.0050	0.0023	0.0027
78	0.0050	0.0023	0.0027
79	0.0051	0.0023	0.0028
80	0.0051	0.0023	0.0028
81	0.0051	0.0023	0.0028
82	0.0051	0.0023	0.0028
83	0.0052	0.0024	0.0028
84	0.0052	0.0024	0.0028
85	0.0052	0.0024	0.0028
86	0.0052	0.0024	0.0029

87	0.0053	0.0024	0.0029
88	0.0053	0.0024	0.0029
89	0.0053	0.0024	0.0029
90	0.0054	0.0024	0.0029
91	0.0054	0.0025	0.0029
92	0.0054	0.0025	0.0030
93	0.0055	0.0025	0.0030
94	0.0055	0.0025	0.0030
95	0.0055	0.0025	0.0030
96	0.0055	0.0025	0.0030
97	0.0056	0.0025	0.0030
98	0.0056	0.0026	0.0031
99	0.0057	0.0026	0.0031
100	0.0057	0.0026	0.0031
101	0.0057	0.0026	0.0031
102	0.0057	0.0026	0.0031
103	0.0058	0.0026	0.0032
104	0.0058	0.0026	0.0032
105	0.0059	0.0027	0.0032
106	0.0059	0.0027	0.0032
107	0.0059	0.0027	0.0032
108	0.0060	0.0027	0.0033
109	0.0060	0.0027	0.0033
110	0.0060	0.0028	0.0033
111	0.0061	0.0028	0.0033
112	0.0061	0.0028	0.0033
113	0.0062	0.0028	0.0034
114	0.0062	0.0028	0.0034
115	0.0063	0.0029	0.0034
116	0.0063	0.0029	0.0034
117	0.0064	0.0029	0.0035
118	0.0064	0.0029	0.0035
119	0.0065	0.0029	0.0035
120	0.0065	0.0030	0.0035
121	0.0066	0.0030	0.0036
122	0.0066	0.0030	0.0036
123	0.0067	0.0030	0.0036
124	0.0067	0.0031	0.0037
125	0.0068	0.0031	0.0037
126	0.0068	0.0031	0.0037
127	0.0069	0.0031	0.0038
128	0.0069	0.0032	0.0038
129	0.0070	0.0032	0.0038
130	0.0071	0.0032	0.0038
131	0.0071	0.0033	0.0039
132	0.0072	0.0033	0.0039
133	0.0073	0.0033	0.0040
134	0.0073	0.0033	0.0040
135	0.0074	0.0034	0.0040
136	0.0075	0.0034	0.0041
137	0.0076	0.0034	0.0041
138	0.0076	0.0035	0.0041
139	0.0077	0.0035	0.0042
140	0.0078	0.0035	0.0042
141	0.0079	0.0036	0.0043
142	0.0080	0.0036	0.0043
143	0.0081	0.0037	0.0044
144	0.0081	0.0037	0.0044
145	0.0092	0.0042	0.0050
146	0.0092	0.0042	0.0050
147	0.0094	0.0043	0.0051
148	0.0094	0.0043	0.0051
149	0.0096	0.0044	0.0052
150	0.0097	0.0044	0.0053
151	0.0098	0.0045	0.0053
152	0.0099	0.0045	0.0054
153	0.0101	0.0046	0.0055
154	0.0102	0.0046	0.0055
155	0.0103	0.0047	0.0056
156	0.0104	0.0048	0.0057
157	0.0106	0.0048	0.0058

158	0.0107	0.0049	0.0058
159	0.0110	0.0050	0.0060
160	0.0111	0.0050	0.0060
161	0.0113	0.0051	0.0062
162	0.0114	0.0052	0.0062
163	0.0117	0.0053	0.0064
164	0.0118	0.0054	0.0064
165	0.0121	0.0055	0.0066
166	0.0123	0.0056	0.0067
167	0.0126	0.0057	0.0069
168	0.0128	0.0058	0.0070
169	0.0131	0.0060	0.0072
170	0.0133	0.0061	0.0073
171	0.0137	0.0063	0.0075
172	0.0140	0.0064	0.0076
173	0.0144	0.0066	0.0079
174	0.0147	0.0067	0.0080
175	0.0153	0.0070	0.0083
176	0.0156	0.0071	0.0085
177	0.0162	0.0074	0.0088
178	0.0166	0.0076	0.0090
179	0.0174	0.0079	0.0095
180	0.0179	0.0081	0.0097
181	0.0189	0.0086	0.0103
182	0.0195	0.0089	0.0106
183	0.0208	0.0095	0.0113
184	0.0216	0.0098	0.0117
185	0.0145	0.0066	0.0079
186	0.0155	0.0070	0.0084
187	0.0179	0.0082	0.0098
188	0.0196	0.0089	0.0107
189	0.0244	0.0111	0.0133
190	0.0281	0.0128	0.0153
191	0.0426	0.0194	0.0232
192	0.0618	0.0282	0.0337
193	0.2674	0.0326	0.2348
194	0.0335	0.0153	0.0183
195	0.0217	0.0099	0.0118
196	0.0166	0.0076	0.0090
197	0.0224	0.0102	0.0122
198	0.0201	0.0092	0.0109
199	0.0184	0.0084	0.0100
200	0.0170	0.0077	0.0093
201	0.0159	0.0072	0.0087
202	0.0150	0.0068	0.0082
203	0.0142	0.0065	0.0077
204	0.0135	0.0062	0.0074
205	0.0129	0.0059	0.0070
206	0.0124	0.0057	0.0068
207	0.0120	0.0055	0.0065
208	0.0116	0.0053	0.0063
209	0.0112	0.0051	0.0061
210	0.0108	0.0049	0.0059
211	0.0105	0.0048	0.0057
212	0.0103	0.0047	0.0056
213	0.0100	0.0045	0.0054
214	0.0097	0.0044	0.0053
215	0.0095	0.0043	0.0052
216	0.0093	0.0042	0.0051
217	0.0082	0.0037	0.0045
218	0.0080	0.0036	0.0044
219	0.0078	0.0036	0.0043
220	0.0077	0.0035	0.0042
221	0.0075	0.0034	0.0041
222	0.0074	0.0034	0.0040
223	0.0072	0.0033	0.0039
224	0.0071	0.0032	0.0039
225	0.0070	0.0032	0.0038
226	0.0069	0.0031	0.0037
227	0.0067	0.0031	0.0037
228	0.0066	0.0030	0.0036

229	0.0065	0.0030	0.0036
230	0.0064	0.0029	0.0035
231	0.0063	0.0029	0.0035
232	0.0062	0.0028	0.0034
233	0.0062	0.0028	0.0034
234	0.0061	0.0028	0.0033
235	0.0060	0.0027	0.0033
236	0.0059	0.0027	0.0032
237	0.0058	0.0027	0.0032
238	0.0058	0.0026	0.0031
239	0.0057	0.0026	0.0031
240	0.0056	0.0026	0.0031
241	0.0056	0.0025	0.0030
242	0.0055	0.0025	0.0030
243	0.0054	0.0025	0.0030
244	0.0054	0.0024	0.0029
245	0.0053	0.0024	0.0029
246	0.0053	0.0024	0.0029
247	0.0052	0.0024	0.0028
248	0.0052	0.0023	0.0028
249	0.0051	0.0023	0.0028
250	0.0051	0.0023	0.0028
251	0.0050	0.0023	0.0027
252	0.0050	0.0023	0.0027
253	0.0049	0.0022	0.0027
254	0.0049	0.0022	0.0026
255	0.0048	0.0022	0.0026
256	0.0048	0.0022	0.0026
257	0.0047	0.0022	0.0026
258	0.0047	0.0021	0.0026
259	0.0047	0.0021	0.0025
260	0.0046	0.0021	0.0025
261	0.0046	0.0021	0.0025
262	0.0045	0.0021	0.0025
263	0.0045	0.0021	0.0025
264	0.0045	0.0020	0.0024
265	0.0044	0.0020	0.0024
266	0.0044	0.0020	0.0024
267	0.0044	0.0020	0.0024
268	0.0043	0.0020	0.0024
269	0.0043	0.0020	0.0023
270	0.0043	0.0019	0.0023
271	0.0042	0.0019	0.0023
272	0.0042	0.0019	0.0023
273	0.0042	0.0019	0.0023
274	0.0042	0.0019	0.0023
275	0.0041	0.0019	0.0022
276	0.0041	0.0019	0.0022
277	0.0041	0.0019	0.0022
278	0.0040	0.0018	0.0022
279	0.0040	0.0018	0.0022
280	0.0040	0.0018	0.0022
281	0.0040	0.0018	0.0022
282	0.0039	0.0018	0.0021
283	0.0039	0.0018	0.0021
284	0.0039	0.0018	0.0021
285	0.0039	0.0018	0.0021
286	0.0038	0.0017	0.0021
287	0.0038	0.0017	0.0021
288	0.0038	0.0017	0.0021

Total soil rain loss = 1.04(In)
Total effective rainfall = 1.44(In)
Peak flow rate in flood hydrograph = 15.17(CFS)

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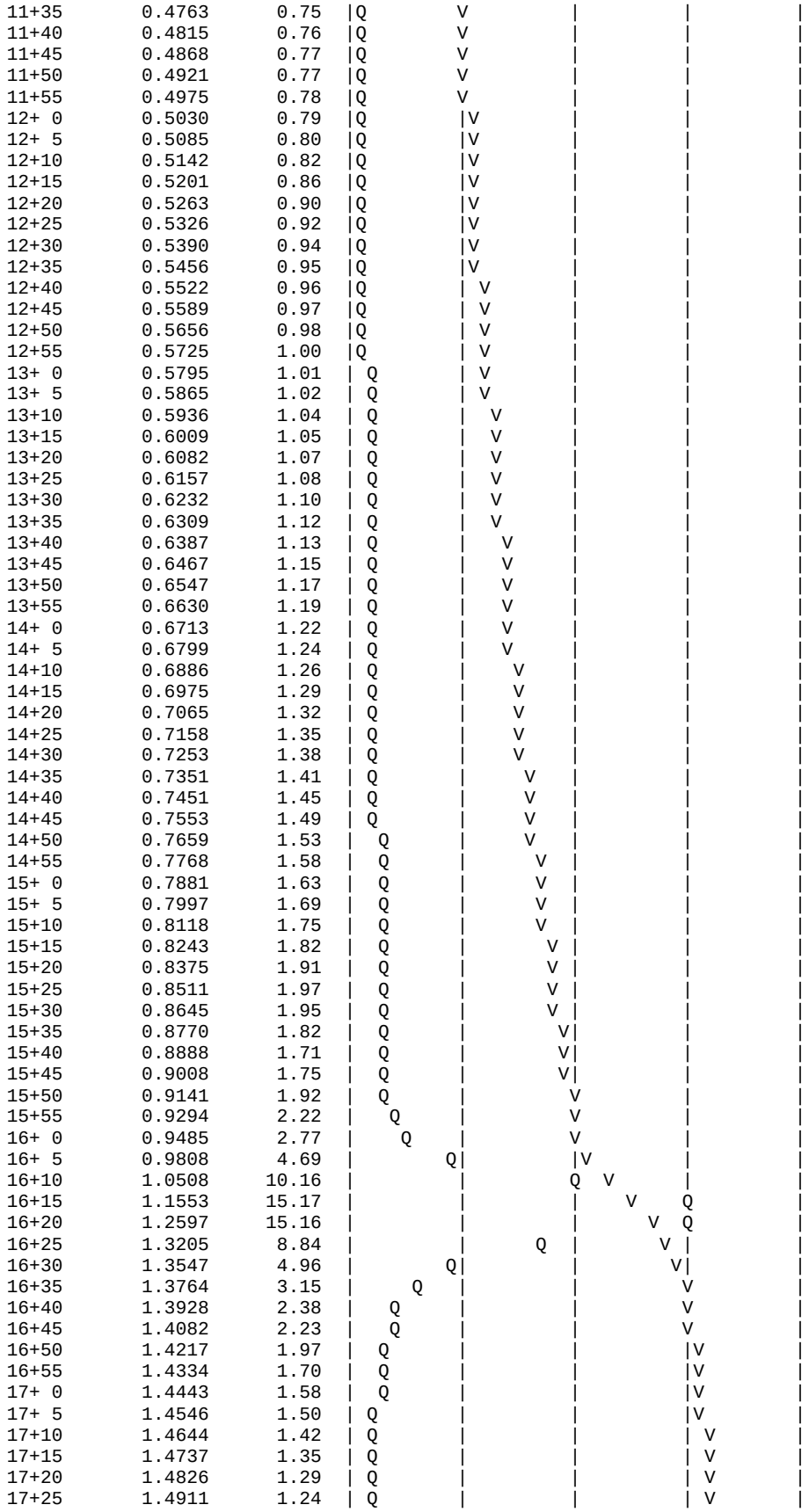
24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	5.0	10.0	15.0	20.0
0+ 5	0.0001	0.01	Q				
0+10	0.0005	0.07	Q				
0+15	0.0017	0.17	Q				
0+20	0.0037	0.28	Q				
0+25	0.0060	0.34	Q				
0+30	0.0085	0.36	Q				
0+35	0.0111	0.38	Q				
0+40	0.0137	0.38	Q				
0+45	0.0163	0.38	Q				
0+50	0.0190	0.39	Q				
0+55	0.0217	0.39	Q				
1+ 0	0.0243	0.39	Q				
1+ 5	0.0270	0.39	Q				
1+10	0.0297	0.39	Q				
1+15	0.0324	0.39	Q				
1+20	0.0351	0.39	Q				
1+25	0.0378	0.39	Q				
1+30	0.0405	0.40	Q				
1+35	0.0433	0.40	Q				
1+40	0.0460	0.40	QV				
1+45	0.0487	0.40	QV				
1+50	0.0515	0.40	QV				
1+55	0.0543	0.40	QV				
2+ 0	0.0570	0.40	QV				
2+ 5	0.0598	0.40	QV				
2+10	0.0626	0.41	QV				
2+15	0.0654	0.41	QV				
2+20	0.0682	0.41	QV				
2+25	0.0710	0.41	QV				
2+30	0.0739	0.41	QV				
2+35	0.0767	0.41	QV				
2+40	0.0796	0.41	QV				
2+45	0.0824	0.42	QV				
2+50	0.0853	0.42	QV				
2+55	0.0882	0.42	QV				
3+ 0	0.0911	0.42	QV				
3+ 5	0.0940	0.42	Q V				
3+10	0.0969	0.42	Q V				
3+15	0.0998	0.42	Q V				
3+20	0.1027	0.43	Q V				
3+25	0.1057	0.43	Q V				
3+30	0.1086	0.43	Q V				
3+35	0.1116	0.43	Q V				
3+40	0.1146	0.43	Q V				
3+45	0.1175	0.43	Q V				
3+50	0.1205	0.44	Q V				
3+55	0.1235	0.44	Q V				
4+ 0	0.1266	0.44	Q V				
4+ 5	0.1296	0.44	Q V				
4+10	0.1326	0.44	Q V				
4+15	0.1357	0.44	Q V				
4+20	0.1388	0.45	Q V				
4+25	0.1418	0.45	Q V				
4+30	0.1449	0.45	Q V				
4+35	0.1480	0.45	Q V				
4+40	0.1511	0.45	Q V				
4+45	0.1543	0.45	Q V				
4+50	0.1574	0.46	Q V				
4+55	0.1606	0.46	Q V				
5+ 0	0.1637	0.46	Q V				
5+ 5	0.1669	0.46	Q V				
5+10	0.1701	0.46	Q V				
5+15	0.1733	0.47	Q V				
5+20	0.1765	0.47	Q V				
5+25	0.1798	0.47	Q V				
5+30	0.1830	0.47	Q V				
5+35	0.1863	0.47	Q V				

5+40	0.1895	0.48	Q	V	|	|	|	|
5+45	0.1928	0.48	Q	V	|	|	|	|
5+50	0.1961	0.48	Q	V	|	|	|	|
5+55	0.1995	0.48	Q	V	|	|	|	|
6+ 0	0.2028	0.48	Q	V	|	|	|	|
6+ 5	0.2061	0.49	Q	V	|	|	|	|
6+10	0.2095	0.49	Q	V	|	|	|	|
6+15	0.2129	0.49	Q	V	|	|	|	|
6+20	0.2163	0.49	Q	V	|	|	|	|
6+25	0.2197	0.50	Q	V	|	|	|	|
6+30	0.2231	0.50	Q	V	|	|	|	|
6+35	0.2266	0.50	|Q	V	|	|	|	|
6+40	0.2300	0.50	|Q	V	|	|	|	|
6+45	0.2335	0.51	|Q	V	|	|	|	|
6+50	0.2370	0.51	|Q	V	|	|	|	|
6+55	0.2405	0.51	|Q	V	|	|	|	|
7+ 0	0.2441	0.51	|Q	V	|	|	|	|
7+ 5	0.2476	0.52	|Q	V	|	|	|	|
7+10	0.2512	0.52	|Q	V	|	|	|	|
7+15	0.2548	0.52	|Q	V	|	|	|	|
7+20	0.2584	0.52	|Q	V	|	|	|	|
7+25	0.2620	0.53	|Q	V	|	|	|	|
7+30	0.2656	0.53	|Q	V	|	|	|	|
7+35	0.2693	0.53	|Q	V	|	|	|	|
7+40	0.2730	0.53	|Q	V	|	|	|	|
7+45	0.2767	0.54	|Q	V	|	|	|	|
7+50	0.2804	0.54	|Q	V	|	|	|	|
7+55	0.2841	0.54	|Q	V	|	|	|	|
8+ 0	0.2879	0.55	|Q	V	|	|	|	|
8+ 5	0.2917	0.55	|Q	V	|	|	|	|
8+10	0.2955	0.55	|Q	V	|	|	|	|
8+15	0.2993	0.56	|Q	V	|	|	|	|
8+20	0.3032	0.56	|Q	V	|	|	|	|
8+25	0.3071	0.56	|Q	V	|	|	|	|
8+30	0.3110	0.57	|Q	V	|	|	|	|
8+35	0.3149	0.57	|Q	V	|	|	|	|
8+40	0.3188	0.57	|Q	V	|	|	|	|
8+45	0.3228	0.58	|Q	V	|	|	|	|
8+50	0.3268	0.58	|Q	V	|	|	|	|
8+55	0.3308	0.58	|Q	V	|	|	|	|
9+ 0	0.3349	0.59	|Q	V	|	|	|	|
9+ 5	0.3389	0.59	|Q	V	|	|	|	|
9+10	0.3430	0.60	|Q	V	|	|	|	|
9+15	0.3472	0.60	|Q	V	|	|	|	|
9+20	0.3513	0.60	|Q	V	|	|	|	|
9+25	0.3555	0.61	|Q	V	|	|	|	|
9+30	0.3597	0.61	|Q	V	|	|	|	|
9+35	0.3639	0.62	|Q	V	|	|	|	|
9+40	0.3682	0.62	|Q	V	|	|	|	|
9+45	0.3725	0.62	|Q	V	|	|	|	|
9+50	0.3768	0.63	|Q	V	|	|	|	|
9+55	0.3812	0.63	|Q	V	|	|	|	|
10+ 0	0.3856	0.64	|Q	V	|	|	|	|
10+ 5	0.3900	0.64	|Q	V	|	|	|	|
10+10	0.3945	0.65	|Q	V	|	|	|	|
10+15	0.3990	0.65	|Q	V	|	|	|	|
10+20	0.4035	0.66	|Q	V	|	|	|	|
10+25	0.4081	0.66	|Q	V	|	|	|	|
10+30	0.4127	0.67	|Q	V	|	|	|	|
10+35	0.4173	0.67	|Q	V	|	|	|	|
10+40	0.4220	0.68	|Q	V	|	|	|	|
10+45	0.4267	0.69	|Q	V	|	|	|	|
10+50	0.4315	0.69	|Q	V	|	|	|	|
10+55	0.4363	0.70	|Q	V	|	|	|	|
11+ 0	0.4411	0.70	|Q	V	|	|	|	|
11+ 5	0.4460	0.71	|Q	V	|	|	|	|
11+10	0.4509	0.72	|Q	V	|	|	|	|
11+15	0.4559	0.72	|Q	V	|	|	|	|
11+20	0.4609	0.73	|Q	V	|	|	|	|
11+25	0.4660	0.74	|Q	V	|	|	|	|
11+30	0.4711	0.74	|Q	V	|	|	|	|



17+30	1.4994	1.19	| Q	|	|	| V	|
17+35	1.5073	1.15	| Q	|	|	| V	|
17+40	1.5150	1.12	| Q	|	|	| V	|
17+45	1.5224	1.08	| Q	|	|	| V	|
17+50	1.5297	1.05	| Q	|	|	| V	|
17+55	1.5367	1.02	| Q	|	|	| V	|
18+ 0	1.5436	1.00	|Q	|	|	| V	|
18+ 5	1.5503	0.97	|Q	|	|	| V	|
18+10	1.5567	0.93	|Q	|	|	| V	|
18+15	1.5628	0.89	|Q	|	|	| V	|
18+20	1.5686	0.84	|Q	|	|	| V	|
18+25	1.5742	0.81	|Q	|	|	| V	|
18+30	1.5796	0.79	|Q	|	|	| V	|
18+35	1.5849	0.77	|Q	|	|	| V	|
18+40	1.5900	0.75	|Q	|	|	| V	|
18+45	1.5951	0.74	|Q	|	|	| V	|
18+50	1.6001	0.72	|Q	|	|	| V	|
18+55	1.6050	0.71	|Q	|	|	| V	|
19+ 0	1.6098	0.70	|Q	|	|	| V	|
19+ 5	1.6145	0.68	|Q	|	|	| V	|
19+10	1.6191	0.67	|Q	|	|	| V	|
19+15	1.6237	0.66	|Q	|	|	| V	|
19+20	1.6282	0.65	|Q	|	|	| V	|
19+25	1.6326	0.64	|Q	|	|	| V	|
19+30	1.6369	0.63	|Q	|	|	| V	|
19+35	1.6412	0.62	|Q	|	|	| V	|
19+40	1.6455	0.62	|Q	|	|	| V	|
19+45	1.6497	0.61	|Q	|	|	| V	|
19+50	1.6538	0.60	|Q	|	|	| V	|
19+55	1.6578	0.59	|Q	|	|	| V	|
20+ 0	1.6619	0.58	|Q	|	|	| V	|
20+ 5	1.6658	0.58	|Q	|	|	| V	|
20+10	1.6698	0.57	|Q	|	|	| V	|
20+15	1.6736	0.56	|Q	|	|	| V	|
20+20	1.6775	0.56	|Q	|	|	| V	|
20+25	1.6812	0.55	|Q	|	|	| V	|
20+30	1.6850	0.54	|Q	|	|	| V	|
20+35	1.6887	0.54	|Q	|	|	| V	|
20+40	1.6923	0.53	|Q	|	|	| V	|
20+45	1.6960	0.53	|Q	|	|	| V	|
20+50	1.6995	0.52	|Q	|	|	| V	|
20+55	1.7031	0.52	|Q	|	|	| V	|
21+ 0	1.7066	0.51	|Q	|	|	| V	|
21+ 5	1.7101	0.50	|Q	|	|	| V	|
21+10	1.7135	0.50	|Q	|	|	| V	|
21+15	1.7169	0.50	Q	|	|	| V	|
21+20	1.7203	0.49	Q	|	|	| V	|
21+25	1.7237	0.49	Q	|	|	| V	|
21+30	1.7270	0.48	Q	|	|	| V	|
21+35	1.7303	0.48	Q	|	|	| V	|
21+40	1.7335	0.47	Q	|	|	| V	|
21+45	1.7368	0.47	Q	|	|	| V	|
21+50	1.7400	0.47	Q	|	|	| V	|
21+55	1.7431	0.46	Q	|	|	| V	|
22+ 0	1.7463	0.46	Q	|	|	| V	|
22+ 5	1.7494	0.45	Q	|	|	| V	|
22+10	1.7525	0.45	Q	|	|	| V	|
22+15	1.7556	0.45	Q	|	|	| V	|
22+20	1.7586	0.44	Q	|	|	| V	|
22+25	1.7617	0.44	Q	|	|	| V	|
22+30	1.7647	0.44	Q	|	|	| V	|
22+35	1.7677	0.43	Q	|	|	| V	|
22+40	1.7706	0.43	Q	|	|	| V	|
22+45	1.7736	0.43	Q	|	|	| V	|
22+50	1.7765	0.42	Q	|	|	| V	|
22+55	1.7794	0.42	Q	|	|	| V	|
23+ 0	1.7823	0.42	Q	|	|	| V	|
23+ 5	1.7851	0.41	Q	|	|	| V	|
23+10	1.7880	0.41	Q	|	|	| V	|
23+15	1.7908	0.41	Q	|	|	| V	|
23+20	1.7936	0.41	Q	|	|	| V	|

```
  23+25       1.7964      0.40  Q         |         |         |         V|
  23+30       1.7991      0.40  Q         |         |         |         V|
  23+35       1.8019      0.40  Q         |         |         |         V|
  23+40       1.8046      0.40  Q         |         |         |         V|
  23+45       1.8073      0.39  Q         |         |         |         V|
  23+50       1.8100      0.39  Q         |         |         |         V|
  23+55       1.8127      0.39  Q         |         |         |         V|
  24+ 0       1.8153      0.39  Q         |         |         |         V|
  24+ 5       1.8179      0.37  Q         |         |         |         V|
  24+10       1.8201      0.31  Q         |         |         |         V|
  24+15       1.8215      0.21  Q         |         |         |         V|
  24+20       1.8222      0.10  Q         |         |         |         V|
  24+25       1.8225      0.04  Q         |         |         |         V|
  24+30       1.8226      0.02  Q         |         |         |         V|
  24+35       1.8226      0.01  Q         |         |         |         V|
  24+40       1.8227      0.00  Q         |         |         |         V|
  24+45       1.8227      0.00  Q         |         |         |          V
-------------------------------------------------------------------------
```

~ 79,397 CF

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

Study date 10/08/21

++

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

Program License Serial Number 6484

UH METHOD
2YR 24HR DURATION STORM
EXISTING CONDITION

Storm Event Year = 2

Antecedent Moisture Condition = 2

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		
15.20	1	0.56
Rainfall data for year 2		
15.20	6	1.35
Rainfall data for year 2		
15.20	24	2.48

++

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

SCS curve No.(AMCII)	SCS curve NO.(AMC 2)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
32.0	32.0	15.20	1.000	0.978	0.900	0.880

Area-averaged adjusted loss rate Fm (In/Hr) = 0.880

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

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC2)	S	Pervious Yield Fr
13.68	0.900	32.0	32.0	12.40	0.000
1.52	0.100	98.0	98.0	0.20	0.908

Area-averaged catchment yield fraction, Y = 0.091
Area-averaged low loss fraction, Yb = 0.909
Direct entry of lag time by user

++

Watershed area = 15.20(Ac.)
Catchment Lag time = 0.217 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 38.4025
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.880(In/Hr)
Average low loss rate fraction (Yb) = 0.909 (decimal)
VALLEY DEVELOPED S-Graph Selected
Computed peak 5-minute rainfall = 0.268(In)
Computed peak 30-minute rainfall = 0.458(In)
Specified peak 1-hour rainfall = 0.564(In)
Computed peak 3-hour rainfall = 0.963(In)
Specified peak 6-hour rainfall = 1.350(In)
Specified peak 24-hour rainfall = 2.480(In)

Rainfall depth area reduction factors:
Using a total area of 15.20(Ac.) (Ref: fig. E-4)

5-minute factor = 0.999 Adjusted rainfall = 0.267(In)
30-minute factor = 0.999 Adjusted rainfall = 0.458(In)
1-hour factor = 0.999 Adjusted rainfall = 0.564(In)
3-hour factor = 1.000 Adjusted rainfall = 0.963(In)
6-hour factor = 1.000 Adjusted rainfall = 1.350(In)
24-hour factor = 1.000 Adjusted rainfall = 2.480(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 = 183.82 (CFS))	
1	2.841	5.223
2	18.097	28.044
3	46.118	51.509
4	75.108	53.291
5	89.671	26.771
6	95.903	11.456
7	98.251	4.316
8	98.984	1.348
9	99.670	1.261
10	100.000	0.606

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.2674	0.2674
2	0.3292	0.0618
3	0.3718	0.0426
4	0.4054	0.0335
5	0.4334	0.0281
6	0.4578	0.0244
7	0.4795	0.0217
8	0.4990	0.0196
9	0.5170	0.0179
10	0.5336	0.0166
11	0.5491	0.0155
12	0.5636	0.0145
13	0.5860	0.0224
14	0.6076	0.0216
15	0.6284	0.0208
16	0.6485	0.0201
17	0.6679	0.0195
18	0.6868	0.0189
19	0.7052	0.0184
20	0.7230	0.0179
21	0.7405	0.0174
22	0.7574	0.0170
23	0.7740	0.0166
24	0.7903	0.0162

25	0.8062	0.0159
26	0.8217	0.0156
27	0.8370	0.0153
28	0.8520	0.0150
29	0.8667	0.0147
30	0.8811	0.0144
31	0.8953	0.0142
32	0.9093	0.0140
33	0.9231	0.0137
34	0.9366	0.0135
35	0.9499	0.0133
36	0.9631	0.0131
37	0.9760	0.0129
38	0.9888	0.0128
39	1.0014	0.0126
40	1.0138	0.0124
41	1.0261	0.0123
42	1.0382	0.0121
43	1.0501	0.0120
44	1.0620	0.0118
45	1.0737	0.0117
46	1.0852	0.0116
47	1.0967	0.0114
48	1.1080	0.0113
49	1.1191	0.0112
50	1.1302	0.0111
51	1.1412	0.0110
52	1.1520	0.0108
53	1.1628	0.0107
54	1.1734	0.0106
55	1.1839	0.0105
56	1.1944	0.0104
57	1.2047	0.0103
58	1.2150	0.0103
59	1.2251	0.0102
60	1.2352	0.0101
61	1.2452	0.0100
62	1.2551	0.0099
63	1.2649	0.0098
64	1.2747	0.0097
65	1.2843	0.0097
66	1.2939	0.0096
67	1.3034	0.0095
68	1.3129	0.0094
69	1.3222	0.0094
70	1.3315	0.0093
71	1.3408	0.0092
72	1.3499	0.0092
73	1.3581	0.0082
74	1.3663	0.0081
75	1.3743	0.0081
76	1.3823	0.0080
77	1.3903	0.0080
78	1.3982	0.0079
79	1.4060	0.0078
80	1.4138	0.0078
81	1.4215	0.0077
82	1.4292	0.0077
83	1.4368	0.0076
84	1.4444	0.0076
85	1.4519	0.0075
86	1.4594	0.0075
87	1.4668	0.0074
88	1.4742	0.0074
89	1.4815	0.0073
90	1.4888	0.0073
91	1.4960	0.0072
92	1.5032	0.0072
93	1.5103	0.0071
94	1.5174	0.0071
95	1.5245	0.0071

96	1.5315	0.0070
97	1.5385	0.0070
98	1.5454	0.0069
99	1.5523	0.0069
100	1.5592	0.0069
101	1.5660	0.0068
102	1.5728	0.0068
103	1.5796	0.0067
104	1.5863	0.0067
105	1.5929	0.0067
106	1.5996	0.0066
107	1.6062	0.0066
108	1.6127	0.0066
109	1.6193	0.0065
110	1.6258	0.0065
111	1.6322	0.0065
112	1.6387	0.0064
113	1.6451	0.0064
114	1.6515	0.0064
115	1.6578	0.0063
116	1.6641	0.0063
117	1.6704	0.0063
118	1.6766	0.0062
119	1.6829	0.0062
120	1.6890	0.0062
121	1.6952	0.0062
122	1.7013	0.0061
123	1.7074	0.0061
124	1.7135	0.0061
125	1.7196	0.0060
126	1.7256	0.0060
127	1.7316	0.0060
128	1.7375	0.0060
129	1.7435	0.0059
130	1.7494	0.0059
131	1.7553	0.0059
132	1.7612	0.0059
133	1.7670	0.0058
134	1.7728	0.0058
135	1.7786	0.0058
136	1.7844	0.0058
137	1.7901	0.0057
138	1.7958	0.0057
139	1.8015	0.0057
140	1.8072	0.0057
141	1.8129	0.0057
142	1.8185	0.0056
143	1.8241	0.0056
144	1.8297	0.0056
145	1.8353	0.0056
146	1.8408	0.0055
147	1.8463	0.0055
148	1.8518	0.0055
149	1.8573	0.0055
150	1.8628	0.0055
151	1.8682	0.0054
152	1.8736	0.0054
153	1.8790	0.0054
154	1.8844	0.0054
155	1.8897	0.0054
156	1.8951	0.0053
157	1.9004	0.0053
158	1.9057	0.0053
159	1.9110	0.0053
160	1.9163	0.0053
161	1.9215	0.0052
162	1.9267	0.0052
163	1.9319	0.0052
164	1.9371	0.0052
165	1.9423	0.0052
166	1.9475	0.0052

167	1.9526	0.0051
168	1.9577	0.0051
169	1.9628	0.0051
170	1.9679	0.0051
171	1.9730	0.0051
172	1.9780	0.0051
173	1.9831	0.0050
174	1.9881	0.0050
175	1.9931	0.0050
176	1.9981	0.0050
177	2.0030	0.0050
178	2.0080	0.0050
179	2.0129	0.0049
180	2.0179	0.0049
181	2.0228	0.0049
182	2.0277	0.0049
183	2.0326	0.0049
184	2.0374	0.0049
185	2.0423	0.0049
186	2.0471	0.0048
187	2.0519	0.0048
188	2.0567	0.0048
189	2.0615	0.0048
190	2.0663	0.0048
191	2.0711	0.0048
192	2.0758	0.0048
193	2.0806	0.0047
194	2.0853	0.0047
195	2.0900	0.0047
196	2.0947	0.0047
197	2.0994	0.0047
198	2.1040	0.0047
199	2.1087	0.0047
200	2.1133	0.0046
201	2.1180	0.0046
202	2.1226	0.0046
203	2.1272	0.0046
204	2.1318	0.0046
205	2.1364	0.0046
206	2.1409	0.0046
207	2.1455	0.0046
208	2.1500	0.0045
209	2.1545	0.0045
210	2.1591	0.0045
211	2.1636	0.0045
212	2.1681	0.0045
213	2.1725	0.0045
214	2.1770	0.0045
215	2.1815	0.0045
216	2.1859	0.0044
217	2.1903	0.0044
218	2.1948	0.0044
219	2.1992	0.0044
220	2.2036	0.0044
221	2.2080	0.0044
222	2.2123	0.0044
223	2.2167	0.0044
224	2.2211	0.0044
225	2.2254	0.0043
226	2.2297	0.0043
227	2.2341	0.0043
228	2.2384	0.0043
229	2.2427	0.0043
230	2.2470	0.0043
231	2.2512	0.0043
232	2.2555	0.0043
233	2.2598	0.0043
234	2.2640	0.0042
235	2.2683	0.0042
236	2.2725	0.0042
237	2.2767	0.0042

238	2.2809	0.0042
239	2.2851	0.0042
240	2.2893	0.0042
241	2.2935	0.0042
242	2.2977	0.0042
243	2.3018	0.0042
244	2.3060	0.0042
245	2.3101	0.0041
246	2.3143	0.0041
247	2.3184	0.0041
248	2.3225	0.0041
249	2.3266	0.0041
250	2.3307	0.0041
251	2.3348	0.0041
252	2.3388	0.0041
253	2.3429	0.0041
254	2.3470	0.0041
255	2.3510	0.0040
256	2.3551	0.0040
257	2.3591	0.0040
258	2.3631	0.0040
259	2.3671	0.0040
260	2.3711	0.0040
261	2.3751	0.0040
262	2.3791	0.0040
263	2.3831	0.0040
264	2.3871	0.0040
265	2.3910	0.0040
266	2.3950	0.0040
267	2.3989	0.0039
268	2.4029	0.0039
269	2.4068	0.0039
270	2.4107	0.0039
271	2.4146	0.0039
272	2.4185	0.0039
273	2.4224	0.0039
274	2.4263	0.0039
275	2.4302	0.0039
276	2.4341	0.0039
277	2.4379	0.0039
278	2.4418	0.0039
279	2.4457	0.0038
280	2.4495	0.0038
281	2.4533	0.0038
282	2.4572	0.0038
283	2.4610	0.0038
284	2.4648	0.0038
285	2.4686	0.0038
286	2.4724	0.0038
287	2.4762	0.0038
288	2.4800	0.0038

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0038	0.0034	0.0003
2	0.0038	0.0034	0.0003
3	0.0038	0.0035	0.0003
4	0.0038	0.0035	0.0003
5	0.0038	0.0035	0.0003
6	0.0038	0.0035	0.0003
7	0.0038	0.0035	0.0003
8	0.0039	0.0035	0.0004
9	0.0039	0.0035	0.0004
10	0.0039	0.0035	0.0004
11	0.0039	0.0035	0.0004
12	0.0039	0.0036	0.0004
13	0.0039	0.0036	0.0004
14	0.0039	0.0036	0.0004
15	0.0039	0.0036	0.0004

16	0.0040	0.0036	0.0004
17	0.0040	0.0036	0.0004
18	0.0040	0.0036	0.0004
19	0.0040	0.0036	0.0004
20	0.0040	0.0036	0.0004
21	0.0040	0.0037	0.0004
22	0.0040	0.0037	0.0004
23	0.0040	0.0037	0.0004
24	0.0041	0.0037	0.0004
25	0.0041	0.0037	0.0004
26	0.0041	0.0037	0.0004
27	0.0041	0.0037	0.0004
28	0.0041	0.0037	0.0004
29	0.0041	0.0038	0.0004
30	0.0041	0.0038	0.0004
31	0.0042	0.0038	0.0004
32	0.0042	0.0038	0.0004
33	0.0042	0.0038	0.0004
34	0.0042	0.0038	0.0004
35	0.0042	0.0038	0.0004
36	0.0042	0.0038	0.0004
37	0.0042	0.0039	0.0004
38	0.0043	0.0039	0.0004
39	0.0043	0.0039	0.0004
40	0.0043	0.0039	0.0004
41	0.0043	0.0039	0.0004
42	0.0043	0.0039	0.0004
43	0.0043	0.0040	0.0004
44	0.0044	0.0040	0.0004
45	0.0044	0.0040	0.0004
46	0.0044	0.0040	0.0004
47	0.0044	0.0040	0.0004
48	0.0044	0.0040	0.0004
49	0.0044	0.0040	0.0004
50	0.0045	0.0041	0.0004
51	0.0045	0.0041	0.0004
52	0.0045	0.0041	0.0004
53	0.0045	0.0041	0.0004
54	0.0045	0.0041	0.0004
55	0.0046	0.0041	0.0004
56	0.0046	0.0042	0.0004
57	0.0046	0.0042	0.0004
58	0.0046	0.0042	0.0004
59	0.0046	0.0042	0.0004
60	0.0046	0.0042	0.0004
61	0.0047	0.0042	0.0004
62	0.0047	0.0043	0.0004
63	0.0047	0.0043	0.0004
64	0.0047	0.0043	0.0004
65	0.0048	0.0043	0.0004
66	0.0048	0.0043	0.0004
67	0.0048	0.0044	0.0004
68	0.0048	0.0044	0.0004
69	0.0048	0.0044	0.0004
70	0.0049	0.0044	0.0004
71	0.0049	0.0044	0.0004
72	0.0049	0.0045	0.0004
73	0.0049	0.0045	0.0004
74	0.0049	0.0045	0.0004
75	0.0050	0.0045	0.0005
76	0.0050	0.0045	0.0005
77	0.0050	0.0046	0.0005
78	0.0050	0.0046	0.0005
79	0.0051	0.0046	0.0005
80	0.0051	0.0046	0.0005
81	0.0051	0.0047	0.0005
82	0.0051	0.0047	0.0005
83	0.0052	0.0047	0.0005
84	0.0052	0.0047	0.0005
85	0.0052	0.0048	0.0005
86	0.0052	0.0048	0.0005

87	0.0053	0.0048	0.0005
88	0.0053	0.0048	0.0005
89	0.0053	0.0049	0.0005
90	0.0054	0.0049	0.0005
91	0.0054	0.0049	0.0005
92	0.0054	0.0049	0.0005
93	0.0055	0.0050	0.0005
94	0.0055	0.0050	0.0005
95	0.0055	0.0050	0.0005
96	0.0055	0.0050	0.0005
97	0.0056	0.0051	0.0005
98	0.0056	0.0051	0.0005
99	0.0057	0.0051	0.0005
100	0.0057	0.0052	0.0005
101	0.0057	0.0052	0.0005
102	0.0057	0.0052	0.0005
103	0.0058	0.0053	0.0005
104	0.0058	0.0053	0.0005
105	0.0059	0.0053	0.0005
106	0.0059	0.0054	0.0005
107	0.0059	0.0054	0.0005
108	0.0060	0.0054	0.0005
109	0.0060	0.0055	0.0005
110	0.0060	0.0055	0.0005
111	0.0061	0.0055	0.0006
112	0.0061	0.0056	0.0006
113	0.0062	0.0056	0.0006
114	0.0062	0.0057	0.0006
115	0.0063	0.0057	0.0006
116	0.0063	0.0057	0.0006
117	0.0064	0.0058	0.0006
118	0.0064	0.0058	0.0006
119	0.0065	0.0059	0.0006
120	0.0065	0.0059	0.0006
121	0.0066	0.0060	0.0006
122	0.0066	0.0060	0.0006
123	0.0067	0.0061	0.0006
124	0.0067	0.0061	0.0006
125	0.0068	0.0062	0.0006
126	0.0068	0.0062	0.0006
127	0.0069	0.0063	0.0006
128	0.0069	0.0063	0.0006
129	0.0070	0.0064	0.0006
130	0.0071	0.0064	0.0006
131	0.0071	0.0065	0.0006
132	0.0072	0.0065	0.0007
133	0.0073	0.0066	0.0007
134	0.0073	0.0067	0.0007
135	0.0074	0.0067	0.0007
136	0.0075	0.0068	0.0007
137	0.0076	0.0069	0.0007
138	0.0076	0.0069	0.0007
139	0.0077	0.0070	0.0007
140	0.0078	0.0071	0.0007
141	0.0079	0.0072	0.0007
142	0.0080	0.0072	0.0007
143	0.0081	0.0073	0.0007
144	0.0081	0.0074	0.0007
145	0.0092	0.0083	0.0008
146	0.0092	0.0084	0.0008
147	0.0094	0.0085	0.0009
148	0.0094	0.0086	0.0009
149	0.0096	0.0087	0.0009
150	0.0097	0.0088	0.0009
151	0.0098	0.0089	0.0009
152	0.0099	0.0090	0.0009
153	0.0101	0.0092	0.0009
154	0.0102	0.0092	0.0009
155	0.0103	0.0094	0.0009
156	0.0104	0.0095	0.0009
157	0.0106	0.0097	0.0010

158	0.0107	0.0098	0.0010
159	0.0110	0.0100	0.0010
160	0.0111	0.0101	0.0010
161	0.0113	0.0103	0.0010
162	0.0114	0.0104	0.0010
163	0.0117	0.0106	0.0011
164	0.0118	0.0108	0.0011
165	0.0121	0.0110	0.0011
166	0.0123	0.0112	0.0011
167	0.0126	0.0114	0.0011
168	0.0128	0.0116	0.0012
169	0.0131	0.0119	0.0012
170	0.0133	0.0121	0.0012
171	0.0137	0.0125	0.0012
172	0.0140	0.0127	0.0013
173	0.0144	0.0131	0.0013
174	0.0147	0.0134	0.0013
175	0.0153	0.0139	0.0014
176	0.0156	0.0142	0.0014
177	0.0162	0.0148	0.0015
178	0.0166	0.0151	0.0015
179	0.0174	0.0158	0.0016
180	0.0179	0.0162	0.0016
181	0.0189	0.0172	0.0017
182	0.0195	0.0177	0.0018
183	0.0208	0.0189	0.0019
184	0.0216	0.0196	0.0020
185	0.0145	0.0132	0.0013
186	0.0155	0.0141	0.0014
187	0.0179	0.0163	0.0016
188	0.0196	0.0178	0.0018
189	0.0244	0.0222	0.0022
190	0.0281	0.0255	0.0025
191	0.0426	0.0387	0.0039
192	0.0618	0.0562	0.0056
193	0.2674	0.0733	0.1941
194	0.0335	0.0305	0.0030
195	0.0217	0.0197	0.0020
196	0.0166	0.0151	0.0015
197	0.0224	0.0204	0.0020
198	0.0201	0.0183	0.0018
199	0.0184	0.0167	0.0017
200	0.0170	0.0154	0.0015
201	0.0159	0.0144	0.0014
202	0.0150	0.0136	0.0014
203	0.0142	0.0129	0.0013
204	0.0135	0.0123	0.0012
205	0.0129	0.0118	0.0012
206	0.0124	0.0113	0.0011
207	0.0120	0.0109	0.0011
208	0.0116	0.0105	0.0010
209	0.0112	0.0102	0.0010
210	0.0108	0.0099	0.0010
211	0.0105	0.0096	0.0010
212	0.0103	0.0093	0.0009
213	0.0100	0.0091	0.0009
214	0.0097	0.0089	0.0009
215	0.0095	0.0087	0.0009
216	0.0093	0.0085	0.0008
217	0.0082	0.0074	0.0007
218	0.0080	0.0073	0.0007
219	0.0078	0.0071	0.0007
220	0.0077	0.0070	0.0007
221	0.0075	0.0068	0.0007
222	0.0074	0.0067	0.0007
223	0.0072	0.0066	0.0007
224	0.0071	0.0065	0.0006
225	0.0070	0.0063	0.0006
226	0.0069	0.0062	0.0006
227	0.0067	0.0061	0.0006
228	0.0066	0.0060	0.0006

229	0.0065	0.0059	0.0006
230	0.0064	0.0059	0.0006
231	0.0063	0.0058	0.0006
232	0.0062	0.0057	0.0006
233	0.0062	0.0056	0.0006
234	0.0061	0.0055	0.0006
235	0.0060	0.0055	0.0005
236	0.0059	0.0054	0.0005
237	0.0058	0.0053	0.0005
238	0.0058	0.0052	0.0005
239	0.0057	0.0052	0.0005
240	0.0056	0.0051	0.0005
241	0.0056	0.0051	0.0005
242	0.0055	0.0050	0.0005
243	0.0054	0.0049	0.0005
244	0.0054	0.0049	0.0005
245	0.0053	0.0048	0.0005
246	0.0053	0.0048	0.0005
247	0.0052	0.0047	0.0005
248	0.0052	0.0047	0.0005
249	0.0051	0.0046	0.0005
250	0.0051	0.0046	0.0005
251	0.0050	0.0046	0.0005
252	0.0050	0.0045	0.0004
253	0.0049	0.0045	0.0004
254	0.0049	0.0044	0.0004
255	0.0048	0.0044	0.0004
256	0.0048	0.0043	0.0004
257	0.0047	0.0043	0.0004
258	0.0047	0.0043	0.0004
259	0.0047	0.0042	0.0004
260	0.0046	0.0042	0.0004
261	0.0046	0.0042	0.0004
262	0.0045	0.0041	0.0004
263	0.0045	0.0041	0.0004
264	0.0045	0.0041	0.0004
265	0.0044	0.0040	0.0004
266	0.0044	0.0040	0.0004
267	0.0044	0.0040	0.0004
268	0.0043	0.0039	0.0004
269	0.0043	0.0039	0.0004
270	0.0043	0.0039	0.0004
271	0.0042	0.0039	0.0004
272	0.0042	0.0038	0.0004
273	0.0042	0.0038	0.0004
274	0.0042	0.0038	0.0004
275	0.0041	0.0037	0.0004
276	0.0041	0.0037	0.0004
277	0.0041	0.0037	0.0004
278	0.0040	0.0037	0.0004
279	0.0040	0.0036	0.0004
280	0.0040	0.0036	0.0004
281	0.0040	0.0036	0.0004
282	0.0039	0.0036	0.0004
283	0.0039	0.0036	0.0004
284	0.0039	0.0035	0.0004
285	0.0039	0.0035	0.0004
286	0.0038	0.0035	0.0003
287	0.0038	0.0035	0.0003
288	0.0038	0.0035	0.0003

Total soil rain loss = 2.09(In)
Total effective rainfall = 0.39(In)
Peak flow rate in flood hydrograph = 10.78(CFS)

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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	5.0	10.0	15.0	20.0
0+ 5	0.0000	0.00	Q				
0+10	0.0001	0.01	Q				
0+15	0.0003	0.03	Q				
0+20	0.0006	0.05	Q				
0+25	0.0010	0.06	Q				
0+30	0.0014	0.06	Q				
0+35	0.0019	0.06	Q				
0+40	0.0023	0.06	Q				
0+45	0.0027	0.06	Q				
0+50	0.0032	0.06	Q				
0+55	0.0036	0.06	Q				
1+ 0	0.0041	0.06	Q				
1+ 5	0.0045	0.06	Q				
1+10	0.0050	0.07	Q				
1+15	0.0054	0.07	Q				
1+20	0.0059	0.07	Q				
1+25	0.0063	0.07	Q				
1+30	0.0068	0.07	Q				
1+35	0.0072	0.07	Q				
1+40	0.0077	0.07	Q				
1+45	0.0081	0.07	Q				
1+50	0.0086	0.07	Q				
1+55	0.0091	0.07	Q				
2+ 0	0.0095	0.07	Q				
2+ 5	0.0100	0.07	Q				
2+10	0.0104	0.07	Q				
2+15	0.0109	0.07	Q				
2+20	0.0114	0.07	Q				
2+25	0.0119	0.07	Q				
2+30	0.0123	0.07	Q				
2+35	0.0128	0.07	QV				
2+40	0.0133	0.07	QV				
2+45	0.0137	0.07	QV				
2+50	0.0142	0.07	QV				
2+55	0.0147	0.07	QV				
3+ 0	0.0152	0.07	QV				
3+ 5	0.0157	0.07	QV				
3+10	0.0162	0.07	QV				
3+15	0.0166	0.07	QV				
3+20	0.0171	0.07	QV				
3+25	0.0176	0.07	QV				
3+30	0.0181	0.07	QV				
3+35	0.0186	0.07	QV				
3+40	0.0191	0.07	QV				
3+45	0.0196	0.07	QV				
3+50	0.0201	0.07	QV				
3+55	0.0206	0.07	QV				
4+ 0	0.0211	0.07	QV				
4+ 5	0.0216	0.07	QV				
4+10	0.0221	0.07	QV				
4+15	0.0226	0.07	QV				
4+20	0.0231	0.07	QV				
4+25	0.0237	0.07	QV				
4+30	0.0242	0.07	QV				
4+35	0.0247	0.08	QV				
4+40	0.0252	0.08	Q V				
4+45	0.0257	0.08	Q V				
4+50	0.0262	0.08	Q V				
4+55	0.0268	0.08	Q V				
5+ 0	0.0273	0.08	Q V				
5+ 5	0.0278	0.08	Q V				
5+10	0.0284	0.08	Q V				
5+15	0.0289	0.08	Q V				
5+20	0.0294	0.08	Q V				
5+25	0.0300	0.08	Q V				
5+30	0.0305	0.08	Q V				
5+35	0.0311	0.08	Q V				

5+40	0.0316	0.08	Q V	|	|	|	|
5+45	0.0322	0.08	Q V	|	|	|	|
5+50	0.0327	0.08	Q V	|	|	|	|
5+55	0.0333	0.08	Q V	|	|	|	|
6+ 0	0.0338	0.08	Q V	|	|	|	|
6+ 5	0.0344	0.08	Q V	|	|	|	|
6+10	0.0349	0.08	Q V	|	|	|	|
6+15	0.0355	0.08	Q V	|	|	|	|
6+20	0.0361	0.08	Q V	|	|	|	|
6+25	0.0366	0.08	Q V	|	|	|	|
6+30	0.0372	0.08	Q V	|	|	|	|
6+35	0.0378	0.08	Q V	|	|	|	|
6+40	0.0384	0.08	Q V	|	|	|	|
6+45	0.0389	0.08	Q V	|	|	|	|
6+50	0.0395	0.08	Q V	|	|	|	|
6+55	0.0401	0.09	Q V	|	|	|	|
7+ 0	0.0407	0.09	Q V	|	|	|	|
7+ 5	0.0413	0.09	Q V	|	|	|	|
7+10	0.0419	0.09	Q V	|	|	|	|
7+15	0.0425	0.09	Q V	|	|	|	|
7+20	0.0431	0.09	Q V	|	|	|	|
7+25	0.0437	0.09	Q V	|	|	|	|
7+30	0.0443	0.09	Q V	|	|	|	|
7+35	0.0449	0.09	Q V	|	|	|	|
7+40	0.0455	0.09	Q V	|	|	|	|
7+45	0.0461	0.09	Q V	|	|	|	|
7+50	0.0467	0.09	Q V	|	|	|	|
7+55	0.0474	0.09	Q V	|	|	|	|
8+ 0	0.0480	0.09	Q V	|	|	|	|
8+ 5	0.0486	0.09	Q V	|	|	|	|
8+10	0.0493	0.09	Q V	|	|	|	|
8+15	0.0499	0.09	Q V	|	|	|	|
8+20	0.0505	0.09	Q V	|	|	|	|
8+25	0.0512	0.09	Q V	|	|	|	|
8+30	0.0518	0.09	Q V	|	|	|	|
8+35	0.0525	0.09	Q V	|	|	|	|
8+40	0.0532	0.10	Q V	|	|	|	|
8+45	0.0538	0.10	Q V	|	|	|	|
8+50	0.0545	0.10	Q V	|	|	|	|
8+55	0.0552	0.10	Q V	|	|	|	|
9+ 0	0.0558	0.10	Q V	|	|	|	|
9+ 5	0.0565	0.10	Q V	|	|	|	|
9+10	0.0572	0.10	Q V	|	|	|	|
9+15	0.0579	0.10	Q V	|	|	|	|
9+20	0.0586	0.10	Q V	|	|	|	|
9+25	0.0593	0.10	Q V	|	|	|	|
9+30	0.0600	0.10	Q V	|	|	|	|
9+35	0.0607	0.10	Q V	|	|	|	|
9+40	0.0614	0.10	Q V	|	|	|	|
9+45	0.0621	0.10	Q V	|	|	|	|
9+50	0.0628	0.10	Q V	|	|	|	|
9+55	0.0636	0.11	Q V	|	|	|	|
10+ 0	0.0643	0.11	Q V	|	|	|	|
10+ 5	0.0650	0.11	Q V	|	|	|	|
10+10	0.0658	0.11	Q V	|	|	|	|
10+15	0.0665	0.11	Q V	|	|	|	|
10+20	0.0673	0.11	Q V	|	|	|	|
10+25	0.0680	0.11	Q V	|	|	|	|
10+30	0.0688	0.11	Q V	|	|	|	|
10+35	0.0696	0.11	Q V	|	|	|	|
10+40	0.0704	0.11	Q V	|	|	|	|
10+45	0.0711	0.11	Q V	|	|	|	|
10+50	0.0719	0.12	Q V	|	|	|	|
10+55	0.0727	0.12	Q V	|	|	|	|
11+ 0	0.0735	0.12	Q V	|	|	|	|
11+ 5	0.0744	0.12	Q V	|	|	|	|
11+10	0.0752	0.12	Q V	|	|	|	|
11+15	0.0760	0.12	Q V	|	|	|	|
11+20	0.0768	0.12	Q V	|	|	|	|
11+25	0.0777	0.12	Q V	|	|	|	|
11+30	0.0785	0.12	Q V	|	|	|	|

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11+35       0.0794      0.13  Q     V   |          |          |          |
11+40       0.0803      0.13  Q     V   |          |          |          |
11+45       0.0812      0.13  Q     V   |          |          |          |
11+50       0.0820      0.13  Q     V   |          |          |          |
11+55       0.0829      0.13  Q     V   |          |          |          |
12+ 0       0.0839      0.13  Q     V   |          |          |          |
12+ 5       0.0848      0.13  Q     V   |          |          |          |
12+10       0.0857      0.14  Q     V   |          |          |          |
12+15       0.0867      0.14  Q     V   |          |          |          |
12+20       0.0877      0.15  Q      V  |          |          |          |
12+25       0.0888      0.15  Q      V  |          |          |          |
12+30       0.0899      0.16  Q      V  |          |          |          |
12+35       0.0910      0.16  Q      V  |          |          |          |
12+40       0.0921      0.16  Q      V  |          |          |          |
12+45       0.0932      0.16  Q      V  |          |          |          |
12+50       0.0943      0.16  Q      V  |          |          |          |
12+55       0.0954      0.17  Q      V  |          |          |          |
13+ 0       0.0966      0.17  Q      V  |          |          |          |
13+ 5       0.0978      0.17  Q      V  |          |          |          |
13+10       0.0990      0.17  Q      V  |          |          |          |
13+15       0.1002      0.18  Q       V |          |          |          |
13+20       0.1014      0.18  Q       V |          |          |          |
13+25       0.1026      0.18  Q       V |          |          |          |
13+30       0.1039      0.18  Q       V |          |          |          |
13+35       0.1052      0.19  Q       V |          |          |          |
13+40       0.1065      0.19  Q       V |          |          |          |
13+45       0.1078      0.19  Q       V |          |          |          |
13+50       0.1092      0.20  Q       V |          |          |          |
13+55       0.1105      0.20  Q       V |          |          |          |
14+ 0       0.1119      0.20  Q       V |          |          |          |
14+ 5       0.1133      0.21  Q        V|          |          |          |
14+10       0.1148      0.21  Q        V|          |          |          |
14+15       0.1163      0.22  Q        V|          |          |          |
14+20       0.1178      0.22  Q        V|          |          |          |
14+25       0.1193      0.22  Q        V|          |          |          |
14+30       0.1209      0.23  Q        V|          |          |          |
14+35       0.1226      0.24  Q        V|          |          |          |
14+40       0.1242      0.24  Q        V|          |          |          |
14+45       0.1259      0.25  Q         V          |          |          |
14+50       0.1277      0.26  Q         V          |          |          |
14+55       0.1295      0.26  Q         V          |          |          |
15+ 0       0.1314      0.27  Q         V          |          |          |
15+ 5       0.1333      0.28  Q         V          |          |          |
15+10       0.1353      0.29  Q         V          |          |          |
15+15       0.1374      0.30  Q         V          |          |          |
15+20       0.1396      0.32  Q         |V         |          |          |
15+25       0.1419      0.33  Q         |V         |          |          |
15+30       0.1441      0.32  Q         |V         |          |          |
15+35       0.1462      0.30  Q         |V         |          |          |
15+40       0.1482      0.28  Q         |V         |          |          |
15+45       0.1502      0.29  Q         | V        |          |          |
15+50       0.1524      0.32  Q         | V        |          |          |
15+55       0.1550      0.37  Q         | V        |          |          |
16+ 0       0.1582      0.46  Q         | V        |          |          |
16+ 5       0.1692      1.60  |  Q       |  V       |          |          |
16+10       0.2109      6.06  |          | Q   V    |          |          |
16+15       0.2835     10.54  |          |          |QV        |          |
16+20       0.3577     10.78  |          |          |Q      V  |          |
16+25       0.3963      5.60  |          |Q         |          |V         |
16+30       0.4141      2.59  |    Q     |          |          |  V       |
16+35       0.4222      1.18  | Q        |          |          |  V       |
16+40       0.4264      0.60  |Q         |          |          |   V      |
16+45       0.4303      0.57  |Q         |          |          |   V      |
16+50       0.4332      0.42  Q          |          |          |   V      |
16+55       0.4351      0.28  Q          |          |          |   V      |
17+ 0       0.4369      0.26  Q          |          |          |   V      |
17+ 5       0.4387      0.25  Q          |          |          |    V     |
17+10       0.4403      0.24  Q          |          |          |    V     |
17+15       0.4418      0.22  Q          |          |          |    V     |
17+20       0.4433      0.22  Q          |          |          |    V     |
17+25       0.4447      0.21  Q          |          |          |    V     |
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17+30	0.4461	0.20	Q	|	|	|	V |
17+35	0.4474	0.19	Q	|	|	|	V |
17+40	0.4487	0.19	Q	|	|	|	V |
17+45	0.4500	0.18	Q	|	|	|	V |
17+50	0.4512	0.18	Q	|	|	|	V |
17+55	0.4523	0.17	Q	|	|	|	V |
18+ 0	0.4535	0.17	Q	|	|	|	V |
18+ 5	0.4546	0.16	Q	|	|	|	V |
18+10	0.4557	0.16	Q	|	|	|	V |
18+15	0.4567	0.15	Q	|	|	|	V |
18+20	0.4576	0.14	Q	|	|	|	V |
18+25	0.4586	0.13	Q	|	|	|	V |
18+30	0.4595	0.13	Q	|	|	|	V |
18+35	0.4603	0.13	Q	|	|	|	V |
18+40	0.4612	0.13	Q	|	|	|	V |
18+45	0.4620	0.12	Q	|	|	|	V |
18+50	0.4629	0.12	Q	|	|	|	V |
18+55	0.4637	0.12	Q	|	|	|	V |
19+ 0	0.4645	0.12	Q	|	|	|	V |
19+ 5	0.4653	0.11	Q	|	|	|	V |
19+10	0.4660	0.11	Q	|	|	|	V |
19+15	0.4668	0.11	Q	|	|	|	V |
19+20	0.4676	0.11	Q	|	|	|	V |
19+25	0.4683	0.11	Q	|	|	|	V |
19+30	0.4690	0.11	Q	|	|	|	V |
19+35	0.4697	0.10	Q	|	|	|	V |
19+40	0.4704	0.10	Q	|	|	|	V |
19+45	0.4711	0.10	Q	|	|	|	V |
19+50	0.4718	0.10	Q	|	|	|	V |
19+55	0.4725	0.10	Q	|	|	|	V |
20+ 0	0.4732	0.10	Q	|	|	|	V |
20+ 5	0.4738	0.10	Q	|	|	|	V |
20+10	0.4745	0.09	Q	|	|	|	V |
20+15	0.4751	0.09	Q	|	|	|	V |
20+20	0.4758	0.09	Q	|	|	|	V |
20+25	0.4764	0.09	Q	|	|	|	V |
20+30	0.4770	0.09	Q	|	|	|	V |
20+35	0.4776	0.09	Q	|	|	|	V |
20+40	0.4783	0.09	Q	|	|	|	V |
20+45	0.4789	0.09	Q	|	|	|	V |
20+50	0.4795	0.09	Q	|	|	|	V |
20+55	0.4800	0.09	Q	|	|	|	V |
21+ 0	0.4806	0.08	Q	|	|	|	V |
21+ 5	0.4812	0.08	Q	|	|	|	V |
21+10	0.4818	0.08	Q	|	|	|	V |
21+15	0.4823	0.08	Q	|	|	|	V |
21+20	0.4829	0.08	Q	|	|	|	V |
21+25	0.4835	0.08	Q	|	|	|	V |
21+30	0.4840	0.08	Q	|	|	|	V |
21+35	0.4846	0.08	Q	|	|	|	V |
21+40	0.4851	0.08	Q	|	|	|	V |
21+45	0.4857	0.08	Q	|	|	|	V |
21+50	0.4862	0.08	Q	|	|	|	V |
21+55	0.4867	0.08	Q	|	|	|	V |
22+ 0	0.4872	0.08	Q	|	|	|	V |
22+ 5	0.4878	0.08	Q	|	|	|	V|
22+10	0.4883	0.08	Q	|	|	|	V|
22+15	0.4888	0.07	Q	|	|	|	V|
22+20	0.4893	0.07	Q	|	|	|	V|
22+25	0.4898	0.07	Q	|	|	|	V|
22+30	0.4903	0.07	Q	|	|	|	V|
22+35	0.4908	0.07	Q	|	|	|	V|
22+40	0.4913	0.07	Q	|	|	|	V|
22+45	0.4918	0.07	Q	|	|	|	V|
22+50	0.4923	0.07	Q	|	|	|	V|
22+55	0.4928	0.07	Q	|	|	|	V|
23+ 0	0.4932	0.07	Q	|	|	|	V|
23+ 5	0.4937	0.07	Q	|	|	|	V|
23+10	0.4942	0.07	Q	|	|	|	V|
23+15	0.4947	0.07	Q	|	|	|	V|
23+20	0.4951	0.07	Q	|	|	|	V|

```
  23+25       0.4956      0.07  Q          |          |          |         V|
  23+30       0.4960      0.07  Q          |          |          |         V|
  23+35       0.4965      0.07  Q          |          |          |         V|
  23+40       0.4970      0.07  Q          |          |          |         V|
  23+45       0.4974      0.07  Q          |          |          |         V|
  23+50       0.4979      0.07  Q          |          |          |         V|
  23+55       0.4983      0.06  Q          |          |          |         V|
  24+ 0       0.4987      0.06  Q          |          |          |         V|
  24+ 5       0.4992      0.06  Q          |          |          |         V|
  24+10       0.4995      0.05  Q          |          |          |         V|
  24+15       0.4998      0.03  Q          |          |          |         V|
  24+20       0.4999      0.02  Q          |          |          |         V|
  24+25       0.4999      0.01  Q          |          |          |         V|
  24+30       0.4999      0.00  Q          |          |          |         V|
  24+35       0.5000      0.00  Q          |          |          |         V|
  24+40       0.5000      0.00  Q          |          |          |         V|
  24+45       0.5000      0.00  Q          |          |          |          V
-------------------------------------------------------------------------------
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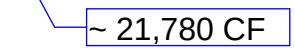


PROJECT SUMMARY

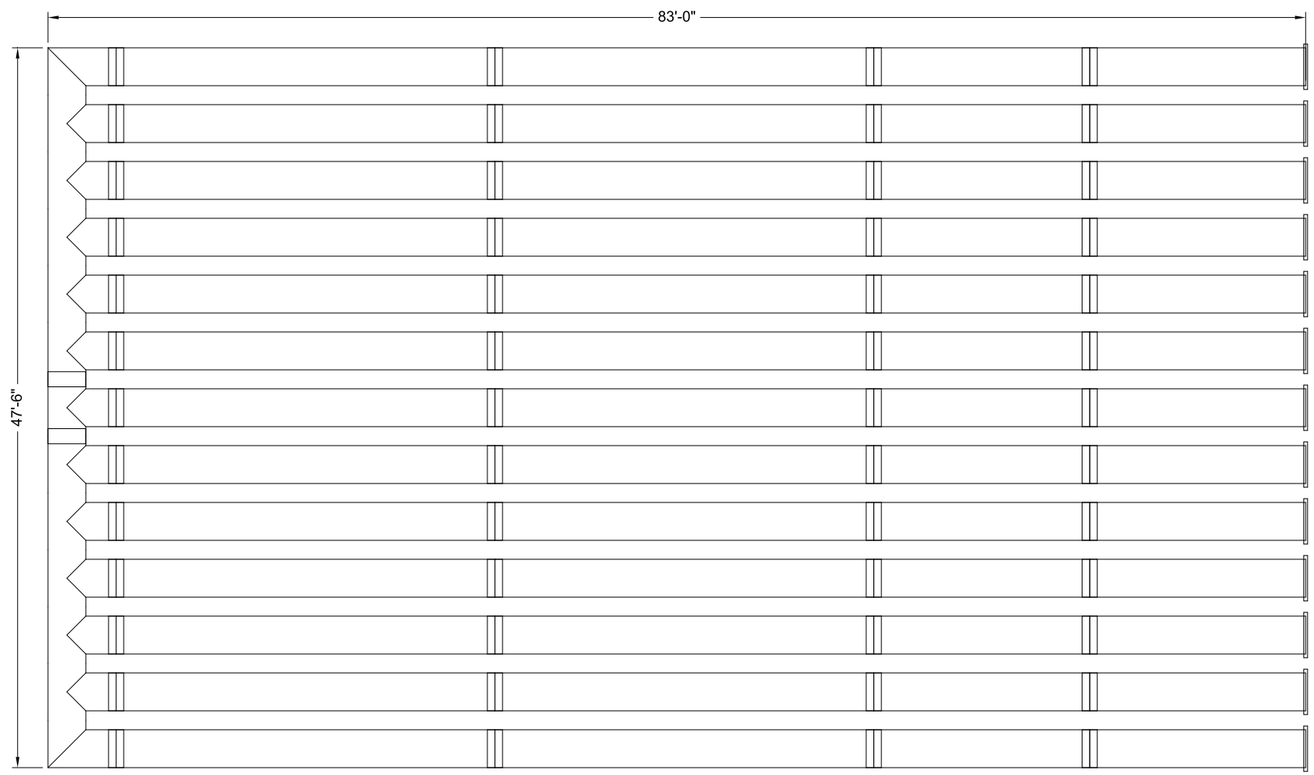
CALCULATION DETAILS
- LOADING = HS20 & HS25
- APPROX. LINEAR FOOTAGE = 1,094 lf.

STORAGE SUMMARY
- STORAGE VOLUME REQUIRED = N/A
- PIPE STORAGE VOLUME = 5,370 cf.
- BACKFILL STORAGE VOLUME = 3,742 cf.
- TOTAL STORAGE PROVIDED = 9,113 cf.

PIPE DETAILS
- DIAMETER = 30 IN.
- CORRUGATION = 2 2/3x1/2
- GAGE = 16
- COATING = ALT2
- WALL TYPE = Perforated
- BARRELL SPACING = 15 IN.

BACKFILL DETAILS
- WIDTH AT ENDS = 12 IN.
- ABOVE PIPE = 6 IN.
- WIDTH AT SIDES = 12 IN.
- BELOW PIPE = 6 IN.

FOR CONTECH SYSTEM-1,2



NOTES

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- RISERS TO BE FIELD TRIMMED TO GRADE.
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ASSEMBLY

SCALE: 1" = 10'

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DATE	REVISION DESCRIPTION	BY

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9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH® CMP DETENTION SYSTEMS
CONTECH **DYODS** DRAWING

DYO10865 Warmington, Palm Ave Retention/Infiltration System Fontana, CA DETENTION SYSTEM

PROJECT No.:	SEQ. No.:	DATE:
6763	10865	10/7/2021
DESIGNED: DYO	DRAWN: DYO	
CHECKED: DYO	APPROVED: DYO	
SHEET NO.: D1		

PROJECT SUMMARY

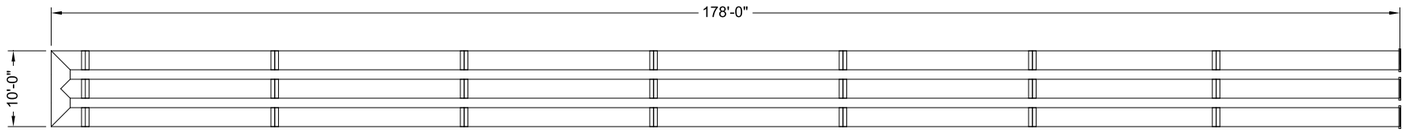
CALCULATION DETAILS
- LOADING = HS20 & HS25
- APPROX. LINEAR FOOTAGE = 537 lf.

STORAGE SUMMARY
- STORAGE VOLUME REQUIRED = N/A
- PIPE STORAGE VOLUME = 2,634 cf.
- BACKFILL STORAGE VOLUME = 1,971 cf.
- TOTAL STORAGE PROVIDED = 4,604 cf.

PIPE DETAILS
- DIAMETER = 30 IN.
- CORRUGATION = 2 2/3x1/2
- GAGE = 16
- COATING = ALT2
- WALL TYPE = Perforated
- BARRELL SPACING = 15 IN.

BACKFILL DETAILS
- WIDTH AT ENDS = 12 IN.
- ABOVE PIPE = 6 IN.
- WIDTH AT SIDES = 12 IN.
- BELOW PIPE = 6 IN.

FOR CONTECH SYSTEM-3,4



NOTES

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ASSEMBLY

SCALE: 1" = 20'

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CONTECH CMP DETENTION SYSTEMS
CONTECH DYODS DRAWING

DYO10865 Warmington, Palm Ave
Retention/Infiltration System
Fontana, CA
DETENTION SYSTEM

PROJECT No.:	SEQ. No.:	DATE:
6763	10865	10/7/2021
DESIGNED: DYO	DRAWN: DYO	
CHECKED: DYO	APPROVED: DYO	
SHEET NO.: D1		

PROJECT SUMMARY

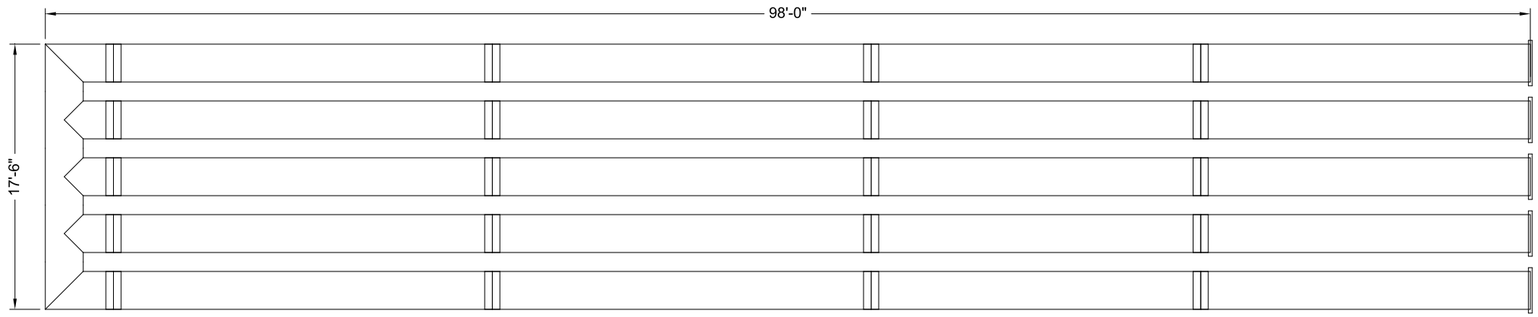
CALCULATION DETAILS
- LOADING = HS20 & HS25
- APPROX. LINEAR FOOTAGE = 495 lf.

STORAGE SUMMARY
- STORAGE VOLUME REQUIRED = N/A
- PIPE STORAGE VOLUME = 2,430 cf.
- BACKFILL STORAGE VOLUME = 1,758 cf.
- TOTAL STORAGE PROVIDED = 4,188 cf.

PIPE DETAILS
- DIAMETER = 30 IN.
- CORRUGATION = 2 2/3x1/2
- GAGE = 16
- COATING = ALT2
- WALL TYPE = Perforated
- BARRELL SPACING = 15 IN.

BACKFILL DETAILS
- WIDTH AT ENDS = 12 IN.
- ABOVE PIPE = 6 IN.
- WIDTH AT SIDES = 12 IN.
- BELOW PIPE = 6 IN.

FOR CONTECH SYSTEM-5



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ASSEMBLY

SCALE: 1" = 10'

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CONTECH® CMP DETENTION SYSTEMS
CONTECH DYODS DRAWING

DYO10865 Warmington, Palm Ave
Retention/Infiltration System
Fontana, CA
DETENTION SYSTEM

PROJECT No.:	SEQ. No.:	DATE:
6763	10865	10/7/2021
DESIGNED: DYO	DRAWN: DYO	
CHECKED: DYO	APPROVED: DYO	
SHEET NO.: D1		

Infiltration/Retention Basin Volume Table (Bottom Elev of Basin 1353.00)

Detention Volume Table

Total Depth	Elevation	Elevation Area (sf)	Average Area (sf)	Depth (ft)	Volume (cf)	Volume (ac-ft)	Total Volume (ac-ft)
Retention							
0.0	1353.0	6,240					**0.00**
			6,491	0.5	3,245	0.07	
0.5	1353.5	6,741					**0.07**
			7,265	1.0	7,265	0.17	
1.5	1354.5	7,788					**0.24**
			8,340	1.0	8,340	0.19	
2.5	1355.5	8,892					**0.43**
Detention			9,473	1.0	9,473	0.22	
3.5	1356.5	10,054					**0.65**
			10,664	1.0	10,664	0.24	
4.5	1357.5	11,274			Det Vol (Total)		**0.90**
4.5							

39,204 CF (0.9 AC-FT)
31,500 CF WITH CHAMBER SYSTEM
70,704 CF TOTAL > REQD. 57,619 CF

5-Contech Chamber System combined capacity

Form 4.2-3 HCOC Assessment for Runoff Volume

Weighted Curve Number Determination for: Pre-developed DA-1								
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. Site Pervious Area: 35,351 SF. (in DA-1: 40,000 SF)*								
Weighted Curve Number Determination for: Post-developed DA			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. Site Pervious Area: 19,847 SF. (in DA-1-40,000 SF)*								

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) = 1.23 *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): Volume increased by 3,848 CF (59% of pre-development volume). Volume reduction provided by the combination of proposed Chamber System and the proposed retention/infiltration basin for HCOC requirement.
*V_{HCOC} = (Item 13 * 0.95) – Item 12*

Form 4.2-4 HCOC Assessment for Time of Concentration

Compute time of concentration for pre and post developed conditions for each DA *(For projects using the Hydrology Manual complete the form below) : Please refer to the Rational Method Hydrology Study For Pre-developed and Post-developed Drainage Area 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*			
	DA 1	DMA B	DMA C	DMA D	DA 1	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):								
14 Post-developed time of concentration (min):								
15 Additional time of concentration needed to meet HCOC requirement (min):								

Form 4.2-5 HCOC Assessment for Peak Runoff

Compute peak runoff for pre- and post-developed conditions

Please refer to the Rational Method Hydrology Study For Pre-developed and Post-developed Drainage Area below

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 (ft^2) *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:	9 Pre-developed Q_p at T_c for DMA B:	10 Pre-developed Q_p at T_c for DMA C:
*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 $7_{DMAA/3}$]*	*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 $7_{DMAB/3}$]*	*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:	12 Post-developed Q_p at T_c for DMA B:	13 Post-developed Q_p at T_c for DMA C:
Same as Item 8 for post-developed values	*Same as Item 9 for post-developed values*	*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 (DMA 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)? Design infiltration rate greater than the 0.3 in/hr

Yes ☐ No ☒

If Yes, Provide basis:

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 9 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

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 (DMA 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):	$V_{retention}$ *=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):	$V_{retention}$ *=Sum of Item 12 for all BMPs*		

Form 4.3-2 cont. Site Design Hydrologic Source Control BMPs (DMA1)

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 ft^3 *$V_{retention}$ =Sum of Item 19 for all BMPs*			
21 Implementation of Street Trees: Yes ☐ No ☒ *If yes, complete Items 20-2. If no, proceed to Item 24*	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 ft^3 *$V_{retention}$ = Sum of Item 24 for all BMPs*			
26 Implementation of residential rain barrels/cisterns: Yes ☐ No ☒ *If yes, complete Items 27-28; If no, proceed to Item 29*	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 ft^3 *$V_{retention}$ =Sum of Item 28 for all BMPs*			
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: 0 ft^3 *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 (DMA1)

1 Remaining LID DCV not met by site design HSC BMP (ft^3): 40,637 ft^3 *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*	DMA 1 BMP Type Inf. Chamber (Contech-5units combined)	DMA 1 BMP Type Ret Basin-1	DA DMA BMP Type
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*	1.66	1.66	
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*	2.5	2.5	
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*	0.66	0.66	
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*	43.3	47.5	
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*	-	-	
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*	2.5	2.5	
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*	13,161	6,240	
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*	0	0	
10 Amended soil porosity	0	0	
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*	0	5	
12 Gravel porosity	0.4	0.4	
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*	-	-	
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))]*	-	-	
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*	31,500	16411	

16 Total Retention Volume from LID Infiltration BMPs: 47,911 ft^3 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 118% *Retention% = Item 16 / Form 4.2-1 Item 7*

18 Is full LID DCV retained on-site with combination of hydrologic source control and LID retention and 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.

Inf/Ret Basin-1 Inf. Volume Capacity Calculation

Surface Area	6240	SF	Basin Bottom Surface Area
Rock Depth	0	FT	Water depth: 2.5-ft
Surface Depth	2.3	FT	
Infiltration	*0.165*	*FT*	[Inf. rate 0.66/12)*3]
			3hr: Duration of storm as basin filling
Infiltration (3 hr)	1029.6		
Volume Provided	16411	CF	
Volume Needed	*11,000*	*CF*	
Difference	5,411	CF	

Infiltration Drawdown Time Calculation:

Inf Basin-1

Infiltration Surface Area Provided:	6,240	SF	
Infiltration Rate per Soil Report	1.66	in/hr	
	0.14	ft/hr	
Facor of Safety	2.5		
Design Infiltration Rate	0.055	ft/hr	
Volume needed to be Infiltrated	16411	cu.ft	
Infiltration Volume per hour	345.28	cu.ft/hr	(6240 sft * 0.055 ft/hr)
Infiltration Draw Down Time	47.53	Hours	(16411 cu.ft / 345.28 cu.ft/hr)
	47.5	< 48 hr draw down time. OK	

PROJECT SUMMARY

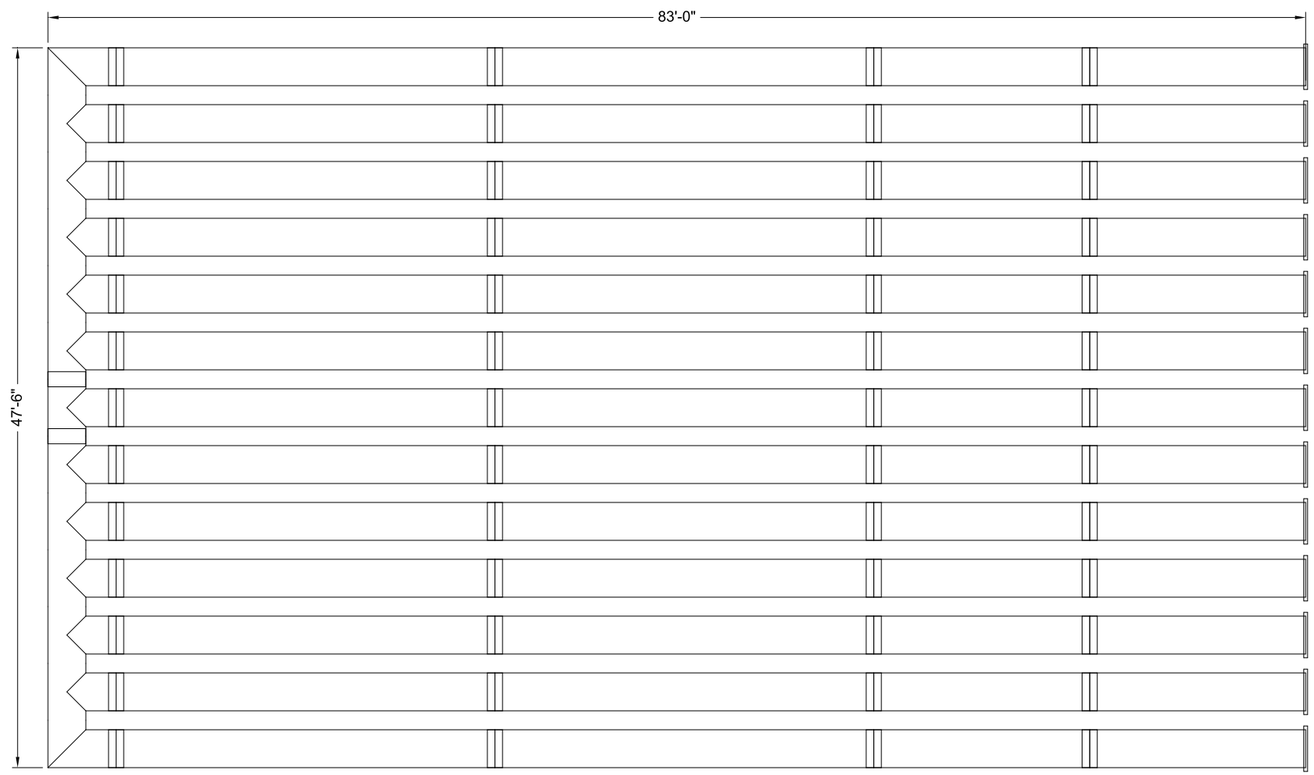
CALCULATION DETAILS
- LOADING = HS20 & HS25
- APPROX. LINEAR FOOTAGE = 1,094 lf.

STORAGE SUMMARY
- STORAGE VOLUME REQUIRED = N/A
- PIPE STORAGE VOLUME = 5,370 cf.
- BACKFILL STORAGE VOLUME = 3,742 cf.
- TOTAL STORAGE PROVIDED = 9,113 cf.

PIPE DETAILS
- DIAMETER = 30 IN.
- CORRUGATION = 2 2/3x1/2
- GAGE = 16
- COATING = ALT2
- WALL TYPE = Perforated
- BARRELL SPACING = 15 IN.

BACKFILL DETAILS
- WIDTH AT ENDS = 12 IN.
- ABOVE PIPE = 6 IN.
- WIDTH AT SIDES = 12 IN.
- BELOW PIPE = 6 IN.

FOR CONTECH SYSTEM-1,2



NOTES

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- ALL FITTINGS AND REINFORCEMENT COMPLY WITH ASTM A998.
- ALL RISERS AND STUBS ARE $2\frac{2}{3}$" x $\frac{1}{2}$" CORRUGATION AND 16 GAGE UNLESS OTHERWISE NOTED.
- RISERS TO BE FIELD TRIMMED TO GRADE.
- QUANTITY OF PIPE SHOWN DOES NOT PROVIDE EXTRA PIPE FOR CONNECTING THE SYSTEM TO EXISTING PIPE OR DRAINAGE STRUCTURES. OUR SYSTEM AS DETAILED PROVIDES NOMINAL INLET AND/OR OUTLET PIPE STUB FOR CONNECTION TO EXISTING DRAINAGE FACILITIES. IF ADDITIONAL PIPE IS NEEDED IT IS THE RESPONSIBILITY OF THE CONTRACTOR.
- BAND TYPE TO BE DETERMINED UPON FINAL DESIGN.
- THE PROJECT SUMMARY IS REFLECTIVE OF THE DYODS DESIGN, QUANTITIES ARE APPROX. AND SHOULD BE VERIFIED UPON FINAL DESIGN AND APPROVAL. FOR EXAMPLE, TOTAL EXCAVATION DOES NOT CONSIDER ALL VARIABLES SUCH AS SHORING AND ONLY ACCOUNTS FOR MATERIAL WITHIN THE ESTIMATED EXCAVATION FOOTPRINT.
- THESE DRAWINGS ARE FOR CONCEPTUAL PURPOSES AND DO NOT REFLECT ANY LOCAL PREFERENCES OR REGULATIONS. PLEASE CONTACT YOUR LOCAL CONTECH REP FOR MODIFICATIONS.

ASSEMBLY

SCALE: 1" = 10'

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DATE	REVISION DESCRIPTION	BY

CONTECH® ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH® CMP DETENTION SYSTEMS
CONTECH **DYODS** DRAWING

DYO10865 Warmington, Palm Ave Retention/Infiltration System Fontana, CA DETENTION SYSTEM

PROJECT No.:	SEQ. No.:	DATE:
6763	10865	10/7/2021
DESIGNED: DYO	DRAWN: DYO	
CHECKED: DYO	APPROVED: DYO	
SHEET NO.: D1		

PROJECT SUMMARY

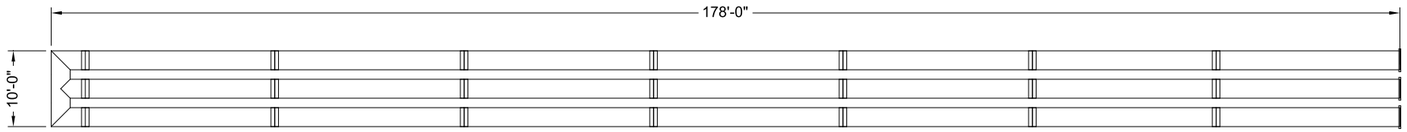
CALCULATION DETAILS
- LOADING = HS20 & HS25
- APPROX. LINEAR FOOTAGE = 537 lf.

STORAGE SUMMARY
- STORAGE VOLUME REQUIRED = N/A
- PIPE STORAGE VOLUME = 2,634 cf.
- BACKFILL STORAGE VOLUME = 1,971 cf.
- TOTAL STORAGE PROVIDED = 4,604 cf.

PIPE DETAILS
- DIAMETER = 30 IN.
- CORRUGATION = 2 2/3x1/2
- GAGE = 16
- COATING = ALT2
- WALL TYPE = Perforated
- BARRELL SPACING = 15 IN.

BACKFILL DETAILS
- WIDTH AT ENDS = 12 IN.
- ABOVE PIPE = 6 IN.
- WIDTH AT SIDES = 12 IN.
- BELOW PIPE = 6 IN.

FOR CONTECH SYSTEM-3,4



NOTES

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- ALL FITTINGS AND REINFORCEMENT COMPLY WITH ASTM A998.
- ALL RISERS AND STUBS ARE $2\frac{2}{3}$" x $\frac{1}{2}$" CORRUGATION AND 16 GAGE UNLESS OTHERWISE NOTED.
- RISERS TO BE FIELD TRIMMED TO GRADE.
- QUANTITY OF PIPE SHOWN DOES NOT PROVIDE EXTRA PIPE FOR CONNECTING THE SYSTEM TO EXISTING PIPE OR DRAINAGE STRUCTURES. OUR SYSTEM AS DETAILED PROVIDES NOMINAL INLET AND/OR OUTLET PIPE STUB FOR CONNECTION TO EXISTING DRAINAGE FACILITIES. IF ADDITIONAL PIPE IS NEEDED IT IS THE RESPONSIBILITY OF THE CONTRACTOR.
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ASSEMBLY

SCALE: 1" = 20'

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CONTECH CMP DETENTION SYSTEMS
CONTECH DYODS DRAWING

DYO10865 Warmington, Palm Ave
Retention/Infiltration System
Fontana, CA
DETENTION SYSTEM

PROJECT No.:	SEQ. No.:	DATE:
6763	10865	10/7/2021
DESIGNED: DYO	DRAWN: DYO	
CHECKED: DYO	APPROVED: DYO	
SHEET NO.: D1		

PROJECT SUMMARY

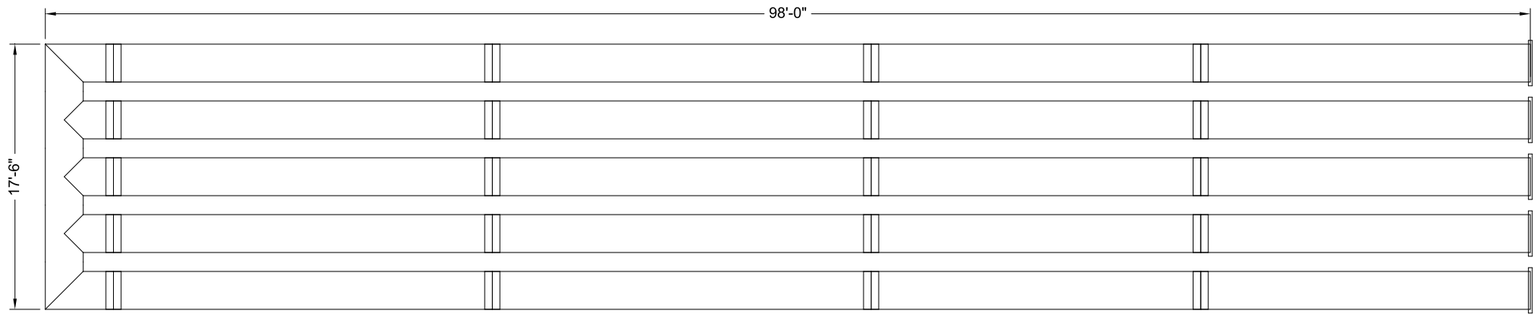
CALCULATION DETAILS
- LOADING = HS20 & HS25
- APPROX. LINEAR FOOTAGE = 495 lf.

STORAGE SUMMARY
- STORAGE VOLUME REQUIRED = N/A
- PIPE STORAGE VOLUME = 2,430 cf.
- BACKFILL STORAGE VOLUME = 1,758 cf.
- TOTAL STORAGE PROVIDED = 4,188 cf.

PIPE DETAILS
- DIAMETER = 30 IN.
- CORRUGATION = 2 2/3x1/2
- GAGE = 16
- COATING = ALT2
- WALL TYPE = Perforated
- BARRELL SPACING = 15 IN.

BACKFILL DETAILS
- WIDTH AT ENDS = 12 IN.
- ABOVE PIPE = 6 IN.
- WIDTH AT SIDES = 12 IN.
- BELOW PIPE = 6 IN.

FOR CONTECH SYSTEM-5



NOTES

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- ALL FITTINGS AND REINFORCEMENT COMPLY WITH ASTM A998.
- ALL RISERS AND STUBS ARE $2\frac{2}{3}$" x $\frac{1}{2}$" CORRUGATION AND 16 GAGE UNLESS OTHERWISE NOTED.
- RISERS TO BE FIELD TRIMMED TO GRADE.
- QUANTITY OF PIPE SHOWN DOES NOT PROVIDE EXTRA PIPE FOR CONNECTING THE SYSTEM TO EXISTING PIPE OR DRAINAGE STRUCTURES. OUR SYSTEM AS DETAILED PROVIDES NOMINAL INLET AND/OR OUTLET PIPE STUB FOR CONNECTION TO EXISTING DRAINAGE FACILITIES. IF ADDITIONAL PIPE IS NEEDED IT IS THE RESPONSIBILITY OF THE CONTRACTOR.
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ASSEMBLY

SCALE: 1" = 10'

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CONTECH® CMP DETENTION SYSTEMS
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DYO10865 Warmington, Palm Ave
Retention/Infiltration System
Fontana, CA
DETENTION SYSTEM

PROJECT No.:	SEQ. No.:	DATE:
6763	10865	10/7/2021
DESIGNED: DYO	DRAWN: DYO	
CHECKED: DYO	APPROVED: DYO	
SHEET NO.: D1		

Infiltration Drawdown Time Calculation:

Combined 5 Units : (CONTECH SYSTEM 1 THROUGH 5)

Infiltration Surface Area Provided:	13,161	SF	
Infiltration Rate per Soil Report	1.66	in/hr	
	0.14	ft/hr	
Facor of Safety	2.5		
Design Infiltration Rate	0.055	ft/hr	
Volume needed to be Infiltrated	31500	cu.ft	
Infiltration Volume per hour	728.24	cu.ft/hr	(13161 sft * 0.055 ft/hr)
Infiltration Draw Down Time	43.25	Hours	(31500 cu.ft / 728.24 cu.ft/hr)
	43.3	< 48 hr draw down time. OK	

SUMMARY OF RESULTS		
Boring	Measured Field Percolation Rate (minutes per inch)	Calculated Infiltration Rate (inches per hour)
I-1	3.33	1.76
I-2	3.70	1.57

Copies of the field data sheet and infiltration conversion sheet (Porchet Method) are included in Appendix C. The reported infiltration rates are the measured rate without any factor of safety applied. Over the lifetime of the detention basin, the infiltration rate may be affected by silt build up and biological activities, as well as local variations in near surface soil conditions. A suitable factor of safety should be applied to the field rates in design the infiltration system.

It should be noted that the infiltration rate provided above was performed in relatively undisturbed native soils. Infiltration rates will vary and are mostly dependent on the underlying consistency of the site soils and relative density. Infiltration rates will be impacted by weight of equipment travelling over the soils, placement of engineered fill and other various factors. GeoTek, Inc. assumes no responsibility or liability for the ultimate design or performance of the storm water facility.

4. GEOLOGIC AND SOILS CONDITIONS

4.1 REGIONAL SETTING

The subject property is situated in the Peninsular Ranges geomorphic province near the border with the Transverse Ranges. The Peninsular Ranges province is one of the largest geomorphic units in western North America. Basically, it extends roughly 975 miles from the north and extends from the Transverse Ranges geomorphic province to the tip of Baja California, from north to south. This province varies in width from about 30 to 100 miles. It is bounded on the west by the Pacific Ocean, on the south by the Gulf of California and on the east by the Colorado Desert Province.

The Peninsular Ranges are essentially a series of northwest-southeast oriented fault blocks. Several major fault zones are found in this province. The Elsinore Fault zone and the San Jacinto Fault zone trend northwest-southeast and are found in the near the middle of the province. The San Andreas Fault zone borders the northeasterly margin of the province.

Worksheet H: Factor of Safety and Design Infiltration Rate and Worksheet

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25	1	0.25
		Predominant soil texture	0.25	2	0.50
		Site soil variability	0.25	**1**	**0.25**
		Depth to groundwater / impervious layer	0.25	**1**	**0.25**
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			**1.25**
B	Design	Tributary area size	0.25	**3**	**0.75**
		Level of pretreatment/ expected sediment loads	0.25	**1**	**0.25**
		Redundancy	0.25	3	0.75
		Compaction during construction	0.25	1	0.25
		Design Safety Factor, $S_B = \Sigma p$			2.00
Combined Safety Factor, $S_{TOT} = S_A \times S_B$					**2.5**
Measured Infiltration Rate, inch/hr, K_M (corrected for test-specific bias)					**1.66**
Design Infiltration Rate, in/hr, $K_{DESIGN} = S_{TOT} / K_M$					**0.66**

Supporting Data

Briefly describe infiltration test and provide reference to test forms:

Average measured Inf. Rtae: 1.66"/hr
Geotechnical and infiltration Evaluation,
dated July 30, 2021

Note: The minimum combined adjustment factor shall not be less than 2.0 and the maximum combined adjustment factor shall not exceed 9.0.

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 (DMA 1)

1 Total LID DCV for the Project DMA-1 (ft^3): 40,637 ft^3 *Copy Item 7 in Form 4.2-1*

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

3 On-site retention with LID infiltration BMP (ft^3): 43,130 ft^3 *Copy Item 16 in Form 4.3-3*

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

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

6 Flow capacity provided by flow based biotreatment BMP (cfs): 0 ft^3 *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 (Not Applicable)

1 Volume reduction needed for HCOC performance criteria (ft^3): 57,619 *(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): 43130 *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 ☐Time of Concentration will be increased due to proposed retention of water in the ret/inf. Basin 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 ☒Pick flow will be decreased due to retention of water in the proposed ret/inf basin BMP. Onsite ret basin is designed to retain volume of water up to 100-yr storm and will substantially reduce the peak outflow.
  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
Contech Chamber System		Step 1) Inspect isolator row for sediment a. inspection ports (if present) a.1. remove/open lid on nyloplast inline drain a.2. remove and clean flexstorm filter if installed a.3. using a flashlight and stadia rod, measure depth of sediment and record on maintenance log a.4. lower a camera into isolator row for visual inspection of sediment levels (optional) a.5. if sediment is at, or above, 3" (80 mm) proceed to step 2. If not, proceed to step 3. b. all isolator rows b.1. remove cover from structure at upstream end of isolator row b.2. using a flashlight, inspect down the isolator row through outlet pipe i) mirrors on poles or cameras may be used to avoid a confined space entry ii) follow osha regulations for confined space entry if entering manhole b.3. if sediment is at, or above, 3" (80 mm) proceed to step 2. if not, proceed to step 3. step 2) clean out isolator row using the jetvac process a. a fixed culvert cleaning nozzle with rear facing spread of 45" (1.1 m) or more is preferred b. apply multiple passes of jetvac until backflush water is clean c. vacuum structure sump as required step 3) replace all covers, grates, filters, and lids; record observations and actions. step 4) inspect and clean basins and manholes upstream of the stormtech system.	1. Inspect every 6 months during the first year of operation. adjust the inspection interval based on previous observations of sediment accumulation and high water elevations. 2. Conduct jetting and vactoring annually or when inspection shows that maintenance is necessary.

Infiltration basin	Warmington Homes	Remove accumulated trash and debris in the basin at the start and end of the wet season. Inspect for standing water at the end of the wet season. Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons. Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of the basin. If erosion is occurring within the basin, re-vegetate immediately and stabilize with an erosion control mulch or mat until vegetation cover is established	2 times a year at the beginning and end of the rainy season (October to March)
Education of Property Owners, Tenants and Occupants on Stormwater BMPs	Warmington Homes	Practical education materials will be provided to property owners covering various water quality issues that will need to be addressed on their specific site. These materials will include general good house keeping practices that contribute to the protection of storm water quality and BMP's that eliminate or reduce pollution during property improvements.	*Ongoing*
Landscape maintenance	Warmington Homes	Landscape planning is implemented to reduce groundwater and storm water contamination. This will be accomplished through an infiltration basin, and landscape areas.	*Monthly* *Ongoing with every*

Litter debris control program	Warmington Homes .	Litter debris control program and site clean will be developed by the Owner	*visit*
Employee training	Warmington Homes .	Employee training may be developed by City of San Bernardino	*Annually and upon new hires by the owner*
Catch basin inspection program	Warmington Homes	Catch basins and the filter devices will be inspected/clean a minimum of once every three months during the dry season and a minimum of once every two months during the rainy season.	*As stated* *Inspect once a year and replaceed if degradation occurs*
Provide storm drain system stencilling and signage	Warmington Homes	Signs will be placed above storm drain inlets to warn the public of prohibitions against waste disposal	
Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	Warmington Homes	Rain sensors will be incorporated into the onsite sprinkler system so that no unnecessary watering of landscaped areas occurs after storm events.	*Once a year or according to Manufacturer Manuals*
Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	Warmington Homes	New landscaped areas will be constructed at a minimum of 1 inch below existing paved areas	*Once a year*
Street Sweeping	Warmington Homes	Street weeping and Vaccuming	*Bi Monthly*

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

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: Warmington Residential

PROPERTY ADDRESS: Highland Ave and Palm Avenue, San Bernardino, California

APN: 0285-211-21 & 0285-211-23

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

_____ 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..

[REMAINDER OF THIS PAGE INTENTIONALLY LEFT BLANK]

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:

Signature: _____

Name: _____

Title: _____

Date: _____

FOR: Maintenance Agreement, dated _____, for the project known as _____ _____ (APN) 0285-211-21 & 0285-211-23 _____, As described in the WQMP dated _____.

OWNER:

Signature: _____

Name: _____

Title: _____

Date: _____

NOTARIES ON FOLLOWING PAGE

A notary acknowledgement is required for recordation.

ACCEPTED BY:

KEVIN BLAKESLEE, P.E., Director of Public Works

Date: _____

Attachment: Notary Acknowledgement

ATTACHMENT 1
Notary Acknowledgement)

EXHIBIT A
(Legal Description)

LEGAL DESCRIPTION

Real property in the City of San Bernardino, County of San Bernardino, State of California, described as follows:

PARCEL NO. 1: (APN: 0285-211-21-0-000 and 0285-211-23-0-000)

PORTION OF THE SOUTHEAST 1/4 OF THE SOUTHEAST 1/4 OF SECTION 29, TOWNSHIP 1 NORTH, RANGE 3 WEST, SAN BERNARDINO BASE AND MERIDIAN, IN THE COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO GOVERNMENT SURVEY, DESCRIBED AS FOLLOWS:

COMMENCING AT A POINT IN SAID SECTION, 10 CHAINS WEST OF THE EAST BOUNDARY LINE OF SAID SECTION AND 10 CHAINS NORTH OF SOUTH BORDER LINE OF SAID SECTION;

RUNNING THENCE SOUTH 10 CHAINS TO SOUTH BOUNDARY LINE OF SAID SECTION;
THENCE WEST ALONG SOUTH BOUNDARY LINE, 9.31 CHAINS;
THENCE NORTH 8.12 CHAINS;
THENCE NORTH 48-1/2° EAST TO A POINT DUE WEST OF INITIAL POINT;
THENCE EAST TO POINT OF BEGINNING.

EXCEPTING THE WEST 300 FEET OF THE SOUTH 341.25 FEET MEASURED FROM THE SOUTH LINE OF SAID SECTION 29.

EXCEPT ALL THAT PORTION OF THE SOUTHEAST 1/4 OF THE SOUTHEAST 1/4 OF SECTION 29, TOWNSHIP 1 NORTH, RANGE 3 WEST, SAN BERNARDINO BASE AND MERIDIAN, ACCORDING TO GOVERNMENT SURVEY, DESCRIBED AS FOLLOWS:

COMMENCING AT THE SOUTHEAST CORNER OF SAID SECTION;
THENCE WEST ALONG THE SOUTH LINE OF SAID SECTION, 1,274.46 FEET, MORE OR LESS, TO THE INTERSECTION OF THE CENTER LINE OF HIGHLAND AVENUE AND ORANGE STREET;
THENCE NORTH 0° 23' 26" WEST, AS SHOWN ON THE MAP OF TRACT NO. 4986, AS RECORDED IN BOOK 79 OF MAPS, PAGES 80 AND 81, A DISTANCE OF 341.25 FEET, TO THE TRUE POINT OF BEGINNING OF THE PARCEL TO BE DESCRIBED;
THENCE EASTERLY, PARALLEL WITH THE NORTH LINE OF HIGHLAND AVENUE, A DISTANCE OF 218 FEET;
THENCE NORTH 11° 20' WEST, 123 FEET;
THENCE SOUTHWESTERLY IN A STRAIGHT LINE, A DISTANCE OF 185 FEET, MORE OR LESS, TO A POINT IN THE CENTER LINE OF ORANGE STREET, WHICH POINT IS A DISTANCE NORTH 0° 23' 26" WEST, 85 FEET FROM THE TRUE POINT OF BEGINNING;
THENCE SOUTH 0° 23' 26" EAST, ALONG THE CENTER LINE OF ORANGE STREET, 85 FEET TO THE TRUE POINT OF BEGINNING.

AND EXCEPT THAT PORTION BEGINNING AT THE INTERSECTION OF THE SOUTHERLY LINE OF LOT 1, MOUNTAIN NURSERY TRACT, RECORDED IN MAP BOOK 7, PAGE 45, AND THE EASTERLY LINE OF ORANGE AVENUE;
THENCE NORTH 47° 45' 39" EAST ALONG SAID SOUTHERLY LINE OF LOT 1, 184.68 FEET (RECORDED NORTH 47° 48' EAST 184.08 FEET);
THENCE NORTH 89° 42' 49" EAST, 80.00 FEET;
THENCE SOUTH 45° 54' 34" WEST, 301.17 FEET TO THE EASTERLY LINE OF ORANGE AVENUE;
THENCE NORTH 0° 17' 11" WEST ALONG SAID EASTERLY LINE, 85.00 FEET TO THE POINT OF BEGINNING.

AND EXCEPT THAT PORTION LYING WITHIN HIGHLAND AVENUE.

ALSO EXCEPT THE WESTERLY 33 FEET THEREOF FOR ROAD PURPOSES.

PARCEL NO. 2: (APN: 0285-211-12-0-000)

ALL THAT PORTION OF THE SOUTHEAST 1/4 OF THE SOUTHEAST 1/4 OF SECTION 29, TOWNSHIP 1 NORTH, RANGE 3 WEST SAN BERNARDINO BASE AND MERIDIAN, IN THE CITY OF SAN BERNARDINO, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO GOVERNMENT SURVEY DESCRIBED AS FOLLOWS:

BEGINNING AT THE INTERSECTION OF THE SOUTHERLY LINE OF LOT 1, MOUNTAIN NURSERY TRACT, RECORDED IN MAP BOOK 7, PAGE 45 AND THE EASTERLY LINE OF ORANGE AVENUE;

THENCE NORTH 47° 48' 39" EAST ALONG SAID SOUTHERLY LINE OF LOT 1, 184.68 FEET (RECORDED NORTH 47° 48' EAST 184.08 FEET);
THENCE NORTH 89° 42' 49" EAST 80.00 FEET;
THENCE SOUTH 45° 54' 34" WEST 301.17 FEET TO THE EASTERLY LINE OF ORANGE AVENUE;
THENCE NORTH 0° 17' 11" WEST ALONG SAID EASTERLY LINE 85.00 FEET TO THE POINT OF BEGINNING.

LYING WITHIN THE FOLLOWING DESCRIBED PROPERTY:

ALL THAT PORTION OF THE SOUTHEAST 1/4 OF THE SOUTHEAST 1/4 OF SECTION 29, TOWNSHIP 1 NORTH, RANGE 3 WEST, SAN BERNARDINO BASE AND MERIDIAN, IN THE CITY OF SAN BERNARDINO, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO GOVERNMENT SURVEY, DESCRIBED AS FOLLOWS:

COMMENCING AT A POINT IN THE SAID SECTION, 10 CHAINS WEST OF THE EAST BOUNDARY LINE OF SAID SECTION AND 10 CHAINS NORTH OF SOUTH BORDER LINE OF SAID SECTION;

RUNNING THENCE SOUTH 10 CHAINS TO SOUTH BOUNDARY LINE OF SAID SECTION;
THENCE WEST ALONG SOUTH BOUNDARY LINE, 9.31 CHAINS;
THENCE NORTH 8.12 CHAINS;
THENCE NORTH 48-1/2° EAST TO A POINT DUE WEST OF INITIAL POINT;
THENCE EAST TO POINT OF BEGINNING.

PARCEL 3: (APN: 0285-211-22-0-000)

ALL THAT PORTION OF THE SOUTHEAST 1/4 OF THE SOUTHEAST 1/4 OF SECTION 29, TOWNSHIP 1 NORTH, RANGE 3 WEST, SAN BERNARDINO BASE AND MERIDIAN, IN THE COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO THE OFFICIAL PLAT THEREOF, DESCRIBED AS FOLLOWS:

COMMENCING AT THE SOUTHEAST CORNER OF SAID SECTION; THENCE WEST ALONG THE SOUTH LINE OF SAID SECTION 1274.46 FEET, MORE OR LESS, TO THE INTERSECTION OF THE CENTER LINE OF HIGHLAND AVENUE AND ORANGE STREET; THENCE NORTH 0 DEG. 23' 26" WEST, AS SHOWN ON THE MAP OF TRACT NO. 4966, AS PER PLAT RECORDED IN BOOK 79 OF MAPS, PAGE(S) 80 AND 81, RECORDS OF SAID COUNTY, A DISTANCE OF 341.25 FEET TO THE TRUE POINT OF BEGINNING OF THE PARCEL TO BE DESCRIBED;

THENCE EASTERLY, PARALLEL WITH THE NORTH LINE OF HIGHLAND AVENUE AND ALONG THE NORTH LINE OF THAT CERTAIN PARCEL AS CONVEYED TO WILLIS L. SEVERSON AND BERNIECE MAE

SEVERSON, BY DEED RECORDED JANUARY 24, 1958, IN BOOK 4421, PAGE 82, OFFICIAL RECORDS, A DISTANCE OF 218 FEET;

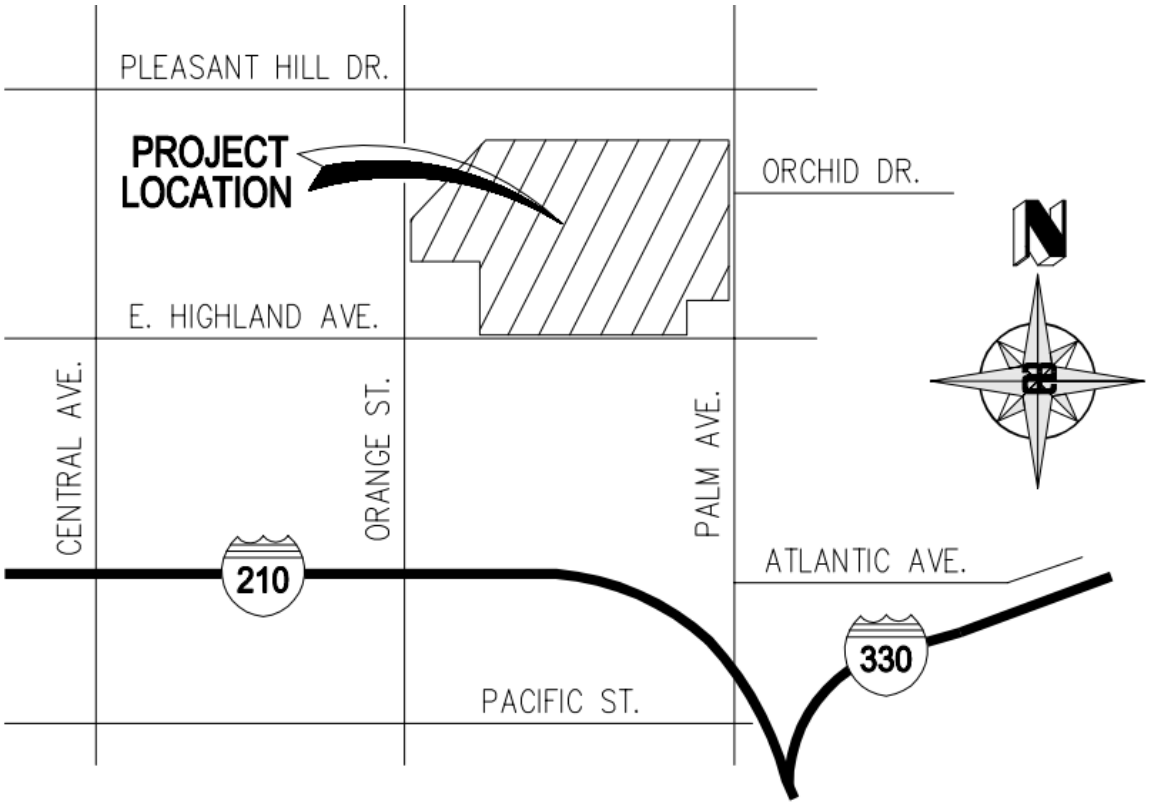
THENCE NORTH 11 DEG. 20' WEST, 123 FEET; 123 FEET;

THENCE SOUTHWESTERLY IN A STRAIGHT LINE, A DISTANCE OF 185 FEET, MORE OR LESS, TO A POINT IN THE CENTER LINE OF SAID ORANGE STREET, WHICH POINT IS DISTANT NORTH 0 DEG. 23' 26" WEST, 85 FEET FROM THE TRUE POINT OF BEGINNING;

THENCE SOUTH 0 DEG. 23' 26" EAST, ALONG THE CENTER LINE OF SAID ORANGE STREET, 85 FEET TO THE TRUE POINT OF BEGINNING.

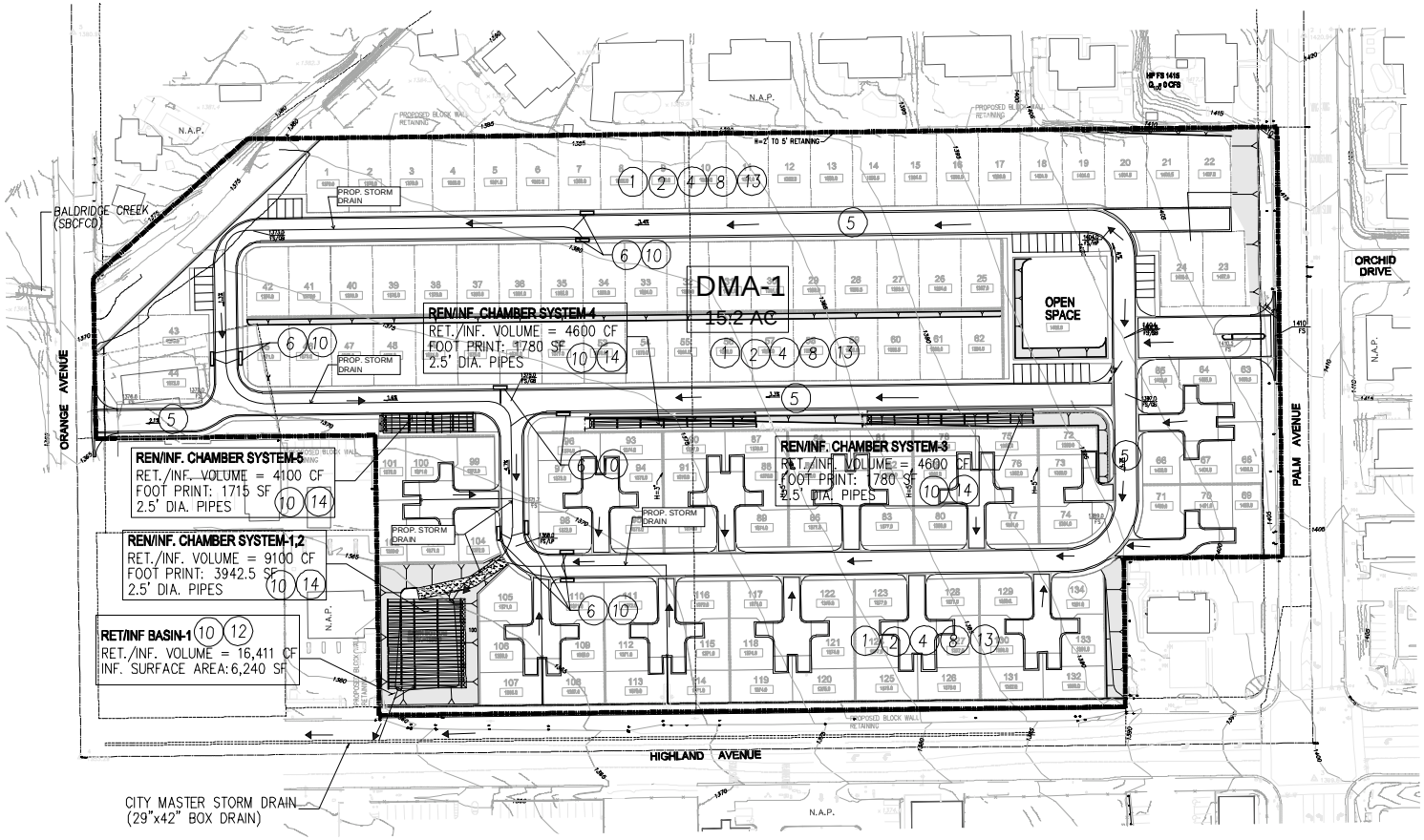
EXCEPTING THEREFROM THE WESTERLY 33 FEET THEREOF FOR ROAD PURPOSES

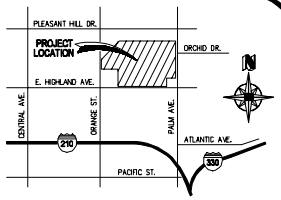
EXHIBIT B
(Map/illustration)



VICINITY MAP

NOT TO SCALE





VICINITY MAP
NOT TO SCALE

BMP LIST:

1. EDUCATION OF PROPERTY OWNERS
2. HARDSCAPE AREA (CONCRETE PAVING)
3. LANDSCAPE AREA
4. TRAINING/EDUCATION PROGRAM
5. STREET/DRIVE WAY SWEEPING/VACUUMING
6. COMMON AREA CATCH BASIN INSPECTION
7. LANDSCAPE PLANNING (SD-10)
8. ROOF RUNOFF CONTROLS (SD-11)
9. EFFICIENT IRRIGAION (SD-12)
10. STORM DRAIN SIGNAGE (SD-13) PER CASQA STANDARD. DETAIL ON THIS SHEET.
11. TRASH STORAGE AREAS (SD-32) PER DETAIL ON SHEET-2
12. RETENTION/INFILTRATION BASIN-1 (2.5' WATER DEPTH, 0' ROCK DEPTH, 3:1 SIDE)
13. GRATE INLET WITH FILTER INSERT- ADS FLEXSTORM FILTER INSERT. REFER TO DETAIL ON SHEET 2.
14. BELOW SURFACE CONTECH RET/INF CHAMBER SYSTEM-1 TO 5
15. ONSITE STORM DRAIN SYSTEM

DRAINAGE AREA	PROPOSED BMP	AREA (AC)	DESIGN CAPTURE VOL. (CF)	PROVIDED VOL. (CF)	TOTAL MITIGATED VOLUME (CF)
DMA-1	RET/INF BASIN BASIN-1	15.2	40,637	16,411	47,911
	RET/INF CHAMBER SYSTEM-1 TO 5			31,500	

DCV ACHEIVED WITH PROPOSED BMPs: 118%

GRAPHIC SCALE
60 0 30 60 120 240
(IN FEET)
1 INCH = 60'
SCALE: 1"= 60'

Prepared By:
ALLARD ENGINEERING
Civil Engineering - Land Surveying - Land Planning
16866 Seville Avenue
Fontana, California 92335
(909) 356-1815 Fax (909) 356-1795

Prepared For:
WARMINGTON RESIDENTIAL
3090 PULLMAN STREET
COSTA MESA, CA 92626
PH: (714) 557-5511

CITY OF SAN BERNARDINO, CA

WQMP EXHIBIT

HIGHLAND & PALM AVENUE RESIDENTIAL

APN: 0285-211-21 & 0285-211-23

PLOT DATE: October 22, 2021 ashafiq

Filename: I:\Warmington Homes\Palm Avenue San Bernardino\DWG's\ENTITLEMENT\EXHIBIT\WQMP\PRELEM WQMP EXHI

Infiltration Test Report

GEOTECHNICAL AND INFILTRATION EVALUATION
PROPOSED 189-UNIT RESIDENTIAL DEVELOPMENT
NWC EAST HIGHLAND AVENUE & PALM AVENUE
SAN BERNARDINO, SAN BERNARDINO COUNTY, CALIFORNIA

PREPARED FOR

WARMINGTON RESIDENTIAL
3090 PULLMAN STREET
COSTA MESA, CALIFORNIA 92626

PREPARED BY

GEOTEK, INC.
1548 NORTH MAPLE STREET
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PROJECT NO. 2813-CR **JULY 30, 2021**

GEOTEK

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July 30, 2021
Project No. 2813-CR

Warmington Residential
3090 Pullman Street
Costa Mesa, California 92626

Attention: Mr. Bret Ilich

Subject: Geotechnical and Infiltration Evaluation
Proposed 189-Unit Residential Development
NWC East Highland Avenue & Palm Avenue
San Bernardino, San Bernardino County, California

Dear Mr. Ilich:

We are pleased to provide herein the results of our geotechnical and infiltration evaluation for the subject site located in San Bernardino, San Bernardino County, California. This report presents a discussion of our evaluation and provides preliminary geotechnical recommendations for earthwork, foundation design, and construction.

In our opinion, site development appears feasible from a geotechnical viewpoint provided that the recommendations included herein are incorporated into the design and construction phases of site development.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to call our office.

Respectfully submitted,
GeoTek, Inc.

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ENCLOSURES

1. PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to complete an evaluation of the existing geotechnical conditions at the project site, as outlined in our proposal P-0604221-CR, dated June 24, 2021. Services provided for this study included the following:

- Research and review of available geologic and geotechnical data, and general information pertinent to the site,
- Perform a site reconnaissance,
- Site exploration consisting of the excavation and sampling of five exploratory borings observed and logged by a geologist from our firm,
- Excavation of two additional shallow borings for infiltration testing and performance of percolation testing in these borings,
- Collection of representative soil samples from the test borings and performing laboratory testing on select samples,
- Review and evaluation of site seismicity, and
- Compilation of this updated geotechnical report which presents our recommendations for site development.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

2.1 SITE DESCRIPTION

The approximate 14.5-acre site is located adjacent to the northwest corner of the intersection of E. Highland Avenue and Palm Avenue in San Bernardino, San Bernardino County, California. The site is also identified as Assessor Parcel Numbers (APN) 0285-211-05, -21, -23, and -25. The site is currently undeveloped vacant land. Existing developments adjacent to the southeast corner and southwest corner of the site are not part of the subject site. A drainage channel, about 10 feet deep, is situated along the northwest property boundary. The site slopes downward to the southwest with about 50 feet of elevation differential. The site is bordered by residential

properties to the north, east and south with the Patton State Hospital Museum property to the west, on the west side of Orange Street. The location of the site is indicated on Figure 1.

2.2 PROPOSED DEVELOPMENT

Based on a review of the Conceptual Density Study, prepared by KTGY, dated June 28, 2021, we understand that the site development will consist of 57-unit single-family residential lots, 132 cluster units, street improvements, open spaces, surface improvements, and underground utilities.

We have assumed that the structures will consist of 1 to 2-story buildings and will be supported by post-tensioned or a conventional shallow foundations and will incorporate slab on-grade floor systems. Although structural loading information has not been provided, we have assumed maximum column and wall laods of less than 40 kips and 3 kips per foot, respectively. Once actual structural loads are known, that information should be provided to GeoTek to determine if revisions to the recommendations presented in this report are warranted.

Based on the current site topography, we anticipate that the maximum depths of cut and fill will be about 10 to 15 feet, not including any remedial grading. If site development differs from the assumptions made herein, the recommendations included in this report should be subject to further review and evaluation. Site development plans should be reviewed by GeoTek when they become available.

3. FIELD EXPLORATION & LABORATORY TESTING

3.1 FIELD EXPLORATION

The field exploration for GeoTek's evaluation was conducted on July 1, 2021 and consisted of excavating five (5) geotechnical exploratory borings extended to depths ranging from about 20 to 43 feet below ground surface. Boring B-1 was terminated at a depth shallower than initially planned due to auger refusal on suspected cobbles or boulders. Two shallow borings were also drilled to a depth of about 5 feet for percolation testing. The approximate locations of the GeoTek excavations are shown on the Boring Location Map (Figure 2). Logs of the GeoTek borings are included in Appendix A.

Relatively undisturbed soil samples were recovered at various intervals in the geotechnical borings with a California sampler. The California sampler is a 3-inch outside diameter, 2.4-inch

inside diameter, split barrel sampler lined with brass rings. The sampler was 18 inches long. The sampler conformed to the requirements of ASTM D 3550. Standard Penetration Tests (SPT) were also performed in Boring B-1 per ASTM D-1586. A 140-pound automatic trip hammer was utilized, dropping 30 inches for each blow. The relatively undisturbed samples, together with bulk samples of representative soil types, were returned to the laboratory for testing and evaluation. The California ring and SPT sampler data is presented on the boring logs.

3.2 LABORATORY TESTING

Laboratory testing was performed by GeoTek on selected soil samples obtained from the borings. The purpose of the laboratory testing was to confirm the field classification of the soils encountered and to evaluate the physical properties of the soils for use in engineering design and analysis.

Included in our laboratory testing were moisture-density determination testing on selected relatively undisturbed samples. Grain-size analysis (percent passing the No. 200 sieve) were performed to aid in the soil classification. Collapse testing was performed on two representative "undisturbed' samples to assess the hydro-consolidation potential of the near-surface soils. The optimum moisture content-maximum dry density relationship was established for a typical soil type so that the relative compaction of the subsoils could be determined. Direct shear testing was performed on selected samples to help evaluate the bearing capacity of the soils. Expansion index testing was performed on one selected sample to evaluate the expansion potential of the site soils. Chemical testing comprised of pH, soluble sulfate, chloride and resistivity testing was conducted on selected samples. The moisture-density data and grain-size data are presented on the exploration logs in Appendix A. The maximum density, direct shear, collapse tests, expansion index and chemical test data are presented in Appendix B.

3.3 PERCOLATION TESTING

Percolation testing was performed at boring locations I-1 and I-2, in the area anticipated to be used for stormwater infiltration, to assess the infiltration characteristics of the site soils within the future stormwater management basin. The borings were excavated to approximately 5 feet below the existing grade. The boring diameters were approximately eight inches. Subsequent to pre-soaking, percolation testing was performed, in accordance with the methods approved by San Bernardino County, within the lower approximately 20 inches in the borings. The percolation rates were then corrected to account for discharge of water from both the sides and bottom of the borings. This correction was performed using the Porchet Method, obtaining the infiltration rates tabulated below:

SUMMARY OF RESULTS		
Boring	Measured Field Percolation Rate (minutes per inch)	Calculated Infiltration Rate (inches per hour)
I-1	3.33	1.76
I-2	3.70	1.57

Copies of the field data sheet and infiltration conversion sheet (Porchet Method) are included in Appendix C. The reported infiltration rates are the measured rate without any factor of safety applied. Over the lifetime of the detention basin, the infiltration rate may be affected by silt build up and biological activities, as well as local variations in near surface soil conditions. A suitable factor of safety should be applied to the field rates in design the infiltration system.

It should be noted that the infiltration rate provided above was performed in relatively undisturbed native soils. Infiltration rates will vary and are mostly dependent on the underlying consistency of the site soils and relative density. Infiltration rates will be impacted by weight of equipment travelling over the soils, placement of engineered fill and other various factors. GeoTek, Inc. assumes no responsibility or liability for the ultimate design or performance of the storm water facility.

4. GEOLOGIC AND SOILS CONDITIONS

4.1 REGIONAL SETTING

The subject property is situated in the Peninsular Ranges geomorphic province near the border with the Transverse Ranges. The Peninsular Ranges province is one of the largest geomorphic units in western North America. Basically, it extends roughly 975 miles from the north and extends from the Transverse Ranges geomorphic province to the tip of Baja California, from north to south. This province varies in width from about 30 to 100 miles. It is bounded on the west by the Pacific Ocean, on the south by the Gulf of California and on the east by the Colorado Desert Province.

The Peninsular Ranges are essentially a series of northwest-southeast oriented fault blocks. Several major fault zones are found in this province. The Elsinore Fault zone and the San Jacinto Fault zone trend northwest-southeast and are found in the near the middle of the province. The San Andreas Fault zone borders the northeasterly margin of the province.

More specific to the subject property, the site is located in an area geologically mapped to be underlain by alluvium (Dibblee, T. W. and Minch, J.A., 2004), described as sand and clay.

4.2 GENERAL SOIL/GEOLOGIC CONDITIONS

A brief description of the earth materials encountered below the site and within the area of anticipated construction is presented in the following section. Based on our field exploration, the area of anticipated improvements is underlain by alluvium.

4.2.1 Alluvium

Alluvium was encountered beneath the ground surface in all geotechnical borings and extended to the maximum depth explored. The alluvium encountered consisted of a loose to very dense silty sand with variable clay content, clayey sand, slightly silty sand and a very stiff to hard sandy silt.

According to the results of the laboratory testing performed on one sample of the near surface fill, the near surface soils have a "very low" expansion potential (EI=1) when tested and classified in accordance with ASTM D 4829. The test results are provided in Appendix B.

4.3 SURFACE AND GROUNDWATER

4.3.1 Surface Water

If encountered during the earthwork construction, surface water on this site is the result of precipitation or surface run-off from surrounding sites. Provisions for surface drainage will need to be accounted for by the project civil engineer.

4.3.2 Groundwater

Groundwater was not encountered within any of the GeoTek borings which extended to a maximum depth of about 51.5 feet below grade. A review of groundwater depth information noted on the State Department of Water Resources Water Data Library website indicates a depth to groundwater is greater than about 150 feet below grade within wells in the site vicinity.

It is possible that seasonal variations (temperature, rainfall, etc.) will cause fluctuations in the groundwater level. Additionally, perched water may be encountered at shallow depths following extensive rain events. If shallow perched water is encountered, we anticipate that it can be managed with conventional sump pumps.

4.4 FAULTING AND SEISMICITY

The geologic structure of the entire southern California area is dominated mainly by northwest-trending faults associated with the San Andreas system. The site is in a seismically active region. No active or potentially active fault is known to exist at this site nor is the site situated within an *"Alquist-Priolo"* Earthquake Fault Zone. The subject property is located within an area that has not yet been evaluated by the CGS for earthquake induced landsliding or liquefaction. However, the site is not within a seismic hazard area as identified on the San Bernardino County Geologic Hazards Overlay Map (Sheet FH23_C). The nearest zoned fault is the San Andreas fault zone, located about 0.4 mile to the northeast.

4.4.1 Seismic Design Parameters

The site is located at approximately 34.1368 degrees Latitude and -117.2109 degrees Longitude. Site spectral accelerations (S_a and S_1), for 0.2 and 1.0 second periods for a Class "D" site, was determined from the SEAOC/OSHPD web interface that utilizes the USGS web services and retrieves the seismic design data and presents that information in a report format. Using the ASCE 7-16 option on the SEAOC/OSHPD website results in the values for S_{M1} and S_{D1} reported as "null-See Section 11.4.8" (of ASCE 7-16). As noted in ASCE 7-16, Section 11.4.8, a site-specific ground motion procedure is recommended for Site Class D when the value S_1 exceeds 0.2. The value S_1 for the subject site exceeds 0.2.

For a site Class D, an exception to performing a site-specific ground motion analysis is allowed in ASCE 7-16 where S_1 exceeds 0.2 provided the value of the seismic response coefficient, Cs, is conservatively calculated by Eq 12.8-2 of ASCE 7-16 for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either Eq. 12.8-3 for $T_L \geq T > 1.5T_s$ or Eq. 12.8-4 for $T > T_L$.

The results, based on the 2015 NEHRP and the 2019 CBC, are presented in the following table and we have assumed that the exception as allowed in ASCE 7-16 is applicable. If the exception is deemed not appropriate, a site-specific ground motion analysis will be required.

SITE SEISMIC PARAMETERS	
Mapped 0.2 sec Period Spectral Acceleration, S_S	2.602g
Mapped 1.0 sec Period Spectral Acceleration, S_1	1.031g
Site Coefficient for Site Class "D", F_a	1.0
Site Coefficient for Site Class "D", F_v	1.7
Maximum Considered Earthquake Spectral Response Acceleration for 0.2 Second, S_{MS}	2.602g
Maximum Considered Earthquake Spectral Response Acceleration for 1.0 Second, S_{M1}	1.753g
5% Damped Design Spectral Response Acceleration Parameter at 0.2 Second, S_{DS}	1.735g
5% Damped Design Spectral Response Acceleration Parameter at 1 second, S_{D1}	1.168g
Peak Ground Acceleration Adjusted for Site Class Effects, PGA_M	1.186g
Seismic Design Category	E

4.5 LIQUEFACTION CONSIDERATIONS

A review of the San Bernardino County Geologic Hazard Maps (Map FH23-C) indicates the site is not situated within an area that is designated as possessing a liquefaction hazard. Due to the current mapping and the great depth to groundwater (150+ feet), it is our opinion that the potential for liquefaction at this site due to nearby seismic activity is nil.

An assessment of the "dry" settlement (i.e. settlement above the water table) resulting from seismic shaking was also evaluated. For this analysis we used a groundwater depth of 150 feet, a ground acceleration (PGA_M) of 1.186g and a mean earthquake magnitude of 7.3. The ground acceleration and earthquake magnitude were obtained from the USGS websites. The computer software program LiquefyPro and the soil profiled from Boring B-1 were used in the analysis. The results of this analysis indicate a potential ground surface settlement of about 2 inches is possible. A differential seismic settlement of about 1 inch over a 40 foot span is estimated. Based on these estimated magnitudes, ground modification or special foundation design is not deemed necessary. The results of the seismic dry settlement analysis are presented in Appendix D.

4.6 OTHER SEISMIC HAZARDS

Evidence of ancient landslides or slope instabilities at this site was not observed during our investigation. Thus, the potential for landslides is considered negligible for design purposes. The potential for secondary seismic hazards such as a seiche or tsunami is considered negligible due to site elevation and distance to an open body of water.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL

Development of the site appears feasible from a geotechnical viewpoint. The following recommendations should be incorporated into the design and construction phases of development.

5.2 EARTHWORK CONSIDERATIONS

Earthwork and grading should be performed in accordance with the applicable grading ordinances of the City of San Bernardino, the 2019 California Building Code (CBC) and recommendations contained in this report. Site grading plans should be reviewed by this office when they become available. Additional recommendations may be offered subsequent to review of these plans. The General Grading Guidelines included in Appendix E outline general procedures and do not anticipate all site-specific situations. In the event of conflict, the recommendations presented in the text of this report should supersede those contained in Appendix E.

5.2.1 Site Clearing & Demolition

Initial site preparation should include removal of all vegetation and any other deleterious materials within the planned development area of the site. The horizontal limits of the clearing should extend at least 8 feet beyond the new buildings and beneath any new improvements.

Voids resulting from removing any materials should be replaced with engineered fill materials with expansion characteristics similar to the onsite materials.

5.2.2 Site Preparation

Following site clearing and lowering of site grades, where necessary, we recommend that any encountered undocumented fill and the upper four feet of the native alluvium be removed below existing or finished grade, whichever is deeper, and stockpiled on-site for future use. The lateral extent of the recommended over-excavation should extend at least 5 feet beyond all buildings and beneath adjacent patio slabs. The soils exposed at the base of the over-excavation should then be examined by a GeoTek representative to confirm that the exposed soils are suitable for structural support. If unsuitable soils are encountered, those materials should be removed as recommended by GeoTek. Once approved, the exposed soils should be scarified to a depth of

about 12 inches, be moisture treated to slightly above the soil's maximum dry density, per ASTM D1557, and then be compacted to at least 90% of the soil's maximum dry density (ASTM D1557).

Beneath new roadways, pavements, other surface improvements and areas to receive new fill, we recommend that the exposed soils, prior to fill placement, be proof rolled in the presence of a GeoTek representative. Proof rolling equipment should possess a minimum static weight of 10 tons and proof rolling should consist of at least four passes, two in each perpendicular direction. Any soil that ruts or excessively deflects during proof rolling should be removed as recommended by the GeoTek representative. Following proof rolling, the exposed soils should be scarified, moisture treated and compacted as recommended in the prior paragraph.

5.2.3 Fills

On-site materials are generally considered suitable for reuse as engineered fill, provided they are free from vegetation, roots, and other deleterious material. Rock fragments (i.e. cobbles or boulders) greater than 6 inches in maximum dimension should not be incorporated into engineered fill. The fill materials should also be placed so that void resulting from nesting of cobbles does not occur.

Engineered fill materials should be placed in horizontal lifts not exceeding 8 inches in loose thickness, moisture conditioned to slightly over the optimum moisture content and compacted to a minimum relative compaction of 90 percent (ASTM D 1557).

5.2.4 Excavation Characteristics

Excavation in the on-site soils is expected to be feasible utilizing heavy-duty grading equipment in good operating condition. All temporary excavations for grading purposes and installation of underground utilities should be constructed in accordance with local and Cal-OSHA guidelines. Temporary excavations within the on-site materials should be stable at 1:1 (h:v) inclinations for cuts less than 5 feet in height.

5.2.5 Shrinkage & Subsidence Estimates

Several factors will impact earthwork balancing on the site, including shrinkage, subsidence, trench spoil from utilities and footing excavations, as well as the accuracy of topography.

Shrinkage is primarily dependent upon the degree of compactive effort achieved during construction. For planning purposes, a shrinkage factor of approximately 5 to 10 percent may be considered for the materials requiring recompaction. Subsidence of about 0.1 feet may also

occur as a result of preparation of exposed ground. Site balance may also be impacted if over-sized materials are exported from the site.

5.2.6 Trench Excavations and Backfill

Temporary excavations within the onsite materials should be stable at 1:1 inclinations for short durations during construction, and where cuts do not exceed 10 feet in height. Temporary cuts to a maximum height of 4 feet can be excavated vertically, but local sloughing and/or failure could occur due to the granulated nature of the soils at this site. Increased caution should be applied when working near or within any excavations at this site.

Trench excavations should conform to Cal-OSHA regulations. The contractor should have a competent person, per OSHA requirements, on site during construction to observe conditions and to make the appropriate recommendations.

Utility trench backfill should be compacted to at least 90 percent relative compaction (as determined per ASTM D 1557). Under-slab trenches should also be compacted to project specifications. Onsite materials are not considered suitable for use as bedding material but should be suitable as backfill, provided over-sized materials are removed.

Compaction should be achieved with a mechanical compaction device. Ponding or jetting of trench backfill is not recommended. If backfill soils have dried out, they should be thoroughly moisture conditioned prior to placement in trenches.

5.3 DESIGN RECOMMENDATIONS

The soils are classified as having a "very low" expansion potential in accordance with ASTM D 4829. We understand that post-tensioned foundations may be used for this site. Since the CBC indicates Post Tensioning Institute (PTI) design methodology is intended for expansive soils conditions, which do not apply, no e_m or y_m parameters as used in the PTI methodology are provided. The foundation elements for the proposed structures should bear entirely in engineered fill soils and should be designed in accordance with the *2019 California Building Code (CBC)*.

MINIMUM DESIGN REQUIREMENTS FOR POST-TENSIONED FOUNDATIONS	
Foundation Design Parameter	"Very Low" Expansion Potential
Foundation Depth or Minimum Perimeter Beam Depth/Turned Down Edge (inches below lowest adjacent grade)	One and Two-Stories – 12 inches*
Minimum Beam/Wall Foundation Width	One and Two-Stories – 12 inches*
Minimum Slab Thickness (actual)	4 inches
Presaturation of Subgrade Soil (Percent of Optimum)	Minimum 100% to a depth of 12 inches

*Greater depths and widths may be required per the structural design. Interior footing depths should be at least 12 inches below interior finished grade for 1-2 story buildings. Interior pad footings should possess a minimum width of 18 inches.

Foundation design criteria for a conventional foundation system, in general conformance with the 2019 CBC, are also presented below. The soils are classified as having a "very low" expansion potential in accordance with ASTM D 4829. Typical design criteria for the site based upon a "very low" expansion potential are tabulated below. These are minimal recommendations and are not intended to supersede the design by the project structural engineer. Once structural loading information is provided, revisions to the recommendations provided in this report may be necessary.

The conventional foundation elements for the proposed permanent buildings should bear entirely in engineered fill soils. Foundations should be designed in accordance with the 2019 CBC.

Expansion index and soluble sulfate evaluation of the soils should be performed during construction to evaluate the as-graded conditions. Final recommendations should be based upon the as-graded soils conditions.

A summary of our foundation design recommendations is presented in the following table:

GEOTECHNICAL RECOMMENDATIONS FOR FOUNDATION DESIGN

Design Parameter	"Very Low" Expansion Potential
Foundation Depth or Minimum Perimeter Beam Depth (inches below lowest adjacent grade)	12-1 & 2 story
Minimum Foundation Width (Inches)*	12-1 story 15-2 story
Minimum Slab Thickness (actual)	4 – Actual
Minimum Slab Reinforcing	6" x 6" – W1.4/W1.4 welded wire fabric placed in middle of slab or No. 3 bars at 24 inch centers
Minimum Footing Reinforcement	Two No. 4 reinforcing bars, one placed near the top and one near the bottom
Effective Plasticity Index	PI<15
Presaturation of Subgrade Soil (Percent of Optimum)	Minimum of 100% of the optimum moisture content to a depth of at least 12 inches prior to placing concrete

* Code minimums per Table 1809.7 of the 2019 CBC

An allowable bearing capacity of 2,500 pounds per square foot (psf) may be used for design of building foundations for footing depths and widths of 12 inches. This allowable soil bearing capacity can be increased by 750 psf and 400 psf for each additional foot of footing depth or width to a maximum value of 3,500 psf. The allowable bearing capacity may also be increased by one-third when considering short-term wind and seismic loads.

For footings designed in accordance with the recommendations presented in this report, we would anticipate a maximum static settlement of less than one inch and a maximum differential static settlement of less than ½-inch in a 40-foot span.

The passive earth pressure may be computed as an equivalent fluid having a density of 295 psf per foot of depth, to a maximum earth pressure of 3,000 psf for footings cast adjacent to compacted fill. A coefficient of friction between soil and concrete of 0.45 may be used with dead load forces. The upper one foot of soil below the adjacent grade should not be used in calculating passive pressure unless the ground surface is covered with pavement. When combining passive and frictional resistance, the passive pressure component should be reduced by one-third.

A moisture and vapor retarding system should be placed below slabs-on-grade where moisture migration through the slab is undesirable. Guidelines for these are provided in the 2019 California Green Building Standards Code (CALGreen) Section 4.505.2 and the 2019 CBC Section 1907.1 and ACI 360R-10. The vapor retarder design and construction should also meet the

requirements of ASTM E1643. A portion of the vapor retarder design should be the implementation of a moisture vapor retardant membrane.

It should be realized that the effectiveness of the vapor retarding membrane can be adversely impacted as a result of construction related punctures (e.g. stake penetrations, tears, punctures from walking on the aggregate layer, etc.). These occurrences should be limited as much as possible during construction. Thicker membranes are generally more resistant to accidental puncture than thinner ones. Products specifically designed for use as moisture/vapor retarders may also be more puncture resistant. Although the CBC specifies a six-mil vapor retarder membrane, it is GeoTek's opinion that a minimum 10 mil thick membrane with joints properly overlapped and sealed should be considered, unless otherwise specified by the slab design professional. The membrane should consist of Stego wrap or the equivalent.

Moisture and vapor retarding systems are intended to provide a certain level of resistance to vapor and moisture transmission through the concrete, but do not eliminate it. The acceptable level of moisture transmission through the slab is to a large extent based on the type of flooring used and environmental conditions. Ultimately, the vapor retarding system should be comprised of suitable elements to limit migration of water and reduce transmission of water vapor through the slab to acceptable levels. The selected elements should have suitable properties (i.e., thickness, composition, strength, and permeability) to achieve the desired performance level. Consideration should be given to consulting with an individual possessing specific expertise in this area for additional evaluation.

Moisture retarders can reduce, but not eliminate, moisture vapor rise from the underlying soils up through the slab. Moisture retarders should be designed and constructed in accordance with applicable American Concrete Institute, Portland Cement Association, Post-Tensioning Concrete Institute, ASTM and California Building Code requirements and guidelines.

GeoTek recommends that a qualified person, such as the flooring contractor, structural engineer, and/or architect be consulted to evaluate the general and specific moisture vapor transmission paths and associated potential impact.

In addition, the recommendations in this report and our services in general are not intended to address mold prevention, since we along with geotechnical consultants in general, do not practice in areas of mold prevention. If specific recommendations are desired, a professional mold prevention consultant should be contacted.

5.3.1 Miscellaneous Foundation Recommendations

5.3.1.1 To minimize moisture penetration beneath the slab on grade areas, utility trenches should be backfilled with engineered fill, lean concrete or concrete slurry where they intercept the perimeter footing or thickened slab edge.

5.3.1.2 Soils from the footing excavations should not be placed in the slab-on-grade areas unless properly compacted and tested. The excavations should be free of loose/sloughed materials and be neatly trimmed at the time of concrete placement.

5.3.1.3 Under-slab utility trenches should be compacted to project specifications. Compaction should be achieved with a mechanical compaction device. If backfill soils have dried out, they should be thoroughly moisture conditioned prior to placement in trenches.

5.3.1.4 Utility trench excavations should be shored or laid back in accordance with applicable CAL/OSHA standards.

5.3.1.5 On-site materials may not be suitable for use as bedding material but will be suitable as backfill. Jetting of native soils will not be acceptable.

5.3.2 Foundation Setbacks

Foundations should comply with the following setbacks. Improvements not conforming to these setbacks are subject to the increased likelihood of excessive lateral movements and/or differential settlements. If large enough, these movements can compromise the integrity of the improvements. The following recommendations are presented:

- The outside bottom edge of all footings should be set back a minimum of H/3 (where H is the slope height) from the face of any descending slope. The setback should be at least 7 feet and need not exceed 40 feet.
- The bottom of all footings for structures near retaining walls should be deepened so as to extend below a 1:1 projection upward from the bottom inside edge of the wall stem.
- The bottom of any existing foundations for structures should be deepened so as to extend below a 1:1 projection upward from the bottom of the nearest excavation.

5.4 RETAINING WALL DESIGN AND CONSTRUCTION

5.4.1 General Design Criteria

Recommendations presented in this report apply to typical masonry or concrete vertical retaining walls. These are typical design criteria and are not intended to supersede the design by the structural engineer.

Retaining wall foundations should be designed in accordance with *Section 5.3* of this report. A minimum foundation embedment of 12 inches into engineered compacted fill with "very low" expansion potential is recommended. Structural needs may govern and should be evaluated by the project structural engineer.

All earth retention structure plans, as applicable, should be reviewed by this office prior to finalization.

The backfill material placement for all earth retention structures should meet the requirement of *Section 5.4.4* in this report.

In general, cantilever earth retention structures, which are designed to yield at least 0.001H, where H is equal to the height of the wall to the base of the footing, may be designed using the active condition. Rigid earth retention structures (including but not limited to rigid walls, and walls braced at top, such as typical basement walls) should be designed using the at-rest condition.

In addition to the design lateral forces due to retained earth, surcharges due to improvements, such as an adjacent building or traffic loading, should be considered in the design of the earth retention structures. Loads applied within a 1:1 (h:v) projection from the surcharge on the stem of the earth retention structure should be considered in the design.

Final selection of the appropriate design parameters should be made by the designer of the earth retention structures.

5.4.2 Cantilevered Walls

The recommendations presented below are for cantilevered retaining walls. Active earth pressure may be used for retaining wall design, provided the top of the wall is not restrained from minor deflections. An equivalent fluid pressure approach may be used to compute the horizontal pressure against the wall. Appropriate fluid unit weights are given below for specific

slope gradients of the retained material. These do not include other superimposed loading conditions such as traffic, structures, seismic events, or adverse geologic conditions.

Surface Slope of Retained Materials (h:v)	Equivalent Fluid Pressure (pcf) Native Backfill*
Level	32
2:1	50

* The design pressures assume the backfill material has an expansion index less than or equal to 20. Backfill zone includes area between the back of the wall and footing to a plane (1:1 h:v) up from the bottom of the wall foundation to the ground surface.

For walls with a retained height greater than 6 feet, an incremental seismic pressure must also be included within the wall design. Based on a ground acceleration (PGA_M) of 1.186g, we recommend that an incremental seismic pressure of 35.6 pcf be used, where required by code. This seismic pressure may be applied as a conventional triangular distribution.

5.4.3 Restrained Retaining Walls

Retaining walls that will be restrained prior to placing and compacting backfill material, or that have reentrant or male corners, should be designed for an at-rest equivalent fluid pressure of 55 pcf, plus any applicable surcharge loading, for very low expansive backfill (EI<20) and level back slope condition. For areas of male or reentrant corners, the restrained wall design should extend a minimum distance of twice the height of the wall laterally from the corner, or a distance otherwise determined by the project structural engineer.

5.4.4 Retaining Wall Backfill and Drainage

Retaining wall backfill should consist of materials with an expansion index (EI) ≤ 20 and free of deleterious and/or oversized materials. The wall backfill should also include a minimum one-foot wide section of ¾- to 1-inch clean crushed rock (or approved equivalent). The rock should be placed immediately adjacent to the back of wall and extend up from the back drain to within approximately 12 inches of finish grade. The upper 12 inches should consist of compacted onsite materials or pavements. Presence of other materials might necessitate revision to the parameters provided and modification of wall designs. The backfill materials should be placed in lifts no greater than 8-inches in thickness and compacted to a minimum of 90 percent relative compaction in accordance with ASTM Test Method D 1557. Proper surface drainage needs to be provided and maintained. Bracing of the walls during backfilling and compaction may also be necessary.

All earth retention structures should be provided with an adequate pipe and gravel back drain system to reduce the potential for hydrostatic pressure build up. As a minimum, backdrains

should consist of a four-inch diameter perforated collector pipe (Schedule 40, SDR 35, or approved equivalent) embedded in a minimum of one cubic foot per lineal foot of ¾- to 1-inch clean crushed rock or equivalent, wrapped in filter fabric (Mirafi 140N or approved equivalent). The drain system should be connected to a suitable outlet, as determined by the civil engineer. Drain outlets should be maintained over the life of the project and should not be obstructed or plugged by adjacent improvements. Waterproofing of site walls should be performed where moisture migration through the wall is undesirable.

Proper surface drainage needs to be provided and maintained. Water should not be allowed to pond behind retaining walls. Waterproofing of site walls should be performed where moisture migration through the wall is undesirable.

5.5 SOIL CORROSIVITY

Based on the chemical test results performed on one sample collected from the site as presented in Appendix B, the corrosivity test results indicate that the on-site soils are "moderately corrosive" to buried ferrous metal. This corrosion classification is obtained from "Handbook of Corrosion Engineering," by Pierre R. Roberge, 2nd Edition, 2000. Recommendations for protection of buried ferrous metal should be provided by a corrosion engineer. Additional corrosion testing should be performed at the time of site grading to assess the corrosion of potential of the as-graded soils.

5.5.1 Soil Sulfate Content

The sulfate content was determined in the laboratory for one representative onsite soil sample. The results indicate that the water-soluble sulfate is less than 0.1 percent by weight which is considered "not applicable" (i.e. negligible) as per Table 4.2.1 of ACI 318. Based upon the test results, no special concrete mix design is required by Code for sulfate attack resistance.

5.5.2 Import Soils

Import soils (if needed) should have an Expansion Index of less than 20 (very low) and should not possess oversized or deleterious materials. GeoTek also recommends that, as a minimum, any proposed import soils be tested for soluble sulfate content. GeoTek should be notified a minimum of 72 hours of potential import sources so that appropriate sampling and laboratory testing can be performed.

5.6 PRELIMINARY PAVEMENT DESIGN

Preliminary pavement design for proposed street improvements was conducted per Caltrans *Highway Design Manual* guidelines for flexible pavements. Based on an assumed design R-value of 40 and for Traffic Indices (TIs) of 5.0 and 6.0, the following preliminary sections were calculated:

PRELIMINARY MINIMUM PAVEMENT SECTION		
Traffic Index	Thickness of Asphalt Concrete (inches)	Thickness of Aggregate Base (inches)
5.0	3	4
6.0	3-½	6

Traffic Indices (TIs) used in our pavement design are considered reasonable values for the proposed residential street areas and should provide a pavement life of approximately 20 years with a normal amount of flexible pavement maintenance. Irrigation adjacent to pavements, without a deep curb or other cutoff to separate landscaping from the paving may result in premature pavement failure. Traffic parameters used for design were selected based upon engineering judgment and not upon information furnished to us such as an equivalent wheel load analysis or a traffic study.

The recommended pavement sections provided are intended as a minimum guideline and final selection of pavement cross section parameters should be made by the project civil engineer, based upon the local laws and ordinates, expected subgrade and pavement response, and desired level of conservatism. If thinner or highly variable pavement sections are constructed, increased maintenance and repair could be expected. Final pavement design should be checked by testing of soils exposed at subgrade (the upper five feet) after final grading has been completed.

Asphalt concrete and aggregate base should conform to current Caltrans Standard Specifications Section 39 and 26-1.02, respectively. As an alternative, asphalt concrete can conform to Section 203-6 of the current Standard Specifications for Public Work (Green Book). Crushed aggregate base or crushed miscellaneous base can conform to Section 200-2.2 and 200-2.4 of the Green Book, respectively. Pavement base should be compacted to at least 95 percent of the ASTM D1557 laboratory maximum dry density (modified proctor).

All pavement installation, including preparation and compaction of subgrade, compaction of base material, placement and rolling of asphaltic concrete should be done in accordance with the City of San Bernardino specifications, and under the observation and testing of GeoTek and a City

Inspector where required. Jurisdictional minimum compaction requirements in excess of the aforementioned minimums may govern.

Deleterious material, excessive wet or dry pockets, oversized rock fragments, and other unsuitable yielding materials encountered during grading should be removed. Once existing compacted fill are brought to the proposed pavement subgrade elevations, the subgrade should be proof-rolled in order to check for a uniform and unyielding surface. The upper 12 inches of pavement subgrade soils should be scarified, moisture conditioned at or near optimum moisture content, and recompacted to at least 95 percent of the laboratory maximum dry density (ASTM D1557). If loose or yielding materials are encountered during construction, additional evaluation of these areas should be carried out by GeoTek. All pavement section changes should be properly transitioned.

5.7 CONCRETE FLATWORK

5.7.1 Exterior Concrete Slabs and Sidewalks

Exterior concrete slabs and sidewalks should be designed using a four (4) inch minimum thickness. No specific reinforcement is required due to the non-structural nature and the very low expansive nature of the site soils. However, the use of some reinforcement should be considered. Recommendations can be provided upon request. Some shrinkage and cracking of the concrete should be anticipated as a result of typical mix designs and curing practices commonly utilized in residential construction.

Sidewalks and driveways may be under the jurisdiction of the governing agency. If so, jurisdictional design and construction criteria would apply, if more restrictive than the recommendations presented herein.

Subgrade soils, classified as having "very low" expansion potential, should be pre-moistened prior to placing concrete. The subgrade soils below exterior slabs, sidewalks, driveways, etc. at the subject site should be pre-saturated to a minimum of 100% of optimum moisture content to a depth of 12 inches for "very low" expansive soils.

All concrete installation, including preparation and compaction of subgrade, should be done in accordance with City of San Bernardino specifications, and under the observation and testing of GeoTek and a City Inspector, if necessary.

5.7.2 Concrete Performance

Concrete cracks should be expected. These cracks can vary from sizes that are essentially unnoticeable to more than 1/8 inch in width. Most cracks in concrete, while unsightly, do not significantly impact long-term performance. While it is possible to take measures (proper concrete mix, placement, curing, control joints, etc.) to reduce the extent and size of cracks that occur, some cracking will occur despite the best efforts to minimize it. Concrete can also undergo chemical processes that are dependent on a wide range of variables, which are difficult, at best, to control. Concrete, while seemingly a stable material, is also subject to internal expansion and contraction due to external changes over time.

One of the simplest means to control cracking is to provide weakened control joints for cracking to occur along. These do not prevent cracks from developing; they simply provide a relief point for the stresses that develop. These joints are a widely accepted means to control cracks but are not always effective. Control joints are more effective the more closely spaced they are. GeoTek suggests that control joints be placed in two directions and located a distance apart roughly equal to 24 to 36 times the slab thickness.

Exterior concrete flatwork (patios, walkways, driveways, etc.) is often some of the most visible aspects of site development. They are typically given the least level of quality control, being considered "non-structural" components. We suggest that the same standards of care be applied to these features as to the structure itself.

5.8 POST CONSTRUCTION CONSIDERATIONS

5.8.1 Landscape Maintenance and Planting

Water has been shown to weaken the inherent strength of soil, and slope stability is significantly reduced by overly wet conditions. Positive surface drainage away from graded slopes should be maintained and only the amount of irrigation necessary to sustain plant life should be provided for planted slopes. Controlling surface drainage and runoff and maintaining a suitable vegetation cover can minimize erosion. Plants selected for landscaping should be lightweight, deep-rooted types that require little water and are capable of surviving the prevailing climate.

Overwatering should be avoided. The soils should be maintained in a solid to semi-solid state as defined by the materials Atterberg Limits. Care should be taken when adding soil amendments to avoid excessive watering. Leaching as a method of soil preparation prior to planting is not recommended. An abatement program to control ground-burrowing rodents should be implemented and maintained. This is critical as burrowing rodents can decreased the long-term performance of slopes.

It is common for planting to be placed adjacent to structures in planter or lawn areas. This will result in the introduction of water into the ground adjacent to the foundation. This type of landscaping should be avoided. If used, then extreme care should be exercised with regard to the irrigation and drainage in these areas.

5.8.2 Drainage

The need to maintain proper surface drainage and subsurface systems cannot be overly emphasized. Positive site drainage should be maintained at all times. Drainage should not flow uncontrolled down any descending slope. Water should be directed away from foundations and not allowed to pond or seep into the ground. Pad drainage should be directed toward approved areas and not be blocked by other improvements.

It is the owner's responsibility to maintain and clean drainage devices on or contiguous to their lot. In order to be effective, maintenance should be conducted on a regular and routine schedule and necessary corrections made prior to each rainy season.

5.9 PLAN REVIEW AND CONSTRUCTION OBSERVATIONS

We recommend that site foundation plans and relevant project specifications be reviewed by this office prior to construction to check for conformance with the recommendations of this report. We also recommend that GeoTek representatives be present during site grading and foundation construction to check for proper implementation of the geotechnical recommendations. The owner/developer should verify that GeoTek representatives perform at least the following duties:

- Observe site clearing and grubbing operations for proper removal of unsuitable materials.
- Observe and test bottom of removals prior to fill placement.
- Evaluate the suitability of onsite and import materials for fill placement and collect soil samples for laboratory testing where necessary.
- Observe the fill for uniformity during placement, including utility trenches.
- Perform field density testing of the fill materials.
- Observe and probe foundation excavations to confirm suitability of bearing materials.

If requested, a construction observation and compaction report can be provided by GeoTek, which can comply with the requirements of the governmental agencies having jurisdiction over the project. We recommend that these agencies be notified prior to commencement of construction so that necessary grading permits can be obtained.

6. INTENT

It is the intent of this report to aid in the design and construction of the proposed development. Implementation of the advice presented in Section 5 of this report is intended to reduce risk associated with construction projects. The professional opinions and geotechnical advice contained in this report are not intended to imply total performance of the project or guarantee that unusual or variable conditions will not be discovered during or after construction.

The scope of our evaluation is limited to the boundaries of the subject residential lot. This review does not and should in no way be construed to encompass any areas beyond the specific area of the proposed construction as indicated to us by the client. Further, no evaluation of any existing site improvements is included. The scope is based on our understanding of the project and the client's needs, our fee estimate (P-0604221-CR) dated June 24, 2021 and geotechnical engineering standards normally used on similar projects in this region.

7. LIMITATIONS

The materials observed on the project site appear to be representative of the area; however, soil and bedrock materials vary in character between excavations and natural outcrops or conditions exposed during site construction. Site conditions may vary due to seasonal changes or other factors. GeoTek, Inc. assumes no responsibility or liability for work, testing or recommendations performed or provided by others.

Since our recommendations are based on the site conditions observed and encountered, and laboratory testing, our conclusion and recommendations are professional opinions that are limited to the extent of the available data. Observations during construction are important to allow for any change in recommendations found to be warranted. These opinions have been derived in accordance with current standards of practice and no warranty is expressed or implied. Standards of practice are subject to change with time.

8. SELECTED REFERENCES

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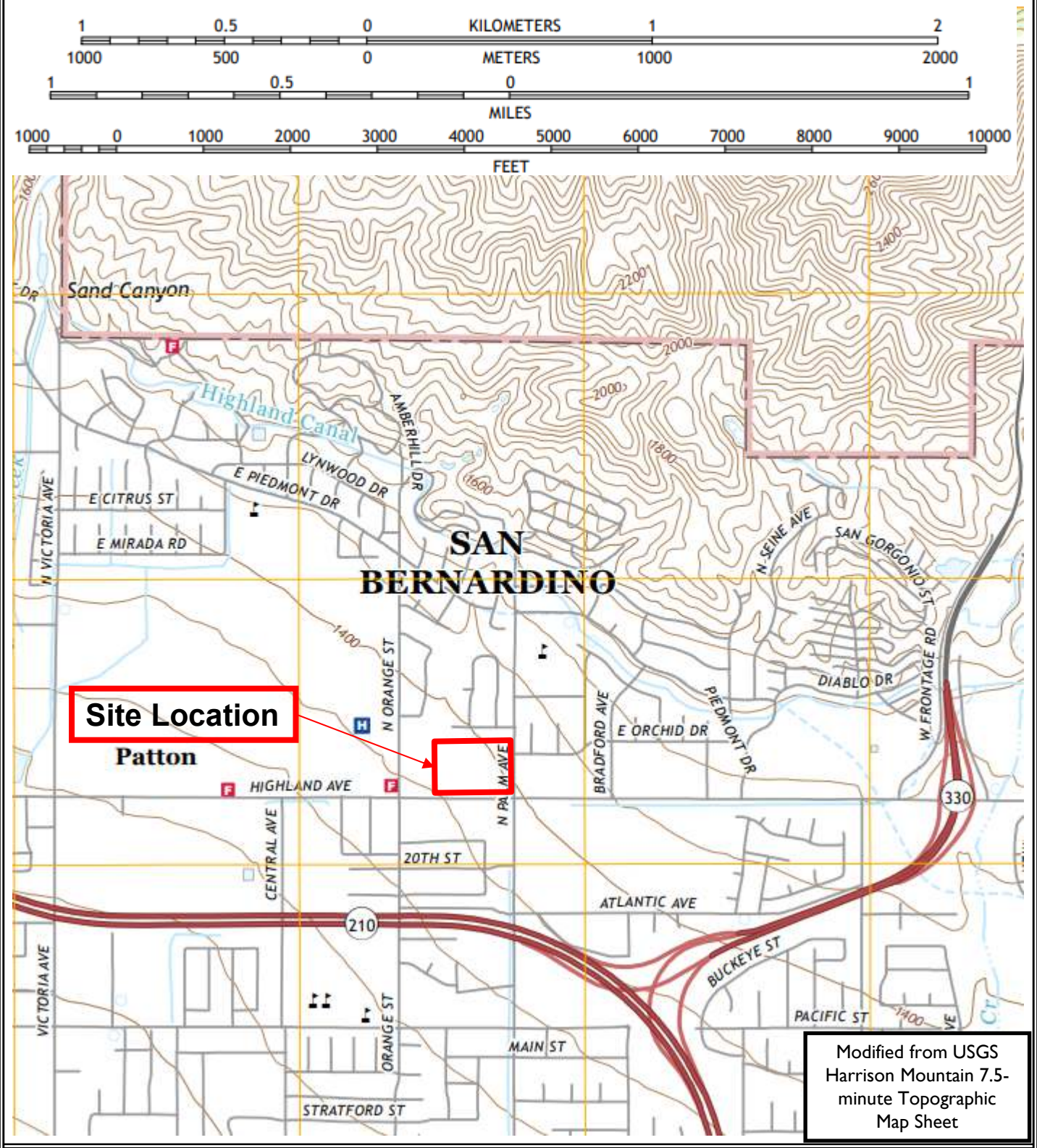


Modified from USGS Harrison Mountain 7.5-minute Topographic Map Sheet

Warmington Residential
APNs 0285-211-05, -21, -23, and -25
San Bernardino, San Bernardino County, California

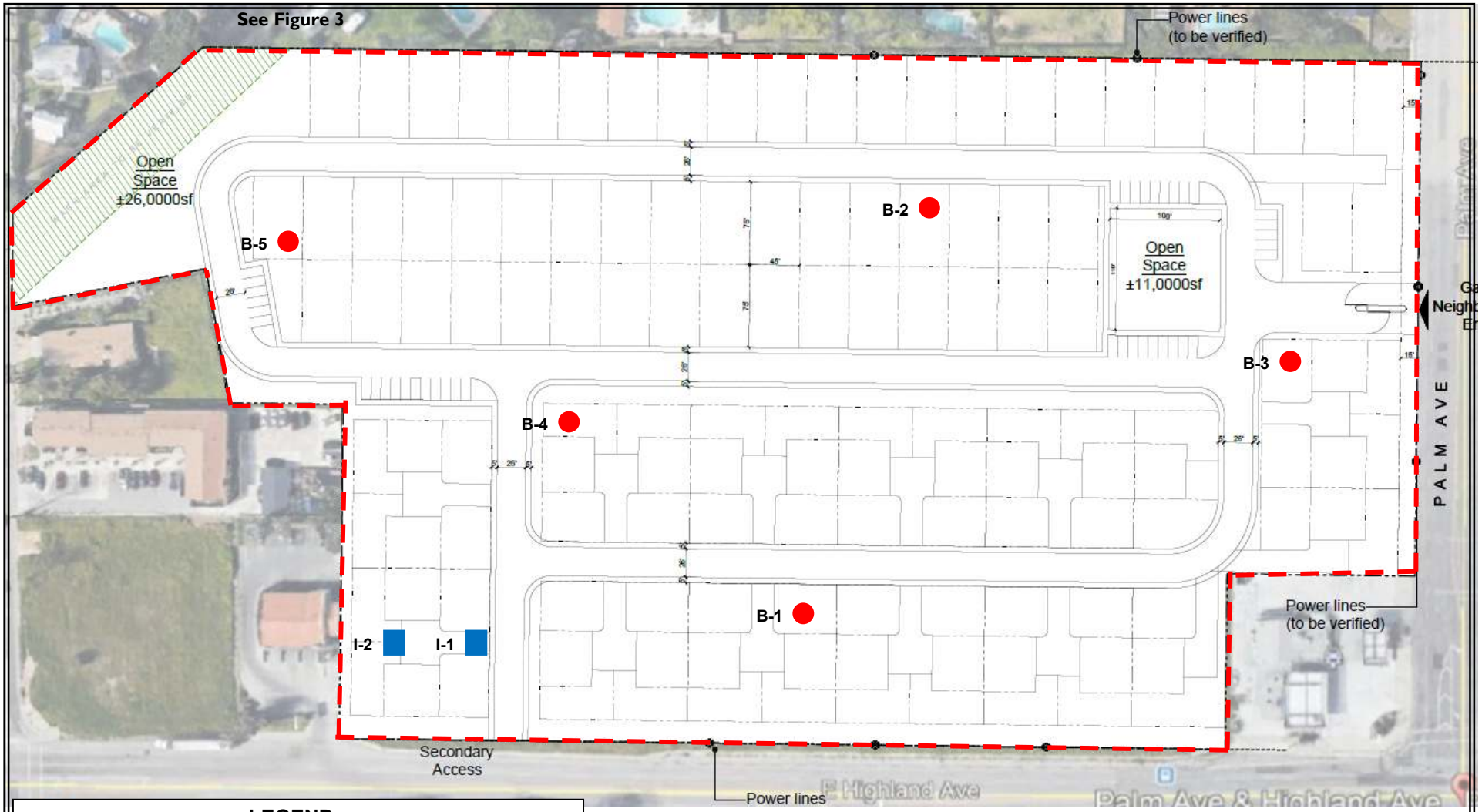
Project No. 2813-CR

NORTH

Figure 1

Site Location Map

GEOTEK



LEGEND
(Locations are Approximate)

I-2 Approximate Infiltration Test Location

B-5 Approximate Boring Location

Limits of the Site

N

Warmington Residential
APNs 0285-211-05, -21, -23, and -25
San Bernardino, San Bernardino County, California

Project No. 2813-CR

Scale: As Shown

0 25 50 100

Figure 2

Boring Location Map

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APPENDIX A

LOGS OF EXPLORATORY BORINGS

189-Unit Residential Development
San Bernardino, San Bernardino County, California
Project No. 2813-CR

GEOTEK

A - FIELD TESTING AND SAMPLING PROCEDURES

The Modified Split-Barrel Sampler (Ring)

The ring sampler is driven into the ground in accordance with ASTM Test Method D 3550. The sampler, with an external diameter of 3.0 inches, is lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sampler is typically driven into the ground 12 or 18 inches with a 140-pound hammer free falling from a height of 30 inches. Blow counts are recorded for every 6 inches of penetration as indicated on the log of boring. The samples are removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

Bulk Samples (Large)

These samples are normally large bags of earth materials over 20 pounds in weight collected from the field by means of hand digging or exploratory cuttings.

B – BORING/TRENCH LOG LEGEND

The following abbreviations and symbols often appear in the classification and description of soil and rock on the logs of borings/trenches:

SOILS

USCS	Unified Soil Classification System
f-c	Fine to coarse
f-m	Fine to medium

GEOLOGIC

B: Attitudes	Bedding: strike/dip
J: Attitudes	Joint: strike/dip
C: Contact line	
……..	Dashed line denotes USCS material change
———	Solid Line denotes unit / formational change
———	Thick solid line denotes end of boring/trench

(Additional denotations and symbols are provided on the log of borings/trenches)

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling Inc.	**LOGGED BY:**	DRW
PROJECT NAME:	APNs 0285-211-05, -21, -23, and -25	**DRILL METHOD:**	Hollw stem Auger	**OPERATOR:**	Jorge
PROJECT NO.:	2813-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	7/1/2021

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	BORING NO.: B-1 / MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Alluvium:			
		3 5 10		SM	Silty f-c SAND, brown, dry, loose, trace gravel	1.6	117.0	MD, SH
5		6 11 13			Same as above, becomes medium dense, some gravel	1.6	111.3	
		14 18 21		ML/SM	F-c sandy SILT to silty f-c SAND, brown, slightly moist, medium dense/very stiff	4.4	105.2	
10		13 18 23		SM	Silty f-c SAND, brown, slightly moist, medium dense	4.8	121.7	
15		21 28 26			Silty f-c SAND, brwon, moist, dense, trace gravel			
20		12 16 23		SM/SP	Silty f-c SAND to f-c SAND, light brown, slightly moist, medium dense			
25		16 21 32			Silty gravelly f-c SAND, graysih brown, slightly moist, very dense			
30		12 7 11		SM	Silty f-c SAND, light brown, slightly moist, medium dense			% Passing #200 = 36.8

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling Inc.	**LOGGED BY:**	DRW
PROJECT NAME:	APNs 0285-211-05, -21, -23, and -25	**DRILL METHOD:**	Hollw stem Auger	**OPERATOR:**	Jorge
PROJECT NO.:	2813-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	7/1/2021

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	BORING NO.: B-1 / MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
35								
		22 50/5"		SM	Silty f-c SAND, light brown, slightly moist, very dense, some gravel, trace cobbles Cobble zone approximately 1.5 feet thick			
40		13 13 23			Silty f-c SAND, light brown, slightly moist to moist, dense, some gravel, trace cobbles			% Passing #200 = 31.6
					BORING TERMINATED AT 42 FEET (REFUSAL) No groundwater encountered Boring backfilled with soil cuttings			
45								
50								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling Inc.	**LOGGED BY:**	DRW
PROJECT NAME:	APNs 0285-211-05, -21, -23, and -25	**DRILL METHOD:**	Hollw stem Auger	**OPERATOR:**	Jorge
PROJECT NO.:	2813-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	7/1/2021

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	BORING NO.: B-2 / MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Alluvium:			
	■	9 13 20		SM/ML	Silty f-c SAND to f-c sandy SILT, brown, slightly moist, medium dense/very stiff	3.2	120.3	
5	■	12 27 34			Same as above, becomes dense/hard, trace gravel	4.4	113.1	
	■	22 30 36		SM/SC	Silty clayey f-c SAND, brown, slightly moist, dense, trace gravel	4.4	124.1	
10	■	20 25 25		SC/SP	Clayey gravelly f-c SAND, grayish brown, slightly moist, dense	2.4	105.5	
	■	14 22 24			Same as above			
15								
	■	14 20 25		SM	Silty f-c SAND, brown, moist, medium dense to dense			
20					**BORING TERMINATED AT 20 FEET**			
					No groundwater encountered Boring backfilled with soil cuttings			
25								
30								

LEGEND

Sample type: ■ ---Ring ■ ---SPT ▨ ---Small Bulk ▩ ---Large Bulk □ ---No Recovery ▽ ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling Inc.	**LOGGED BY:**	DRW
PROJECT NAME:	APNs 0285-211-05, -21, -23, and -25	**DRILL METHOD:**	Hollw stem Auger	**OPERATOR:**	Jorge
PROJECT NO.:	2813-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	7/1/2021

BORING NO.: B-3

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Alluvium:			
								SR
		6 6 7		SM	Silty f-c SAND, brown, slightly moist, loose, trace gravel	2.4	107.4	Collapse
5		4 5 5			Same as above, becomes moist	8.3	109.7	
		7 7 4		SM/SC	Silty clayey f-c SAND, brown, moist, loose, trace gravel	8.4	124.3	
10		4 4 9			Same as above	8.6	113.6	
15		14 15 17		SM	Silty f-c SAND, brown, moist, medium dense, some gravel			
20		14 17 27			Same as above			
					BORING TERMINATED AT 21.5 FEET			
					No groundwater encountered Boring backfilled with soil cuttings			
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling Inc.	**LOGGED BY:**	DRW
PROJECT NAME:	APNs 0285-211-05, -21, -23, and -25	**DRILL METHOD:**	Hollw stem Auger	**OPERATOR:**	Jorge
PROJECT NO.:	2813-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	7/1/2021

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	BORING NO.: B-4 / MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Alluvium:			
		6 6 7		SM	Silty f-c SAND, light brown, slightly moist, loose, trace gravel	3.3	114.5	
5		12 12 13		SM/SC	Silty clayey f-c SAND, brown, slightly moist, medium dense	4.8	115.8	
		15 26 30		SC/SM	Clayey silty f-c SAND, brown, slightly moist, dense, trace gravel	4.6	126.9	
10		18 18 24		SC/SP	Clayey gravelly f-c SAND, brown, moist, medium dense	7.2	127.5	
		9 13 17		SM/SC	Silty clayey f-c SAND, brown, moist, medium dense			
15		8 10 15		SC	Clayey f-c SAND, brown, moist, medium dense, trace gravel			
20					**BORING TERMINATED AT 20 FEET** No groundwater encountered Boring backfilled with soil cuttings			
25								
30								

LEGEND

Sample type: ---Ring; ---SPT; ---Small Bulk; ---Large Bulk; ---No Recovery; ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling Inc.	**LOGGED BY:**	DRW
PROJECT NAME:	APNs 0285-211-05, -21, -23, and -25	**DRILL METHOD:**	Hollw stem Auger	**OPERATOR:**	Jorge
PROJECT NO.:	2813-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	7/1/2021

BORING NO.: B-5

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Alluvium:			
		8 10 12		SM/SC	Silty clayey f-c SAND< brown, slightly moist, medium dense	3.8	119.8	EI=1
5		9 14 17		SM	Silty f-c SAND, brown, slightly moist to moist, medium dense	6.8	114.4	
		25 30 32			Silty f-c SAND, brown, moist, dense	6.4	130.0	Collapse
10		13 16 13		SM/SP	Silty f-c SAND to f-c SAND, brown, slightly moist, medium dense, some gravel	3.7	110.7	
15		13 19 22			Same as above			
20		13 13 15		SM/SC	Silty clayey f-c SAND, brown, moist, medium dense			
					BORING TERMINATED AT 21.5 FEET			
25					No groundwater encountered Boring backfilled with soil cuttings			
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling Inc.	**LOGGED BY:**	DRW
PROJECT NAME:	APNs 0285-211-05, -21, -23, and -25	**DRILL METHOD:**	Hollw stem Auger	**OPERATOR:**	Jorge
PROJECT NO.:	2813-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	7/1/2021

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	BORING NO.: I-1 / MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Alluvium:			
				SM/ML	Silty f SAND to f sandy SILT, brown, moist, some rootlets			
				SM	Silty f-c SAND, brown, moist			
5					**BORING TERMINATED AT 5 FEET**			
					No groundwater encountered			
					Boring backfilled with soil cuttings			
10								
15								
20								
25								
30								

LEGEND

Sample type: ---Ring; ---SPT; ---Small Bulk; ---Large Bulk; ---No Recovery; ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Warmington Residential	**DRILLER:**	2R Drilling Inc.	**LOGGED BY:**	DRW
PROJECT NAME:	APNs 0285-211-05, -21, -23, and -25	**DRILL METHOD:**	Hollw stem Auger	**OPERATOR:**	Jorge
PROJECT NO.:	2813-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	7/1/2021

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	BORING NO.: I-2 / MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Alluvium:			
				SM/ML	Silty f SAND to f sandy SILT, brown, moist, some rootlets			
				SM	Silty f-c SAND, brown, moist			
5					**BORING TERMINATED AT 5 FEET** No groundwater encountered Boring backfilled with soil cuttings			
10								
15								
20								
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

APPENDIX B

LABORATORY TEST RESULTS

189-Unit Residential Development
San Bernardino, San Bernardino County, California
Project No. 2813-CR

GEOTEK

SUMMARY OF LABORATORY TESTING

Classification

Soils were classified visually in general accordance with the Unified Soil Classification System (ASTM Test Method D 2487). The soil classifications by GeoTek are shown on the logs of exploratory borings in Appendix A.

Consolidation/Collapse

Consolidation/collapse testing was performed on selected samples of the site soils according to ASTM Test Method D 4546. The results of this testing are presented in Appendix B.

Percent Passing No. 200 Sieve

The amount of soil particles passing No. 200 Sieve was estimated in accordance with ASTM D 1140. The test results are summarized on the boring logs.

Direct Shear

Shear testing was performed in a direct shear machine of the strain-control type in general accordance with ASTM Test Method D 3080. The rate of deformation is approximately 0.035 inch per minute. The samples were sheared under varying confining loads in order to determine the coulomb shear strength parameters, angle of internal friction and cohesion. The results of the testing are presented graphically in Appendix B.

Expansion Index

Expansion Index testing was performed on one representative soil sample. Testing was performed in general accordance with ASTM Test Method D 4829. The results of the testing is provided below.

Boring No.	Depth (ft.)	Soil Type	Expansion Index	Classification
B-5	0-5	Silty Sand	1	Very Low

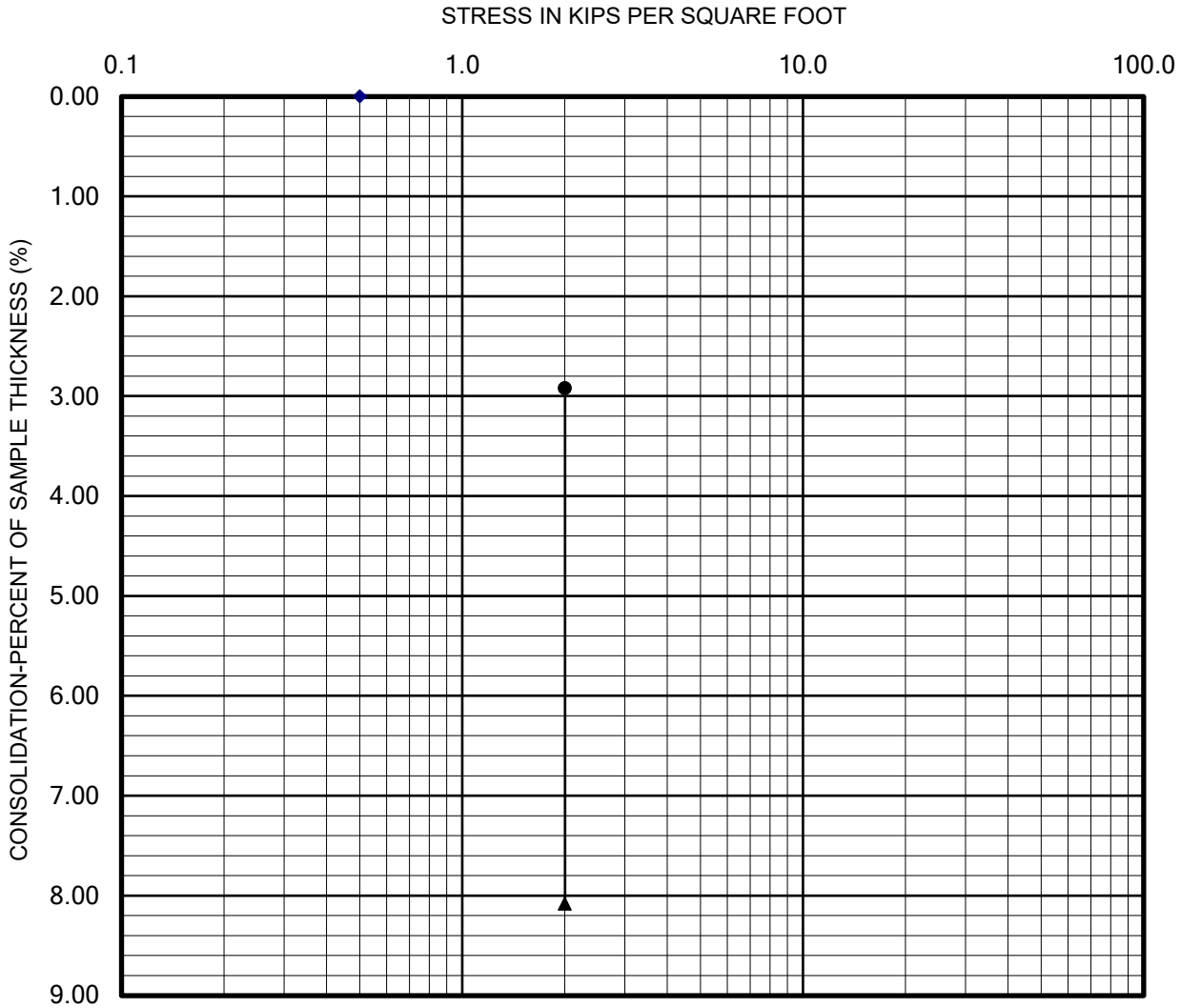
Moisture-Density Relationship

Laboratory testing was performed on two representative site samples collected during the recent subsurface exploration. The laboratory maximum dry density and optimum moisture content for the samples tested were determined in general accordance with test method ASTM Test Procedure D 1557. The results are included in Appendix B.

Sulfate Content, Resistivity and Chloride Content

Testing to determine the water-soluble sulfate content, resistivity testing and the chloride content was performed by others. The results of the testing are provided below and in Appendix B.

Boring No.	Depth (ft.)	pH ASTM G51	Chloride ASTM D4327 (ppm)	Sulfate ASTM D4327 (% by weight)	Resistivity ASTM G187 (ohm-cm)
B-3	1-5	7.1	22.1	0.0047	5,561



Seating Cycle
Loading Prior to Inundation
Loading After Inundation
Rebound Cycle

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4546

GEOTEK

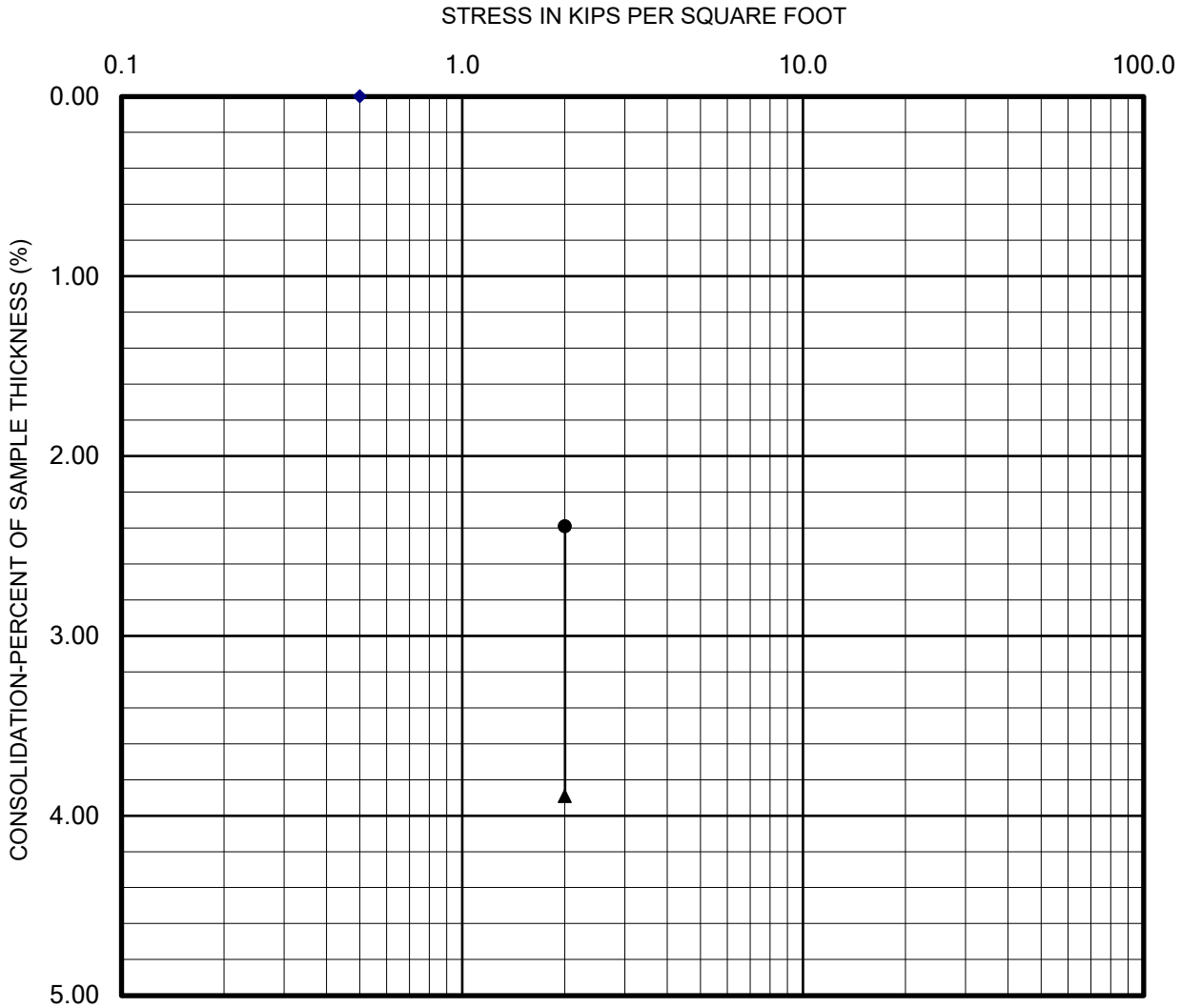
CHECKED BY: RJ	Lab: Corona
PROJECT NO.: 2813-CR	Date: 7-28-21

COLLAPSE REPORT

Sample: B-3 @ 2 feet

189-Unit Residential Development
San Bernardino, California

Plate B-1



Seating Cycle
Loading Prior to Inundation
Loading After Inundation
Rebound Cycle

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4546

GEOTEK

CHECKED BY: RJ	Lab: Corona
PROJECT NO.: 2813-CR	Date: 7-29-21

COLLAPSE REPORT

Sample: B-5 @ 7 feet

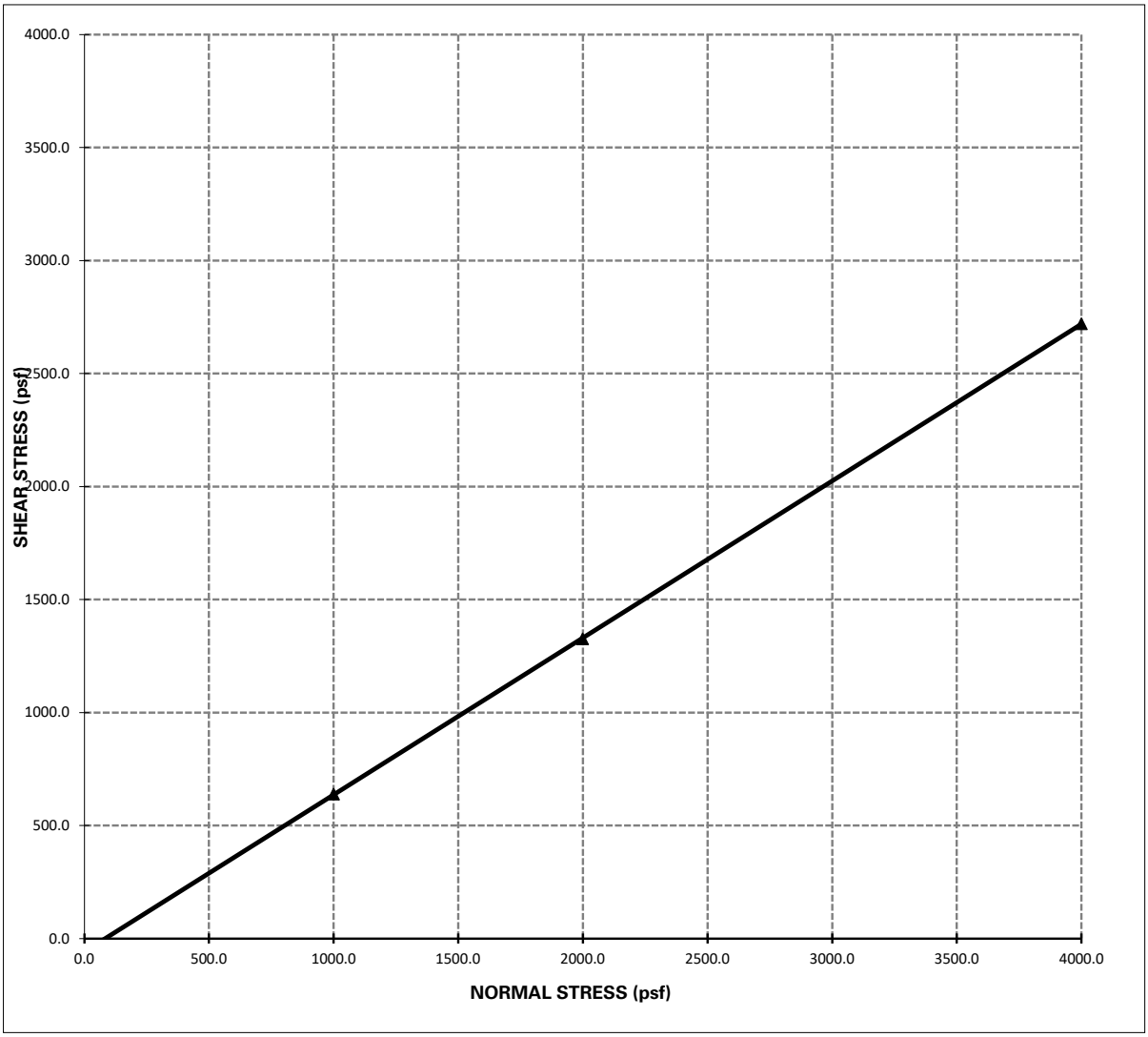
189-Unit Residential Development
San Bernardino, California

Plate B-2

DIRECT SHEAR TEST

Project Name:	Warmington Residential	***Sample Location:***	B1 @ 1-5'
Project Number:	2813-CR	***Date Tested:***	7/29/2021

ULTIMATE STRENGTH



Shear Strength: Φ = **35** ° , **C = 59 psf**

Notes: 1 - The soil specimen used in the shear box was a ring sample remolded to approximately 90% relative compaction from a bulk sample collected during the field investigation.

2 - The above reflect direct shear strength at saturated conditions.

3 - The tests were run at a shear rate of 0.035 in/min.

GEOTEK

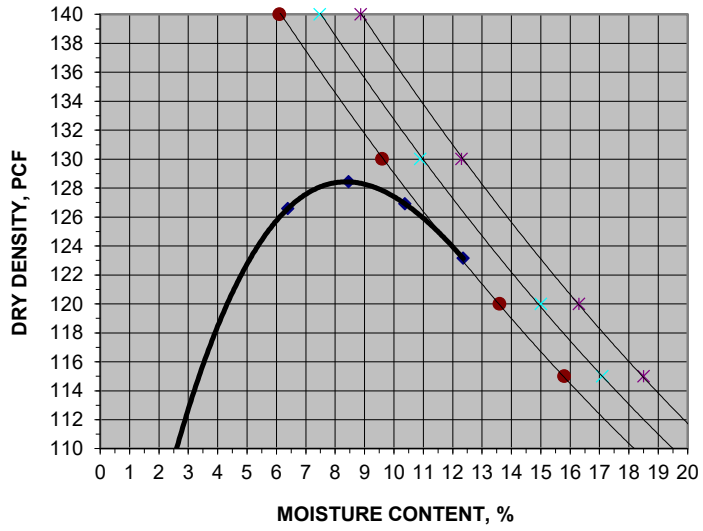
MOISTURE/DENSITY RELATIONSHIP

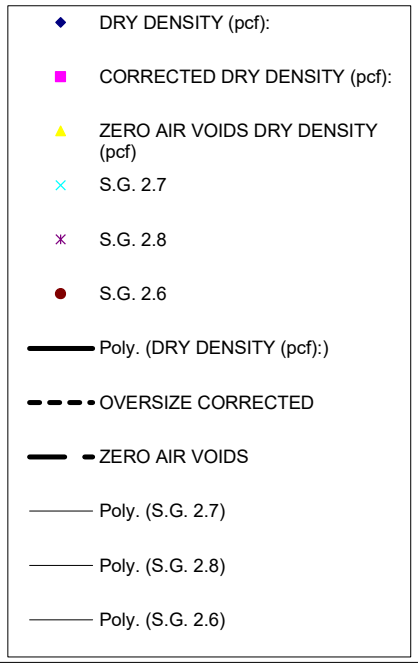
Client:	Warmington Residential	**Job No.:**	2813-CR
Project:	NWC Highland Ave & Palm Ave	**Lab No.:**	Corona
Location:	San Bernardino		
Material Type:	Brown Silty Sand w/ Gravel		
Material Supplier:	-		
Material Source:	-		
Sample Location:	B1 @ 1-5'		
	-		
Sampled By:	DRW	**Date Sampled:**	7/6/2021
Received By:	RJ	**Date Received:**	7/6/2021
Tested By:	RL	**Date Tested:**	7/21/2021
Reviewed By:	RJ	**Date Reviewed:**	7/22/2021

Test Procedure: ASTM D1557 **Method:** A

Oversized Material (%): 19.6 **Correction Required:** ■ yes □ no

MOISTURE/DENSITY RELATIONSHIP CURVE





MOISTURE DENSITY RELATIONSHIP VALUES

Maximum Dry Density, pcf	128.5	**@ Optimum Moisture, %**	8.5
Corrected Maximum Dry Density, pcf		**@ Optimum Moisture, %**	

MATERIAL DESCRIPTION

Grain Size Distribution:

	% Gravel (retained on No. 4)
	% Sand (Passing No. 4, Retained on No. 200)
	% Silt and Clay (Passing No. 200)

Atterberg Limits:

	Liquid Limit, %
	Plastic Limit, %
	Plasticity Index, %

Classification:

Unified Soils Classification:

AASHTO Soils Classification:

Results Only Soil Testing for NWC Highland Ave, Palm Ave, San Bernardino

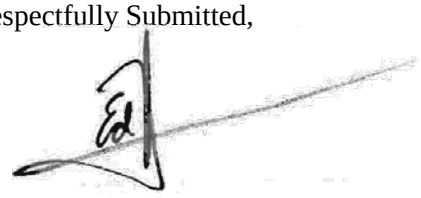
July 22, 2021

Prepared for:

Anna Scott
GeoTek, Inc.
1548 North Maple Street
Corona, CA 92280
ascott@geotekusa.com

Project X Job#: S210720D
Client Job or PO#: 2813-CR Warmington Residential

Respectfully Submitted,



Eduardo Hernandez, M.Sc., P.E.
Sr. Corrosion Consultant
NACE Corrosion Technologist #16592
Professional Engineer
California No. M37102
ehernandez@projectxcorrosion.com

Soil Analysis Lab Results

Client: GeoTek, Inc.
Job Name: NWC Highland Ave, Palm Ave, San Bernardino
Client Job Number: 2813-CR Warmington Residential
Project X Job Number: S210720D
July 22, 2021

	Method	ASTM D4327		ASTM D4327		ASTM G187		ASTM D4972	ASTM G200	ASTM D4658	ASTM D4327	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D4327	ASTM D4327
Bore# / Description	**Depth**	**Sulfates** SO_4^{2-}		**Chlorides** Cl^-		**Resistivity** As Rec'd | Minimum		**pH**	**Redox**	**Sulfide** S^{2-}	**Nitrate** NO_3^-	**Ammonium** NH_4^+	**Lithium** Li^+	**Sodium** Na^+	**Potassium** K^+	**Magnesium** Mg^{2+}	**Calcium** Ca^{2+}	**Fluoride** F_2^{--}	**Phosphate** PO_4^{3-}
	(ft)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(Ohm-cm)	(Ohm-cm)		(mV)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
2813-CR B 3 @	1-5	46.9	0.0047	22.1	0.0022	355,100	5,561	7.1	103	<0.01	66.9	23.3	0.09	27.5	9.0	34.4	226.9	1.4	10.0

Cations and Anions, except Sulfide and Bicarbonate, tested with Ion Chromatography
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
ND = 0 = Not Detected | NT = Not Tested | Unk = Unknown
Chemical Analysis performed on 1:3 Soil-To-Water extract
PPM = mg/kg (soil) = mg/L (Liquid)

APPENDIX C

INFILTRATION TEST DATA

189-Unit Residential Development
San Bernardino, San Bernardino County, California
Project No. 2813-CR

GEOTEK

PERCOLATION DATA SHEET

Project: HIGHLAND AVE / PALM AVE WARMINGTON RES. Job No.: 2813-CE

Test Hole No.: I-1 Tested By: DRW Date: 7/8/21

Depth of Hole As Drilled: 60" Before Test: 60" After Test: 60"

Reading No.	Time	Time Interval (Min)	Total Depth of Hole (Inches)	Initial Water Level (Inches)	Final Water Level (Inches)	Δ In Water Level (Inches)	Rate (minutes per inch)	Comments
1	8:15 8:40	25	60	20	8.5	11.5		
2	8:40 9:05	25	60	20	9.75	10.25		
3	9:05 9:15	10	60	20	16.4	3.6		
4	9:15 9:25	10	60	20	16.6	3.4		
5	9:25 9:35	10	60	20	16.7	3.3		
6	9:35 9:45	10	60	20	16.9	3.1		
7	9:45 9:55	10	60	20	17.0	3.0		
8	9:55 10:05	10	60	20	17.0	3.0		

PERCOLATION DATA SHEET

Project: HIGHLAND AVE / PALM AVE WARMINGTON RES. Job No.: 2813-CR

Test Hole No.: P-2 Tested By: DRW Date: 7/8/21

Depth of Hole As Drilled: 60" Before Test: 60" After Test: 60"

Reading No.	Time	Time Interval (Min)	Total Depth of Hole (Inches)	Initial Water Level (Inches)	Final Water Level (Inches)	Δ In Water Level (Inches)	Rate (minutes per inch)	Comments
1	8:18 8:43	25	60	20	9.7	10.3		
2	8:43 9:08	25	60	20	9.9	10.1		
3	9:08 9:18	10	60	20	16.6	3.4		
4	9:18 9:28	10	60	20	16.9	3.1		
5	9:28 9:38	10	60	20	17.0	3.0		
6	9:38 9:48	10	60	20	17.2	2.8		
7	9:48 9:58	10	60	20	17.3	2.7		
8	9:58 10:08	10	60	20	17.3	2.7		

Client:	**Warmington Residential**
Project:	**San Bernardino**
Project No:	**2813-CR**
Date:	**7/8/2021**

Boring No. **I-1**

Percolation Rate (Porchet Method)

Time Interval, Δt =	10
Final Depth to Water, D_F =	43
Test Hole Radius, r =	4
Initial Depth to Water, D_O =	40
Total Test Hole Depth, D_T =	60

Equation - $I_t = \dfrac{\Delta H\ (60r)}{\Delta t\ (r+2H_{avg})}$

$H_O = D_T - D_O$ =	20
$H_F = D_T - D_F$ =	17
$\Delta H = \Delta D = H_O - H_F$ =	3
$H_{avg} = (H_O+H_F)/2$ =	18.5

I_t = 1.76 **Inches per Hour**

GEOTEK

Client:	**Warmington Residential**
Project:	**San Bernardino**
Project No:	**2813-CR**
Date:	**7/8/2021**

Boring No. **I-2**

Percolation Rate (Porchet Method)

Time Interval, Δt =	10
Final Depth to Water, D_F =	42.7
Test Hole Radius, r =	4
Initial Depth to Water, D_O =	40
Total Test Hole Depth, D_T =	60

Equation - $I_t = \dfrac{\Delta H\ (60r)}{\Delta t\ (r+2H_{avg})}$

$H_O = D_T - D_O$ =	20
$H_F = D_T - D_F$ =	17.3
$\Delta H = \Delta D = H_O - H_F$ =	2.7
$H_{avg} = (H_O+H_F)/2$ =	18.65

I_t = 1.57 **Inches per Hour**

GEOTEK

APPENDIX D

SEISMIC SETTLEMENT ANALYSIS

189-Unit Residential Development
San Bernardino, San Bernardino County, California
Project No. 2813-CR

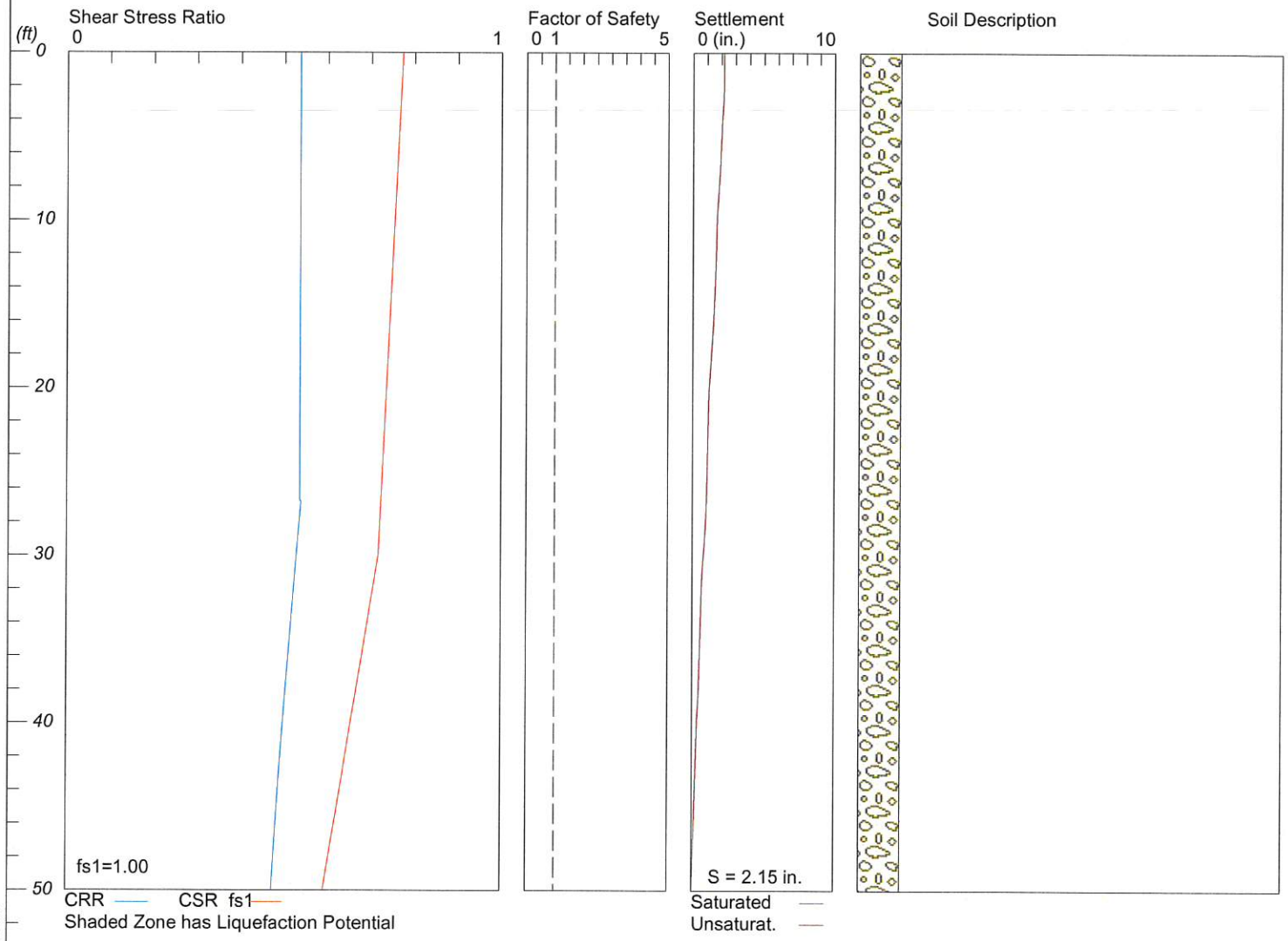
GEOTEK

LIQUEFACTION ANALYSIS

2813-CR

Hole No.=B-1 Water Depth=150 ft

Magnitude=7.3
Acceleration=1.186g



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LIQUEFACTION ANALYSIS SUMMARY

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Input File Name: UNTITLED
Title: 2813-CR
Subtitle: San Bernardino

Surface Elev.=
Hole No.=B-1
Depth of Hole= 50.00 ft
Water Table during Earthquake= 150.00 ft
Water Table during In-Situ Testing= 150.00 ft
Max. Acceleration= 1.19 g
Earthquake Magnitude= 7.30

Input Data:
Surface Elev.=
Hole No.=B-1
Depth of Hole=50.00 ft
Water Table during Earthquake= 150.00 ft
Water Table during In-Situ Testing= 150.00 ft
Max. Acceleration=1.19 g
Earthquake Magnitude=7.30
No-Liquefiable Soils: CL, OL are Non-Liq. Soil

1. SPT or BPT Calculation.
2. Settlement Analysis Method: Ishihara / Yoshimine
3. Fines Correction for Liquefaction: Idriss/Seed
4. Fine Correction for Settlement: During Liquefaction*
5. Settlement Calculation in: All zones*
6. Hammer Energy Ratio, Ce = 1.25
7. Borehole Diameter, Cb= 1.15
8. Sampling Method, Cs= 1.2
9. User request factor of safety (apply to CSR) , User= 1
   Plot one CSR curve (fs1=User)
10. Use Curve Smoothing: Yes*

* Recommended Options

In-Situ Test Data:

Depth	SPT	gamma	Fines

ft		pcf	%
0.00	20.00	120.00	20.00
5.00	16.00	115.00	20.00
7.00	26.00	110.00	50.00
10.00	27.00	125.00	20.00
15.00	36.00	125.00	20.00
20.00	26.00	125.00	36.00
25.00	53.00	125.00	36.00
30.00	18.00	125.00	36.00
35.00	100.00	125.00	31.00
40.00	36.00	125.00	31.00
50.00	36.00	125.00	31.00

Output Results:

Settlement of Saturated Sands=0.00 in.
Settlement of Unsaturated Sands=2.15 in.
Total Settlement of Saturated and Unsaturated Sands=2.15 in.
Differential Settlement=1.077 to 1.422 in.

Depth ft	CRRm	CSRfs	F.S.	S_sat. in.	S_dry in.	S_all in.
0.00	0.54	0.77	5.00	0.00	2.15	2.15
1.00	0.54	0.77	5.00	0.00	2.15	2.15
2.00	0.54	0.77	5.00	0.00	2.15	2.15
3.00	0.54	0.77	5.00	0.00	2.12	2.12
4.00	0.54	0.76	5.00	0.00	2.04	2.04
5.00	0.54	0.76	5.00	0.00	2.00	2.00
6.00	0.54	0.76	5.00	0.00	1.94	1.94
7.00	0.54	0.76	5.00	0.00	1.90	1.90
8.00	0.54	0.76	5.00	0.00	1.82	1.82
9.00	0.54	0.75	5.00	0.00	1.75	1.75
10.00	0.54	0.75	5.00	0.00	1.68	1.68
11.00	0.54	0.75	5.00	0.00	1.66	1.66
12.00	0.54	0.75	5.00	0.00	1.63	1.63
13.00	0.54	0.75	5.00	0.00	1.60	1.60
14.00	0.54	0.75	5.00	0.00	1.56	1.56
15.00	0.54	0.74	5.00	0.00	1.51	1.51
16.00	0.54	0.74	5.00	0.00	1.46	1.46
17.00	0.54	0.74	5.00	0.00	1.39	1.39
18.00	0.54	0.74	5.00	0.00	1.31	1.31
19.00	0.54	0.74	5.00	0.00	1.23	1.23
20.00	0.54	0.73	5.00	0.00	1.16	1.16
21.00	0.54	0.73	5.00	0.00	1.12	1.12
22.00	0.54	0.73	5.00	0.00	1.09	1.09
23.00	0.54	0.73	5.00	0.00	1.07	1.07
24.00	0.54	0.73	5.00	0.00	1.05	1.05
25.00	0.54	0.73	5.00	0.00	1.02	1.02

26.00	0.54	0.72	5.00	0.00	1.00	1.00
27.00	0.54	0.72	5.00	0.00	0.97	0.97
28.00	0.53	0.72	5.00	0.00	0.92	0.92
29.00	0.53	0.72	5.00	0.00	0.85	0.85
30.00	0.53	0.72	5.00	0.00	0.76	0.76
31.00	0.53	0.71	5.00	0.00	0.68	0.68
32.00	0.52	0.70	5.00	0.00	0.63	0.63
33.00	0.52	0.70	5.00	0.00	0.60	0.60
34.00	0.52	0.69	5.00	0.00	0.57	0.57
35.00	0.51	0.69	5.00	0.00	0.54	0.54
36.00	0.51	0.68	5.00	0.00	0.51	0.51
37.00	0.51	0.67	5.00	0.00	0.47	0.47
38.00	0.50	0.67	5.00	0.00	0.44	0.44
39.00	0.50	0.66	5.00	0.00	0.39	0.39
40.00	0.50	0.65	5.00	0.00	0.33	0.33
41.00	0.50	0.65	5.00	0.00	0.30	0.30
42.00	0.49	0.64	5.00	0.00	0.27	0.27
43.00	0.49	0.64	5.00	0.00	0.24	0.24
44.00	0.49	0.63	5.00	0.00	0.20	0.20
45.00	0.49	0.62	5.00	0.00	0.17	0.17
46.00	0.48	0.62	5.00	0.00	0.14	0.14
47.00	0.48	0.61	5.00	0.00	0.10	0.10
48.00	0.48	0.60	5.00	0.00	0.07	0.07
49.00	0.48	0.60	5.00	0.00	0.04	0.04
50.00	0.47	0.59	5.00	0.00	0.00	0.00

---

* F.S.<1, Liquefaction Potential Zone
(F.S. is limited to 5, CRR is limited to 2, CSR is limited to 2)

Units: Unit: qc, fs, Stress or Pressure = atm (1.0581tsf); Unit Weight = pcf; Depth = ft; Settlement = in.

---

1 atm (atmosphere) = 1 tsf (ton/ft2)
CRRm Cyclic resistance ratio from soils
CSRsf Cyclic stress ratio induced by a given earthquake (with user request factor of safety)
F.S. Factor of Safety against liquefaction, F.S.=CRRm/CSRsf
S_sat Settlement from saturated sands
S_dry Settlement from Unsaturated Sands
S_all Total Settlement from Saturated and Unsaturated Sands
NoLiq No-Liquefy Soils

APPENDIX E

GENERAL GRADING GUIDELINES

189-Unit Residential Development
San Bernardino, San Bernardino County, California
Project No. 2813-CR

GEOTEK

GENERAL GRADING GUIDELINES

Guidelines presented herein are intended to address general construction procedures for earthwork construction. Specific situations and conditions often arise which cannot reasonably be discussed in general guidelines, when anticipated these are discussed in the text of the report. Often unanticipated conditions are encountered which may necessitate modification or changes to these guidelines. It is our hope that these will assist the contractor to more efficiently complete the project by providing a reasonable understanding of the procedures that would be expected during earthwork and the testing and observation used to evaluate those procedures.

General

Grading should be performed to at least the minimum requirements of governing agencies, Chapters 18 and 33 of the Uniform Building Code, CBC (2019) and the guidelines presented below.

Preconstruction Meeting

A preconstruction meeting should be held prior to site earthwork. Any questions the contractor has regarding our recommendations, general site conditions, apparent discrepancies between reported and actual conditions and/or differences in procedures the contractor intends to use should be brought up at that meeting. The contractor (including the main onsite representative) should review our report and these guidelines in advance of the meeting. Any comments the contractor may have regarding these guidelines should be brought up at that meeting.

Grading Observation and Testing

1. Observation of the fill placement should be provided by our representative during grading. Verbal communication during the course of each day will be used to inform the contractor of test results. The contractor should receive a copy of the "Daily Field Report" indicating results of field density tests that day. If our representative does not provide the contractor with these reports, our office should be notified.
2. Testing and observation procedures are, by their nature, specific to the work or area observed and location of the tests taken, variability may occur in other locations. The contractor is responsible for the uniformity of the grading operations; our observations and test results are intended to evaluate the contractor's overall level of efforts during grading. The contractor's personnel are the only individuals participating in all aspect of site work. Compaction testing and observation should not be considered as relieving the contractor's responsibility to properly compact the fill.
3. Cleanouts, processed ground to receive fill, key excavations, and subdrains should be observed by our representative prior to placing any fill. It will be the contractor's responsibility to notify our representative or office when such areas are ready for observation.

4. Density tests may be made on the surface material to receive fill, as considered warranted by this firm.
5. In general, density tests would be made at maximum intervals of two feet of fill height or every 1,000 cubic yards of fill placed. Criteria will vary depending on soil conditions and size of the fill. More frequent testing may be performed. In any case, an adequate number of field density tests should be made to evaluate the required compaction and moisture content is generally being obtained.
6. Laboratory testing to support field test procedures will be performed, as considered warranted, based on conditions encountered (e.g. change of material sources, types, etc.) Every effort will be made to process samples in the laboratory as quickly as possible and in progress construction projects are our first priority. However, laboratory workloads may cause in delays and some soils may require a **minimum of 48 to 72 hours to complete test procedures**. Whenever possible, our representative(s) should be informed in advance of operational changes that might result in different source areas for materials.
7. Procedures for testing of fill slopes are as follows:
    a) Density tests should be taken periodically during grading on the flat surface of the fill, three to five feet horizontally from the face of the slope.
    b) If a method other than over building and cutting back to the compacted core is to be employed, slope compaction testing during construction should include testing the outer six inches to three feet in the slope face to determine if the required compaction is being achieved.
8. Finish grade testing of slopes and pad surfaces should be performed after construction is complete.

Site Clearing

1. All vegetation, and other deleterious materials, should be removed from the site. If material is not immediately removed from the site it should be stockpiled in a designated area(s) well outside of all current work areas and delineated with flagging or other means. Site clearing should be performed in advance of any grading in a specific area.
2. Efforts should be made by the contractor to remove all organic or other deleterious material from the fill, as even the most diligent efforts may result in the incorporation of some materials. This is especially important when grading is occurring near the natural grade. All equipment operators should be aware of these efforts. Laborers may be required as root pickers.
3. Nonorganic debris or concrete may be placed in deeper fill areas provided the procedures used are observed and found acceptable by our representative.

Treatment of Existing Ground

1. Following site clearing, all surficial deposits of alluvium and colluvium as well as weathered or creep effected bedrock, should be removed unless otherwise specifically indicated in the text of this report.
2. In some cases, removal may be recommended to a specified depth (e.g. flat sites where partial alluvial removals may be sufficient). The contractor should not exceed these depths unless directed otherwise by our representative.
3. Groundwater existing in alluvial areas may make excavation difficult. Deeper removals than indicated in the text of the report may be necessary due to saturation during winter months.
4. Subsequent to removals, the natural ground should be processed to a depth of six inches, moistened to near optimum moisture conditions and compacted to fill standards.
5. Exploratory back hoe or dozer trenches still remaining after site removal should be excavated and filled with compacted fill if they can be located.

Fill Placement

1. Unless otherwise indicated, all site soil and bedrock may be reused for compacted fill; however, some special processing or handling may be required (see text of report).
2. Material used in the compacting process should be evenly spread, moisture conditioned, processed, and compacted in thin lifts six (6) to eight (8) inches in compacted thickness to obtain a uniformly dense layer. The fill should be placed and compacted on a nearly horizontal plane, unless otherwise found acceptable by our representative.
3. If the moisture content or relative density varies from that recommended by this firm, the contractor should rework the fill until it is in accordance with the following:
    a) Moisture content of the fill should be at or above optimum moisture. Moisture should be evenly distributed without wet and dry pockets. Pre-watering of cut or removal areas should be considered in addition to watering during fill placement, particularly in clay or dry surficial soils. The ability of the contractor to obtain the proper moisture content will control production rates.
    b) Each six-inch layer should be compacted to at least 90 percent of the maximum dry density in compliance with the testing method specified by the controlling governmental agency. In most cases, the testing method is ASTM Test Designation D 1557.
4. Rock fragments less than eight inches in diameter may be utilized in the fill, provided:
    a) They are not placed in concentrated pockets;
    b) There is a sufficient percentage of fine-grained material to surround the rocks;
    c) The distribution of the rocks is observed by, and acceptable to, our representative.

5. Rocks exceeding eight (8) inches in diameter should be taken off site, broken into smaller fragments, or placed in accordance with recommendations of this firm in areas designated suitable for rock disposal. On projects where significant large quantities of oversized materials are anticipated, alternate guidelines for placement may be included. If significant oversize materials are encountered during construction, these guidelines should be requested.
6. In clay soil, dry or large chunks or blocks are common. If in excess of eight (8) inches minimum dimension, then they are considered as oversized. Sheepsfoot compactors or other suitable methods should be used to break up blocks. When dry, they should be moisture conditioned to provide a uniform condition with the surrounding fill.

Slope Construction

1. The contractor should obtain a minimum relative compaction of 90 percent out to the finished slope face of fill slopes. This may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment.
2. Slopes trimmed to the compacted core should be overbuilt by at least three (3) feet with compaction efforts out to the edge of the false slope. Failure to properly compact the outer edge results in trimming not exposing the compacted core and additional compaction after trimming may be necessary.
3. If fill slopes are built "at grade" using direct compaction methods, then the slope construction should be performed so that a constant gradient is maintained throughout construction. Soil should not be "spilled" over the slope face nor should slopes be "pushed out" to obtain grades. Compaction equipment should compact each lift along the immediate top of slope. Slopes should be back rolled or otherwise compacted at approximately every 4 feet vertically as the slope is built.
4. Corners and bends in slopes should have special attention during construction as these are the most difficult areas to obtain proper compaction.
5. Cut slopes should be cut to the finished surface. Excessive undercutting and smoothing of the face with fill may necessitate stabilization.

UTILITY TRENCH CONSTRUCTION AND BACKFILL

Utility trench excavation and backfill is the contractors responsibility. The geotechnical consultant typically provides periodic observation and testing of these operations. While efforts are made to make sufficient observations and tests to verify that the contractors' methods and procedures are adequate to achieve proper compaction, it is typically impractical to observe all backfill procedures. As such, it is critical that the contractor use consistent backfill procedures.

Compaction methods vary for trench compaction and experience indicates many methods can be successful. However, procedures that "worked" on previous projects may or may not prove effective on a given site. The contractor(s) should outline the procedures proposed, so that we may discuss them **prior** to construction. We will offer comments based on our knowledge of site conditions and experience.

1. Utility trench backfill in slopes, structural areas, in streets and beneath flat work or hardscape should be brought to at least optimum moisture and compacted to at least 90 percent of the laboratory standard. Soil should be moisture conditioned prior to placing in the trench.
2. Flooding and jetting are not typically recommended or acceptable for native soils. Flooding or jetting may be used with select sand having a Sand Equivalent (SE) of 30 or higher. This is typically limited to the following uses:
   a) shallow (12 + inches) under slab interior trenches and,
   b) as bedding in pipe zone.

   The water should be allowed to dissipate prior to pouring slabs or completing trench compaction.
3. Care should be taken not to place soils at high moisture content within the upper three feet of the trench backfill in street areas, as overly wet soils may impact subgrade preparation. Moisture may be reduced to 2% below optimum moisture in areas to be paved within the upper three feet below sub grade.
4. Sand backfill should not be allowed in exterior trenches adjacent to and within an area extending below a 1:1 projection from the outside bottom edge of a footing, unless it is similar to the surrounding soil.
5. Trench compaction testing is generally at the discretion of the geotechnical consultant. Testing frequency will be based on trench depth and the contractors procedures. A probing rod would be used to assess the consistency of compaction between tested areas and untested areas. If zones are found that are considered less compact than other areas, this would be brought to the contractors attention.

JOB SAFETY

General

Personnel safety is a primary concern on all job sites. The following summaries are safety considerations for use by all our employees on multi-employer construction sites. On ground personnel are at highest risk of injury and possible fatality on grading construction projects. The company recognizes that construction activities will vary on each site and that job site safety is the contractor's responsibility. However, it is, imperative that all personnel be safety conscious to avoid accidents and potential injury.

In an effort to minimize risks associated with geotechnical testing and observation, the following precautions are to be implemented for the safety of our field personnel on grading and construction projects.

1. Safety Meetings: Our field personnel are directed to attend the contractor's regularly scheduled safety meetings.
2. Safety Vests: Safety vests are provided for and are to be worn by our personnel while on the job site.
3. Safety Flags: Safety flags are provided to our field technicians; one is to be affixed to the vehicle when on site, the other is to be placed atop the spoil pile on all test pits.

In the event that the contractor's representative observes any of our personnel not following the above, we request that it be brought to the attention of our office.

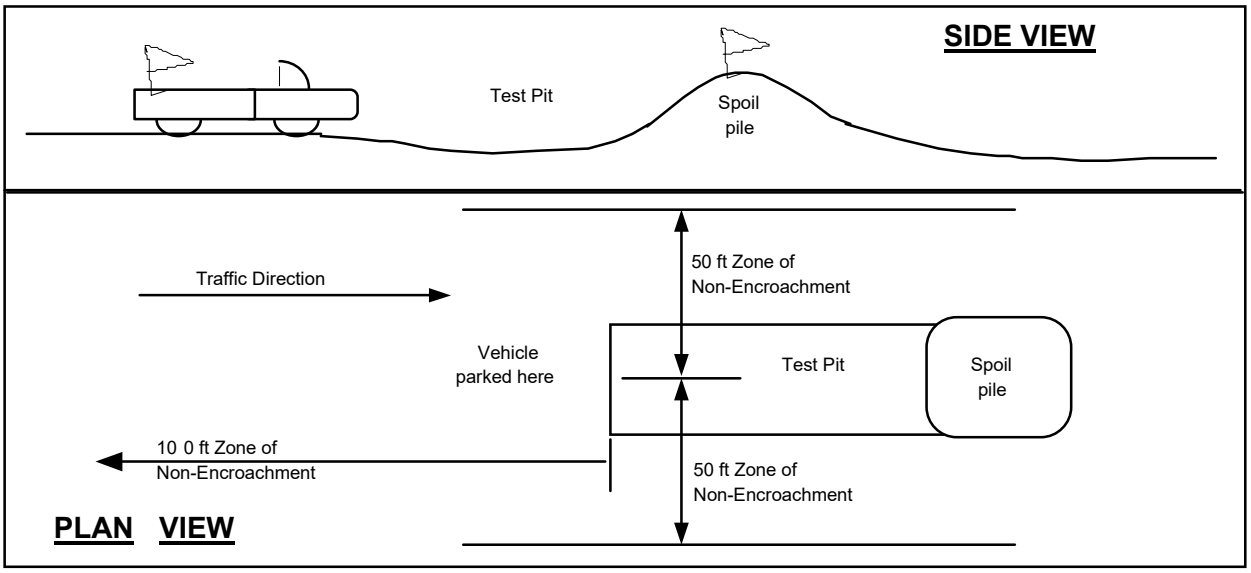
Test Pits Location, Orientation and Clearance

The technician is responsible for selecting test pit locations. The primary concern is the technician's safety. However, it is necessary to take sufficient tests at various locations to obtain a representative sampling of the fill. As such, efforts will be made to coordinate locations with the grading contractors authorized representatives (e.g. dump man, operator, supervisor, grade checker, etc.), and to select locations following or behind the established traffic pattern, preferably outside of current traffic. The contractors authorized representative should direct excavation of the pit and safety during the test period. Again, safety is the paramount concern.

Test pits should be excavated so that the spoil pile is placed away from oncoming traffic. The technician's vehicle is to be placed next to the test pit, opposite the spoil pile. This necessitates that the fill be maintained in a drivable condition. Alternatively, the contractor may opt to park a piece of equipment in front of test pits, particularly in small fill areas or those with limited access.

A zone of non-encroachment should be established for all test pits (see diagram below). No grading equipment should enter this zone during the test procedure. The zone should extend outward to the sides approximately 50 feet from the center of the test pit and 100 feet in the direction of traffic flow. This zone is established both for safety and to avoid excessive ground vibration, which typically decreases test results.

TEST PIT SAFETY PLAN



Slope Tests

When taking slope tests, the technician should park their vehicle directly above or below the test location on the slope. The contractor's representative should effectively keep all equipment at a safe operation distance (e.g. 50 feet) away from the slope during testing.

The technician is directed to withdraw from the active portion of the fill as soon as possible following testing. The technician's vehicle should be parked at the perimeter of the fill in a highly visible location.

Trench Safety

It is the contractor's responsibility to provide safe access into trenches where compaction testing is needed. Trenches for all utilities should be excavated in accordance with CAL-OSHA and any other applicable safety standards. Safe conditions will be required to enable compaction testing of the trench backfill.

All utility trench excavations in excess of 5 feet deep, which a person enters, are to be shored or laid back. Trench access should be provided in accordance with OSHA standards. Our personnel are directed not to enter any trench by being lowered or "riding down" on the equipment.

Our personnel are directed not to enter any excavation which;

1. is 5 feet or deeper unless shored or laid back,
2. exit points or ladders are not provided,
3. displays any evidence of instability, has any loose rock or other debris which could fall into the trench, or

4. displays any other evidence of any unsafe conditions regardless of depth.

If the contractor fails to provide safe access to trenches for compaction testing, our company policy requires that the soil technician withdraws and notifies their supervisor. The contractors representative will then be contacted in an effort to effect a solution. All backfill not tested due to safety concerns or other reasons is subject to reprocessing and/or removal.

Procedures

In the event that the technician's safety is jeopardized or compromised as a result of the contractor's failure to comply with any of the above, the technician is directed to inform both the developer's and contractor's representatives. If the condition is not rectified, the technician is required, by company policy, to immediately withdraw and notify their supervisor. The contractor's representative will then be contacted in an effort to effect a solution. No further testing will be performed until the situation is rectified. Any fill placed in the interim can be considered unacceptable and subject to reprocessing, recompaction or removal.

In the event that the soil technician does not comply with the above or other established safety guidelines, we request that the contractor bring this to technicians attention and notify our project manager or office. Effective communication and coordination between the contractors' representative and the field technician(s) is strongly encouraged in order to implement the above safety program and safety in general.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

Educational Material

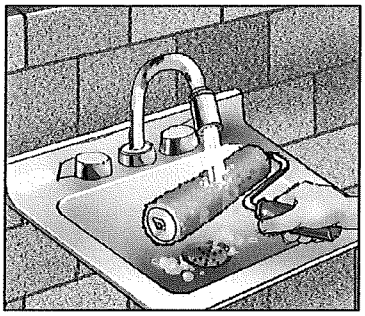
STORMWATER Pollution Prevention

PAINTING

Paints, solvents, adhesives and other toxic chemicals used in painting 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 our health.

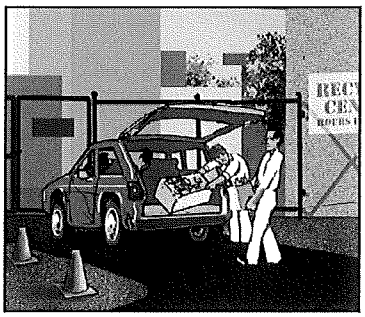
Water-Based Paints
Use water-based paints whenever possible. They are less toxic than oil-based paints and easier to clean up. Look for products labeled "latex" or "cleans with water."

Paint Removal
Sweep up paint stripping residue, chips and dust instead of hosing into the street and dispose of them safely at a household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.



Painting Cleanup
Never clean brushes or rinse paint containers in the street, gutter or near a storm drain. Clean water-based paints in the sink. Clean oil-based paints with thinner, which can be reused by putting it in a jar to settle out the paint particles and then pouring off the clear liquid for future use. Wrap dried paint residue in newspaper and dispose of it in the trash.

Exterior Paint Removal
When stripping or cleaning building exteriors with high-pressure water, block nearby storm drains and divert washwater onto a designated dirt area. Ask your local wastewater treatment authority if you can collect building cleaning water and discharge it to the sewer.



Recycling Paint
Recycle leftover paint at a household hazardous waste collection facility, save it for touch ups or give it to someone who can use it, like a theatre group, school, city or community organization.

PUBLIC SERVICES
CITY OF FONTANA

To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

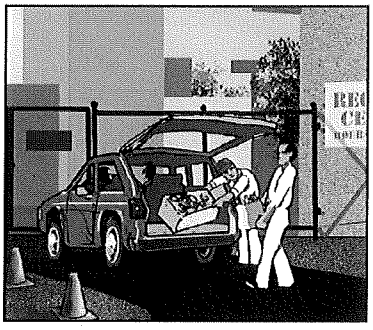
www.1800cleanup.org

San Bernardino County STORMWATER PROGRAM

STORMWATER Pollution Prevention

HOME & GARDEN

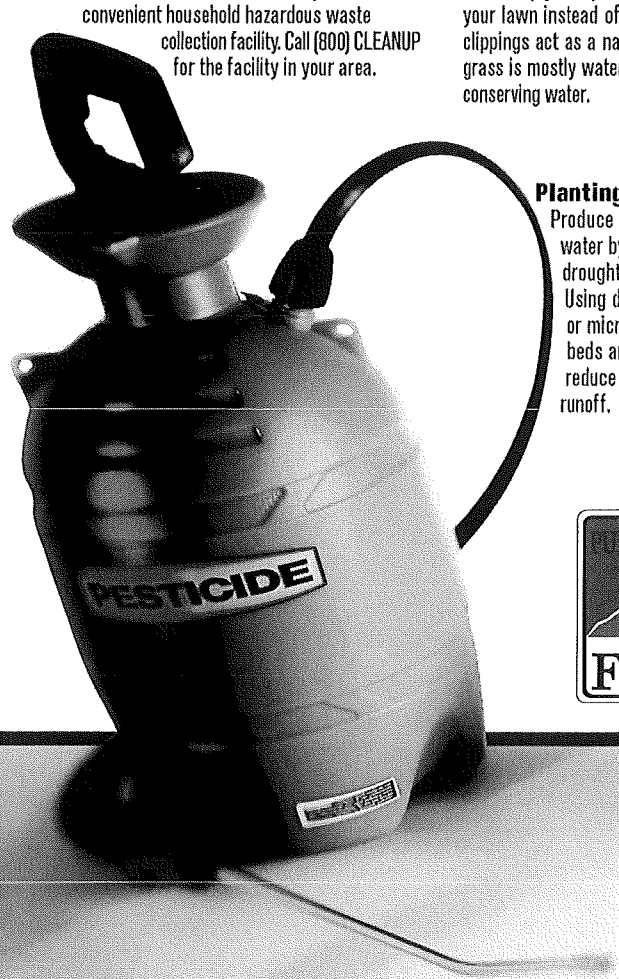
Yard waste and household toxics like paints and pesticides often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow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



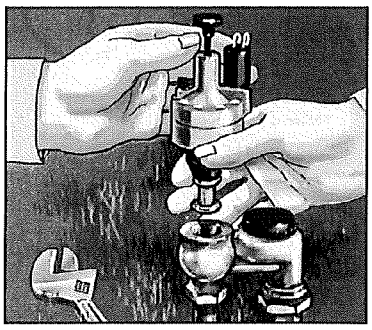
Recycle Household Hazardous Waste
Household products like paint, pesticides, solvents and cleaners are too dangerous to dump and too toxic to trash. Take them to be recycled at a convenient household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.

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.

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To report illegal dumping or for more information on stormwater pollution prevention, call:

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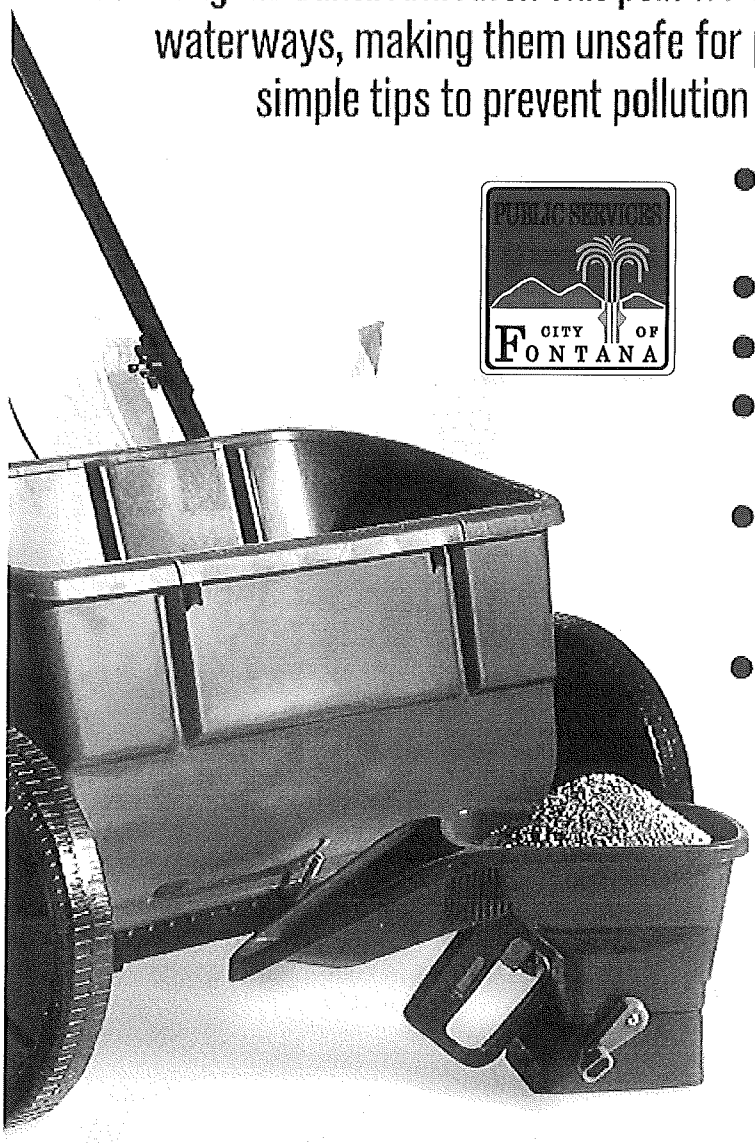
www.1800cleanup.org

San Bernardino County STORMWATER PROGRAM

Fertilizer Tips to Prevent Pollution

Water that runs off your lawn and garden can carry excess fertilizer into the San Bernardino County storm drain system, and it does 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:



- Read the product label and follow the directions carefully, using only as directed.
- Avoid applying near driveways or gutters.
- Never apply fertilizer before a rain.
- Store fertilizers and chemicals in a covered area and in sealed, waterproof containers.
- Take unwanted lawn or garden chemicals to a household hazardous waste collection facility. Call (800) 253-2687.
- Use non-toxic products for your garden and lawn whenever possible.

To report illegal dumping or for more information on Stormwater pollution prevention, call:

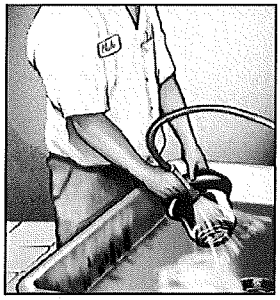
1 (800) CLEANUP

www.1800cleanup.org

STORMWATER Pollution Prevention

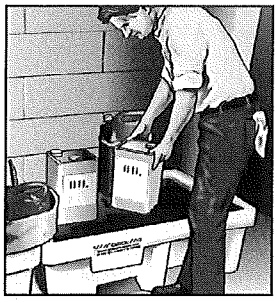
AUTO MAINTENANCE

Oil, grease, anti-freeze and other toxic automotive fluids 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 best management practices to prevent pollution and protect public health.



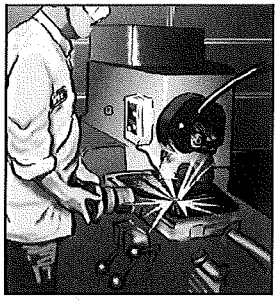
Cleaning Auto Parts

Scrape parts with a wire brush or use a bake oven rather than liquid cleaners. Arrange drip pans, drying racks and drain boards so that fluids are directed back into the parts washer or the fluid holding tank. Do not wash parts or equipment in a shop sink, parking lot, driveway or street.



Storing Hazardous Waste

Keep your liquid waste segregated. Many fluids can be recycled via hazardous waste disposal companies if they are not mixed. Store all materials under cover with spill containment or inside to prevent contamination of rainwater runoff.



Metal Grinding and Polishing

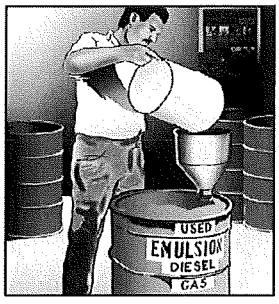
Keep a bin under your lathe or grinder to capture metal filings. Send uncontaminated filings to a scrap metal recycler for reclamation. Store metal filings in a covered container or indoors.

Preventing Leaks and Spills

Place drip pans underneath to capture fluids. Use absorbent cleaning agents instead of water to clean work areas.

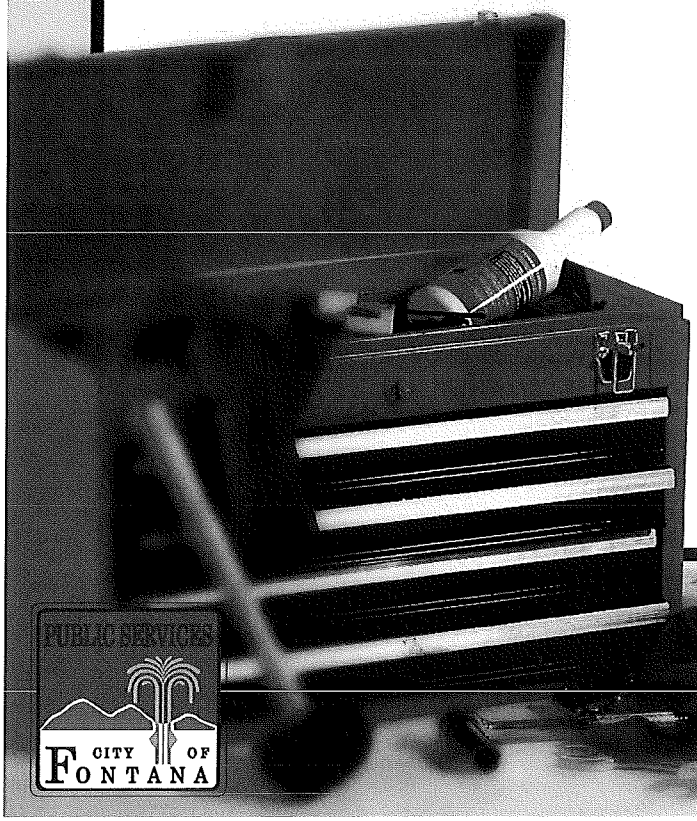
Cleaning Spills

Use dry methods for spill cleanup (sweeping, absorbent materials). Follow your hazardous materials response plan, as filed with your local fire department or other hazardous materials authority. Be sure that all employees are aware of the plan and are capable of implementing each phase. To report serious toxic spills, call 911.



Proper Disposal of Hazardous Waste

Recycle used motor oil and oil filters, anti-freeze and other hazardous automotive fluids, batteries, tires and metal filings collected from grinding or polishing auto parts. Contact a licensed hazardous waste hauler. For more recycling information, call (909) 386-8401.



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1 (800) CLEANUP

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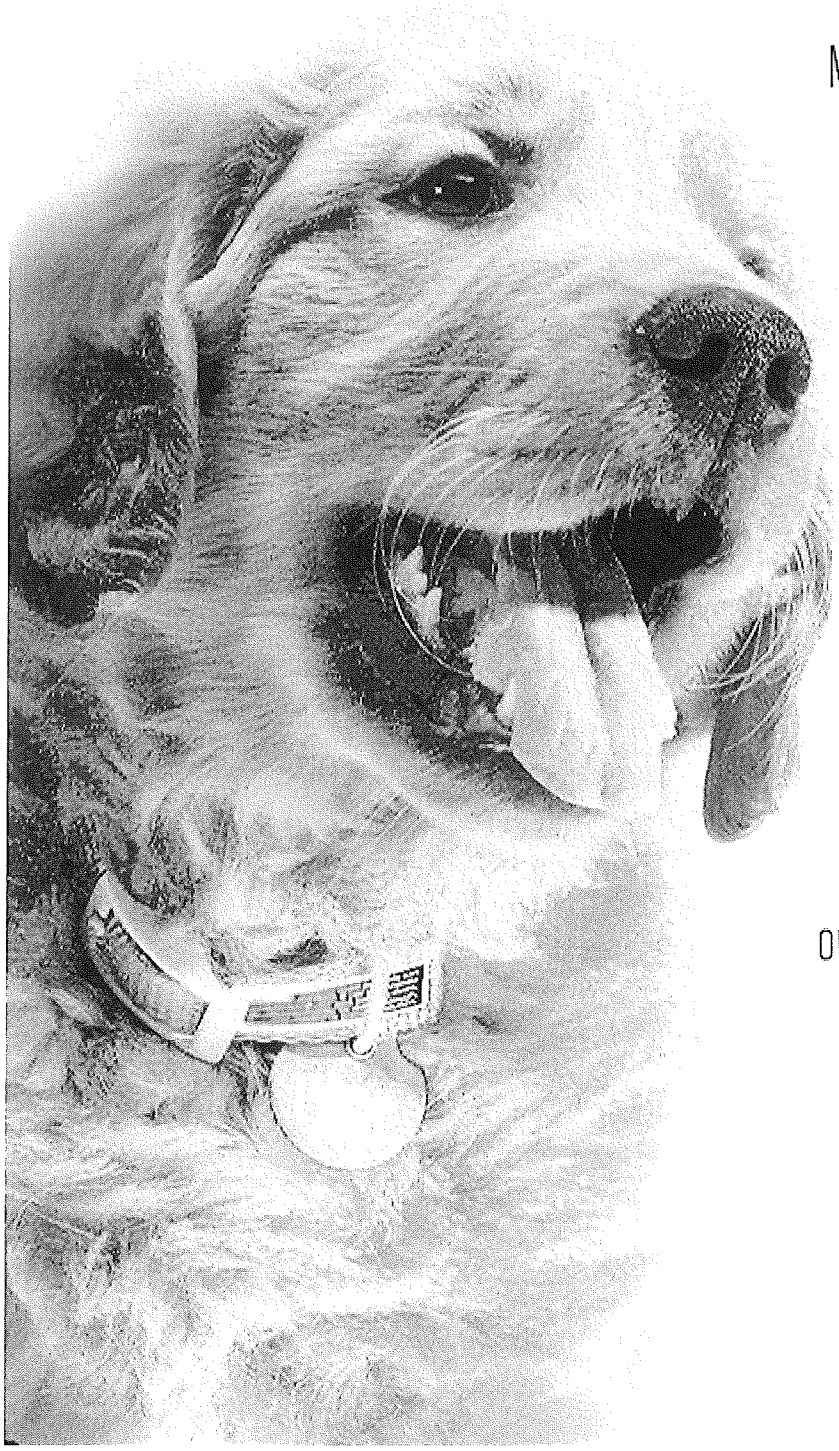
San Bernardino County STORMWATER PROGRAM

Pick up after your pooch to curb pollution.



Maybe you weren't aware, but dog waste left on the ground gets into storm drains, polluting rivers, lakes and beaches.

The bacteria and risk of disease threatens the health of our kids and communities. Wherever you live in San Bernardino County, this pollution is a problem. The answer? Pick up after your dog, to help prevent pollution and protect our health. It's in your hands.

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STORMWATER PROGRAM

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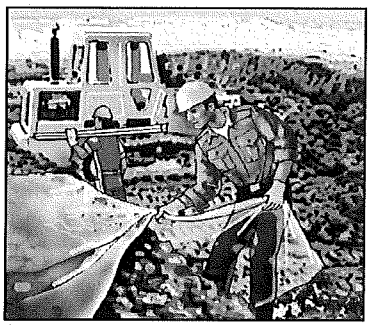
STORMWATER Pollution Prevention

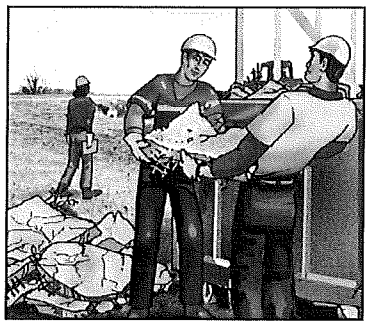
FRESH CONCRETE & MORTAR APPLICATION

Cement wash, sediment, vehicle fluids, dust and hazardous debris from construction sites 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 best management practices to prevent pollution and protect public health.



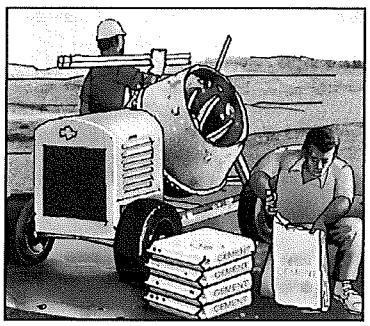
Storing Materials

Keep construction materials and debris away from the street, gutter and storm drains. Secure open bags of cement and cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.



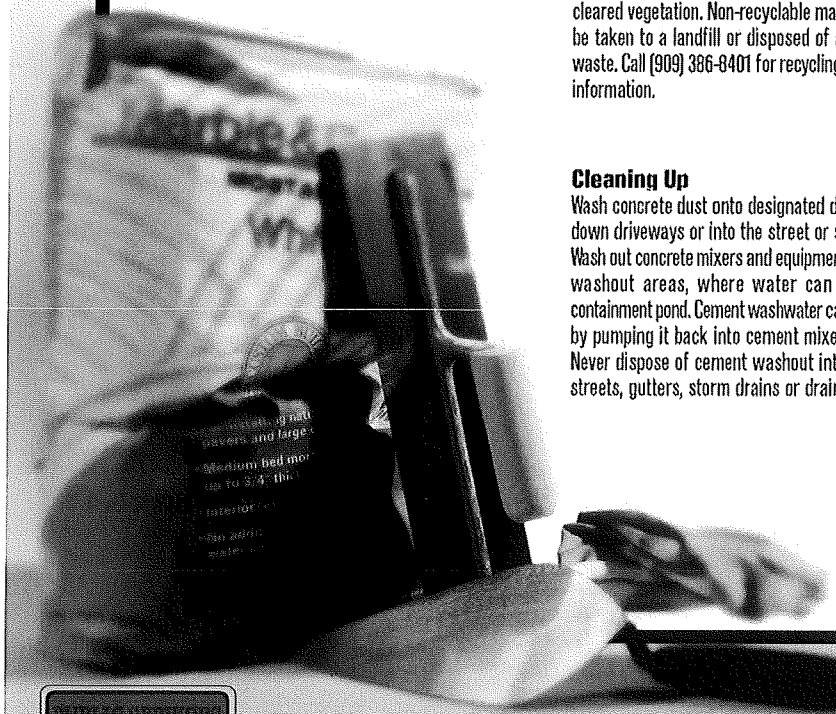
Ordering Materials & Recycling Waste

Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. When breaking up paving, recycle the pieces at a crushing company. You can also recycle broken asphalt, concrete, wood, and cleared vegetation. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. Call (909) 386-8401 for recycling and disposal information.



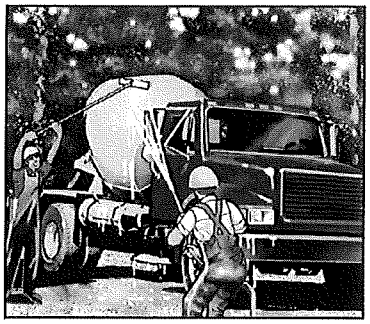
During Construction

Schedule excavation and grading during dry weather. Prevent mortar and cement from entering the street and storm drains by placing erosion controls. Setup small mixers on tarps or drop cloths, for easy cleanup of debris. Never bury waste material. Recycle or dispose of it as hazardous waste.



Cleaning Up

Wash concrete dust onto designated dirt areas, not down driveways or into the street or storm drains. Wash out concrete mixers and equipment in specified washout areas, where water can flow into a containment pond. Cement washwater can be recycled by pumping it back into cement mixers for reuse. Never dispose of cement washout into driveways, streets, gutters, storm drains or drainage ditches.



PUBLIC SERVICES
CITY OF FONTANA

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1 (800) CLEANUP

www.1800cleanup.org

San Bernardino County STORMWATER PROGRAM

STORMWATER Pollution Prevention

HOME REPAIR & REMODELING

Paints, solvents, adhesives and other toxic substances used in home repair and remodeling 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.

Construction Projects

Keep construction debris away from the street, gutter and storm drains. Schedule grading and excavation projects for dry weather. Cover excavated material and stockpiles of soil, sand or gravel, protected from rain, wind and runoff. Prevent erosion by planting fast-growing annual and perennial grass, which can shield and bind soil.

Recycle Household Hazardous Waste

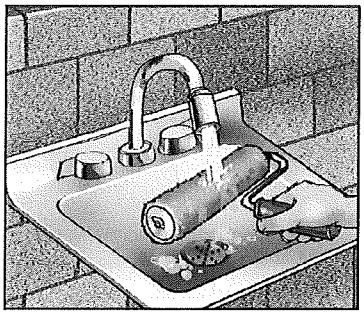
Household cleaners, paint and other home improvement products like wallpaper and tile adhesives are too toxic to trash. Recycle them instead, at a convenient household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.

Landscaping & Gardening

Avoid applying fertilizers or pesticide near curbs and driveways, and store covered, protected from rain, wind and runoff. Try using organic or non-toxic alternatives. Reduce runoff and lower your water bill by using drip irrigation, soaker hoses or micro-spray systems. Recycle leaves instead of blowing, sweeping or raking them into the street, gutter or storm drain.

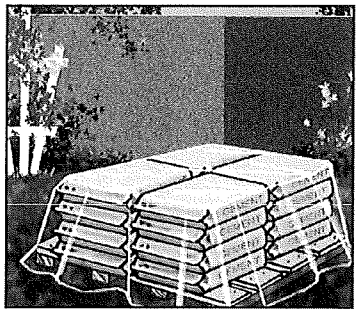
Paint Removal

Paint stripping residue, chips and dust from marine paints and paints containing lead or tributyl tin are hazardous wastes. Sweep them up instead of hosing into the street and dispose of them safely at a household hazardous waste collection facility.



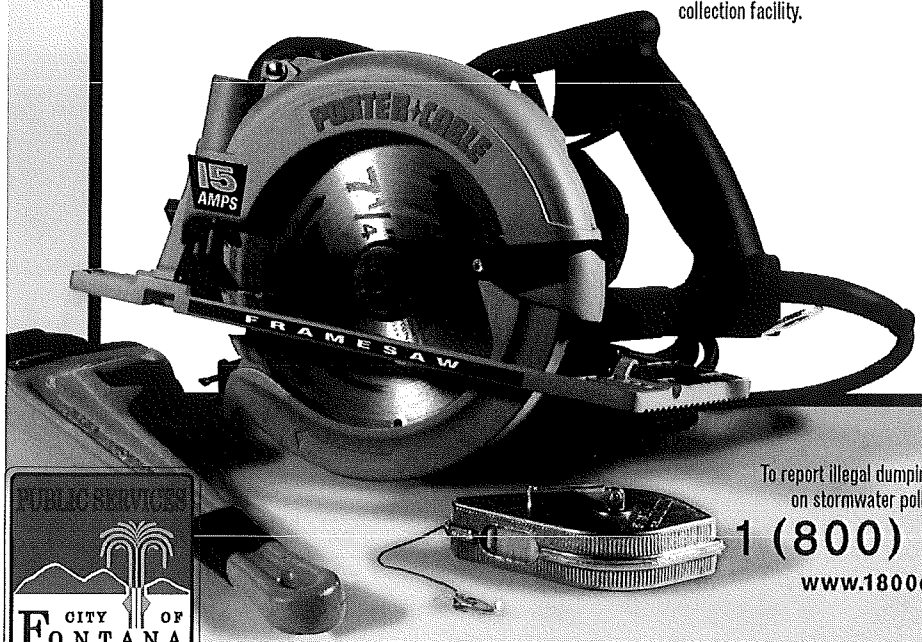
Painting Cleanup

Avoid cleaning brushes or rinsing paint containers in the street, gutter or near a storm drain. Clean water-based paints in the sink. Clean oil-based paints with thinner, which you can filter and reuse. Recycle leftover paint at a household hazardous waste collection facility, save it for touch ups or give it to someone who can use it, like a theatre group, school, city or community organization.



Concrete and Masonry

Store bags of cement and plaster away from gutters and storm drains, and cover them to protect against rain, wind and runoff. Sweep or scoop up cement washout or concrete dust instead of hosing into driveways, streets, gutters or storm drains.



PUBLIC SERVICES
CITY OF FONTANA

To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

www.1800cleanup.org

San Bernardino County STORMWATER PROGRAM

BMP Fact Sheets

Infiltration Basin TC-11

Design Considerations

- Soil for Infiltration
- Slope
- Aesthetics

Targeted Constituents

☑	Sediment	■
☑	Nutrients	■
☑	Trash	■
☑	Metals	■
☑	Bacteria	■
☑	Oil and Grease	■
☑	Organics	■

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater. Infiltration basins use the natural filtering ability of the soil to remove pollutants in stormwater runoff. Infiltration facilities store runoff until it gradually exfiltrates through the soil and eventually into the water table. This practice has high pollutant removal efficiency and can also help recharge groundwater, thus helping to maintain low flows in stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

California Experience

Infiltration basins have a long history of use in California, especially in the Central Valley. Basins located in Fresno were among those initially evaluated in the National Urban Runoff Program and were found to be effective at reducing the volume of runoff, while posing little long-term threat to groundwater quality (EPA, 1983; Schroeder, 1995). Proper siting of these devices is crucial as underscored by the experience of Caltrans in siting two basins in Southern California. The basin with marginal separation from groundwater and soil permeability failed immediately and could never be rehabilitated.

Advantages

- Provides 100% reduction in the load discharged to surface waters.
- The principal benefit of infiltration basins is the approximation of pre-development hydrology during which a

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significant portion of the average annual rainfall runoff is infiltrated and evaporated rather than flushed directly to creeks.

- If the water quality volume is adequately sized, infiltration basins can be useful for providing control of channel forming (erosion) and high frequency (generally less than the 2-year) flood events.

Limitations

- May not be appropriate for industrial sites or locations where spills may occur.
- Infiltration basins require a minimum soil infiltration rate of 0.5 inches/hour, not appropriate at sites with Hydrologic Soil Types C and D.
- If infiltration rates exceed 2.4 inches/hour, then the runoff should be fully treated prior to infiltration to protect groundwater quality.
- Not suitable on fill sites or steep slopes.
- Risk of groundwater contamination in very coarse soils.
- Upstream drainage area must be completely stabilized before construction.
- Difficult to restore functioning of infiltration basins once clogged.

Design and Sizing Guidelines

- Water quality volume determined by local requirements or sized so that 85% of the annual runoff volume is captured.
- Basin sized so that the entire water quality volume is infiltrated within 48 hours.
- Vegetation establishment on the basin floor may help reduce the clogging rate.

Construction/Inspection Considerations

- Before construction begins, stabilize the entire area draining to the facility. If impossible, place a diversion berm around the perimeter of the infiltration site to prevent sediment entrance during construction or remove the top 2 inches of soil after the site is stabililized. Stabilize the entire contributing drainage area, including the side slopes, before allowing any runoff to enter once construction is complete.
- Place excavated material such that it can not be washed back into the basin if a storm occurs during construction of the facility.
- Build the basin without driving heavy equipment over the infiltration surface. Any equipment driven on the surface should have extra-wide ("low pressure") tires. Prior to any construction, rope off the infiltration area to stop entrance by unwanted equipment.
- After final grading, till the infiltration surface deeply.
- Use appropriate erosion control seed mix for the specific project and location.

Performance

As water migrates through porous soil and rock, pollutant attenuation mechanisms include precipitation, sorption, physical filtration, and bacterial degradation. If functioning properly, this approach is presumed to have high removal efficiencies for particulate pollutants and moderate removal of soluble pollutants. Actual pollutant removal in the subsurface would be expected to vary depending upon site-specific soil types. This technology eliminates discharge to surface waters except for the very largest storms; consequently, complete removal of all stormwater constituents can be assumed.

There remain some concerns about the potential for groundwater contamination despite the findings of the NURP and Nightingale (1975; 1987a,b,c; 1989). For instance, a report by Pitt et al. (1994) highlighted the potential for groundwater contamination from intentional and unintentional stormwater infiltration. That report recommends that infiltration facilities not be sited in areas where high concentrations are present or where there is a potential for spills of toxic material. Conversely, Schroeder (1995) reported that there was no evidence of groundwater impacts from an infiltration basin serving a large industrial catchment in Fresno, CA.

Siting Criteria

The key element in siting infiltration basins is identifying sites with appropriate soil and hydrogeologic properties, which is critical for long term performance. In one study conducted in Prince George's County, Maryland (Galli, 1992), all of the infiltration basins investigated clogged within 2 years. It is believed that these failures were for the most part due to allowing infiltration at sites with rates of less than 0.5 in/hr, basing siting on soil type rather than field infiltration tests, and poor construction practices that resulted in soil compaction of the basin invert.

A study of 23 infiltration basins in the Pacific Northwest showed better long-term performance in an area with highly permeable soils (Hilding, 1996). In this study, few of the infiltration basins had failed after 10 years. Consequently, the following guidelines for identifying appropriate soil and subsurface conditions should be rigorously adhered to.

- Determine soil type (consider RCS soil type 'A, B or C' only) from mapping and consult USDA soil survey tables to review other parameters such as the amount of silt and clay, presence of a restrictive layer or seasonal high water table, and estimated permeability. The soil should not have more than 30% clay or more than 40% of clay and silt combined. Eliminate sites that are clearly unsuitable for infiltration.

- Groundwater separation should be at least 3 m from the basin invert to the measured ground water elevation. There is concern at the state and regional levels of the impact on groundwater quality from infiltrated runoff, especially when the separation between groundwater and the surface is small.

- Location away from buildings, slopes and highway pavement (greater than 6 m) and wells and bridge structures (greater than 30 m). Sites constructed of fill, having a base flow or with a slope greater than 15% should not be considered.

- Ensure that adequate head is available to operate flow splitter structures (to allow the basin to be offline) without ponding in the splitter structure or creating backwater upstream of the splitter.

- Base flow should not be present in the tributary watershed.

Secondary Screening Based on Site Geotechnical Investigation

- At least three in-hole conductivity tests shall be performed using USBR 7300-89 or Bouwer-Rice procedures (the latter if groundwater is encountered within the boring), two tests at different locations within the proposed basin and the third down gradient by no more than approximately 10 m. The tests shall measure permeability in the side slopes and the bed within a depth of 3 m of the invert.

- The minimum acceptable hydraulic conductivity as measured in any of the three required test holes is 13 mm/hr. If any test hole shows less than the minimum value, the site should be disqualified from further consideration.

- Exclude from consideration sites constructed in fill or partially in fill unless no silts or clays are present in the soil boring. Fill tends to be compacted, with clays in a dispersed rather than flocculated state, greatly reducing permeability.

- The geotechnical investigation should be such that a good understanding is gained as to how the stormwater runoff will move in the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

Additional Design Guidelines

(1) Basin Sizing - The required water quality volume is determined by local regulations or sufficient to capture 85% of the annual runoff.

(2) Provide pretreatment if sediment loading is a maintenance concern for the basin.

(3) Include energy dissipation in the inlet design for the basins. Avoid designs that include a permanent pool to reduce opportunity for standing water and associated vector problems.

(4) Basin invert area should be determined by the equation:

$$A = \frac{WQV}{kt}$$

where A = Basin invert area (m^2)

WQV = water quality volume (m^3)

k = 0.5 times the lowest field-measured hydraulic conductivity (m/hr)

t = drawdown time (48 hr)

(5) The use of vertical piping, either for distribution or infiltration enhancement shall not be allowed to avoid device classification as a Class V injection well per 40 CFR146.5(e)(4).

Maintenance

Regular maintenance is critical to the successful operation of infiltration basins. Recommended operation and maintenance guidelines include:

- Inspections and maintenance to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 72 hours or less) and that vegetation is carefully managed to prevent creating mosquito and other vector habitats.
- Observe drain time for the design storm after completion or modification of the facility to confirm that the desired drain time has been obtained.
- Schedule semiannual inspections for beginning and end of the wet season to identify potential problems such as erosion of the basin side slopes and invert, standing water, trash and debris, and sediment accumulation.
- Remove accumulated trash and debris in the basin at the start and end of the wet season.
- Inspect for standing water at the end of the wet season.
- Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of the basin.
- If erosion is occurring within the basin, revegetate immediately and stabilize with an erosion control mulch or mat until vegetation cover is established.
- To avoid reversing soil development, scarification or other disturbance should only be performed when there are actual signs of clogging, rather than on a routine basis. Always remove deposited sediments before scarification, and use a hand-guided rotary tiller, if possible, or a disc harrow pulled by a very light tractor.

Cost

Infiltration basins are relatively cost-effective practices because little infrastructure is needed when constructing them. One study estimated the total construction cost at about $2 per ft (adjusted for inflation) of storage for a 0.25-acre basin (SWRPC, 1991). As with other BMPs, these published cost estimates may deviate greatly from what might be incurred at a specific site. For instance, Caltrans spent about $18/ft^3 for the two infiltration basins constructed in southern California, each of which had a water quality volume of about 0.34 ac.-ft. Much of the higher cost can be attributed to changes in the storm drain system necessary to route the runoff to the basin locations.

Infiltration basins typically consume about 2 to 3% of the site draining to them, which is relatively small. Additional space may be required for buffer, landscaping, access road, and fencing. Maintenance costs are estimated at 5 to 10% of construction costs.

One cost concern associated with infiltration practices is the maintenance burden and longevity. If improperly maintained, infiltration basins have a high failure rate. Thus, it may be necessary to replace the basin with a different technology after a relatively short period of time.

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Information Resources

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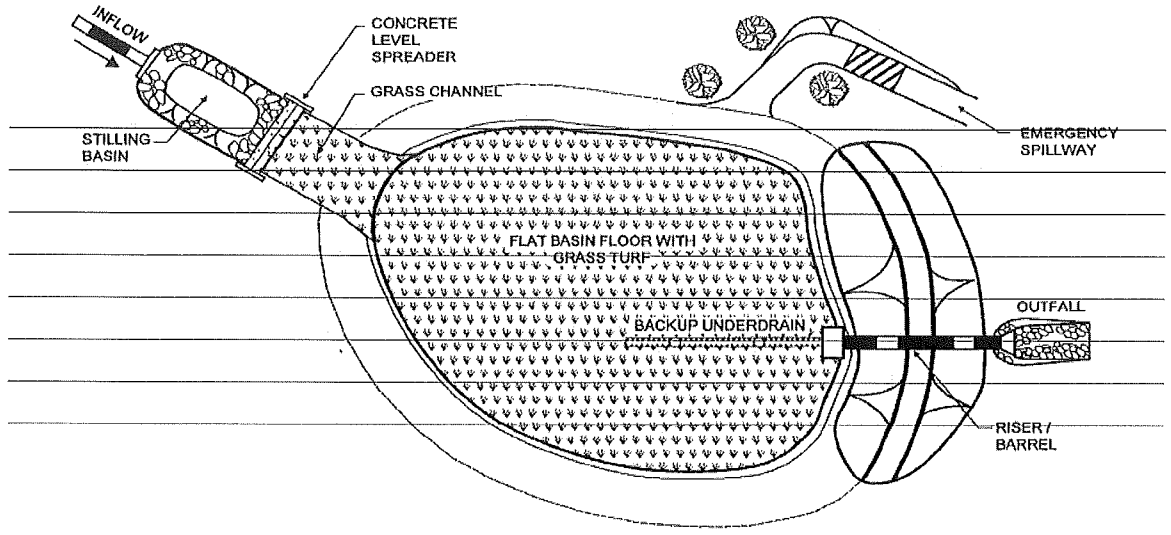
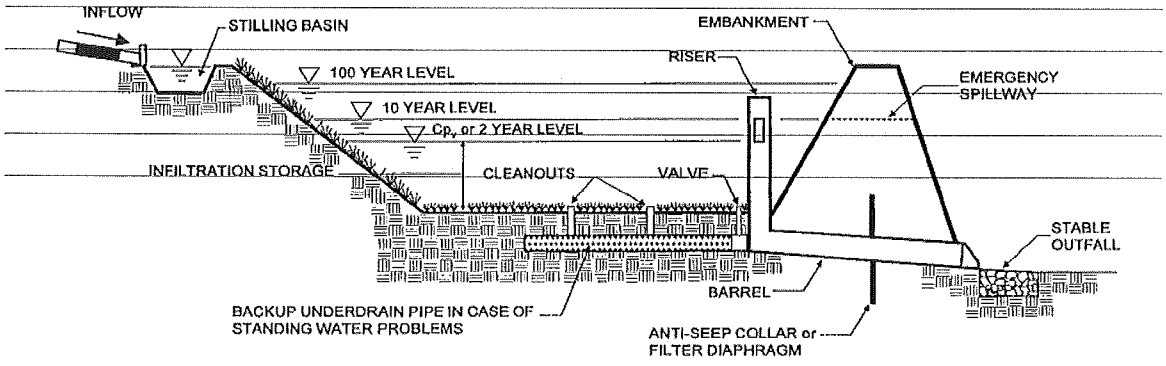


PLAN VIEW



PROFILE

Retention/Irrigation TC-12

Description

Retention/irrigation refers to the capture of stormwater runoff in a holding pond and subsequent use of the captured volume for irrigation of landscape of natural pervious areas. This technology is very effective as a stormwater quality practice in that, for the captured water quality volume, it provides virtually no discharge to receiving waters and high stormwater constituent removal efficiencies. This technology mimics natural undeveloped watershed conditions wherein the vast majority of the rainfall volume during smaller rainfall events is infiltrated through the soil profile. Their main advantage over other infiltration technologies is the use of an irrigation system to spread the runoff over a larger area for infiltration. This allows them to be used in areas with low permeability soils.

Capture of stormwater can be accomplished in almost any kind of runoff storage facility, ranging from dry, concrete-lined ponds to those with vegetated basins and permanent pools. The pump and wet well should be automated with a rainfall sensor to provide irrigation only during periods when required infiltration rates can be realized. Generally, a spray irrigation system is required to provide an adequate flow rate for distributing the water quality volume (LCRA, 1998). Collection of roof runoff for subsequent use (rainwater harvesting) also qualifies as a retention/irrigation practice.

This technology is still in its infancy and there are no published reports on its effectiveness, cost, or operational requirements. The guidelines presented below should be considered tentative until additional data are available.

California Experience

This BMP has never been implemented in California, only in the Austin, Texas area. The use there is limited to watersheds where no increase in pollutant load is allowed because of the sensitive nature of the watersheds.

Advantages

- Pollutant removal effectiveness is high, accomplished primarily by: (1) sedimentation in the primary storage facility; (2) physical filtration of particulates through the soil profile; (3) dissolved constituents uptake in the vegetative root zone by the soil-resident microbial community.

Design Considerations

- Soil for Infiltration
- Area Required
- Slope
- Environmental Side-effects

Targeted Constituents

☑ Sediment	■
☑ Nutrients	■
☑ Trash	■
☑ Metals	■
☑ Bacteria	■
☑ Oil and Grease	■
☑ Organics	■

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

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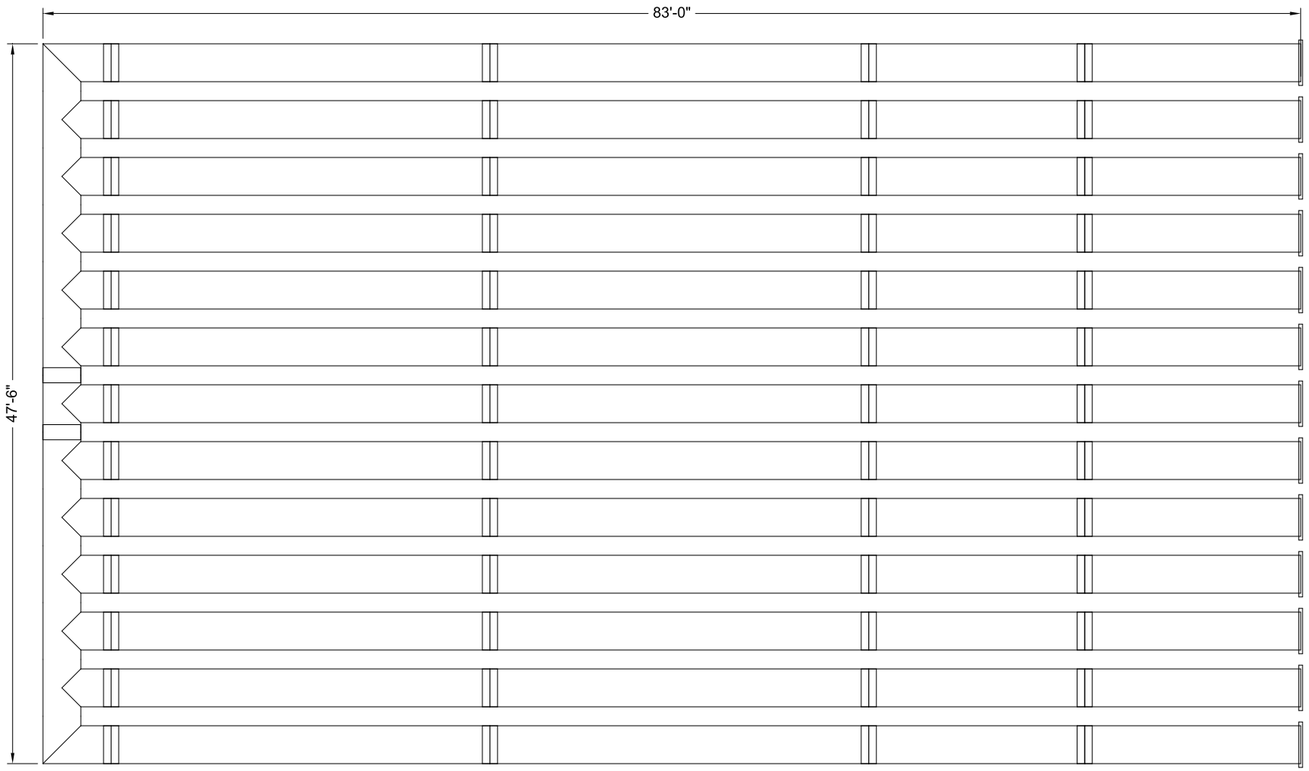
PROJECT SUMMARY

CALCULATION DETAILS
- LOADING = HS20 & HS25
- APPROX. LINEAR FOOTAGE = 1,094 lf.

STORAGE SUMMARY
- STORAGE VOLUME REQUIRED = N/A
- PIPE STORAGE VOLUME = 5,370 cf.
- BACKFILL STORAGE VOLUME = 3,742 cf.
- TOTAL STORAGE PROVIDED = 9,113 cf.

PIPE DETAILS
- DIAMETER = 30 IN.
- CORRUGATION = 2 2/3x1/2
- GAGE = 16
- COATING = ALT2
- WALL TYPE = Perforated
- BARRELL SPACING = 15 IN.

BACKFILL DETAILS
- WIDTH AT ENDS = 12 IN.
- ABOVE PIPE = 6 IN.
- WIDTH AT SIDES = 12 IN.
- BELOW PIPE = 6 IN.



NOTES

- ALL RISER AND STUB DIMENSIONS ARE TO CENTERLINE. ALL ELEVATIONS, DIMENSIONS, AND LOCATIONS OF RISERS AND INLETS, SHALL BE VERIFIED BY THE ENGINEER OF RECORD PRIOR TO RELEASING FOR FABRICATION.
- ALL FITTINGS AND REINFORCEMENT COMPLY WITH ASTM A998.
- ALL RISERS AND STUBS ARE $2\frac{2}{3}$" x $\frac{1}{2}$" CORRUGATION AND 16 GAGE UNLESS OTHERWISE NOTED.
- RISERS TO BE FIELD TRIMMED TO GRADE.
- QUANTITY OF PIPE SHOWN DOES NOT PROVIDE EXTRA PIPE FOR CONNECTING THE SYSTEM TO EXISTING PIPE OR DRAINAGE STRUCTURES. OUR SYSTEM AS DETAILED PROVIDES NOMINAL INLET AND/OR OUTLET PIPE STUB FOR CONNECTION TO EXISTING DRAINAGE FACILITIES. IF ADDITIONAL PIPE IS NEEDED IT IS THE RESPONSIBILITY OF THE CONTRACTOR.
- BAND TYPE TO BE DETERMINED UPON FINAL DESIGN.
- THE PROJECT SUMMARY IS REFLECTIVE OF THE DYODS DESIGN, QUANTITIES ARE APPROX. AND SHOULD BE VERIFIED UPON FINAL DESIGN AND APPROVAL. FOR EXAMPLE, TOTAL EXCAVATION DOES NOT CONSIDER ALL VARIABLES SUCH AS SHORING AND ONLY ACCOUNTS FOR MATERIAL WITHIN THE ESTIMATED EXCAVATION FOOTPRINT.
- THESE DRAWINGS ARE FOR CONCEPTUAL PURPOSES AND DO NOT REFLECT ANY LOCAL PREFERENCES OR REGULATIONS. PLEASE CONTACT YOUR LOCAL CONTECH REP FOR MODIFICATIONS.

ASSEMBLY
SCALE: 1" = 10'

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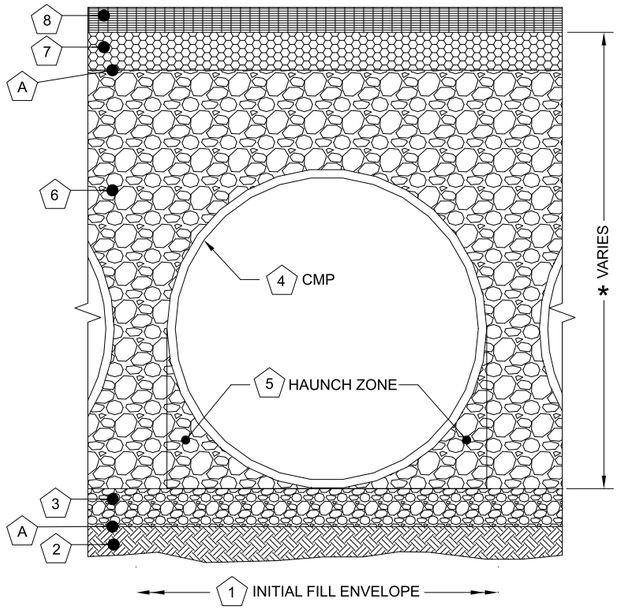
DATE	REVISION DESCRIPTION	BY

CONTECH® ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH® CMP DETENTION SYSTEMS
CONTECH **DYODS** DRAWING

DYO10865 Warmington, Palm Ave
Retention/Infiltration System
Fontana, CA
DETENTION SYSTEM

PROJECT No.:	SEQ. No.:	DATE:
6763	10865	10/7/2021
DESIGNED: DYO	DRAWN: DYO	
CHECKED: DYO	APPROVED: DYO	
SHEET NO.: D1		



Infiltration Systems - CMP Infiltration & CMP Perforated Drainage Pipe			
Material Location	Description	Material Designation	Designation
8 Rigid or Flexible Pavement (if applicable)			
7 Road Base (if applicable			
A Geotextile Layer	Non-Woven Geotextile	CONTECH C-40 or C-45	Engineer Decision for consideration to prevent soil migration into varying soil types. Wrap the trench only.
6 Backfill	Infiltration pipe systems have a pipe perforation sized of 3/8" diameter. An open graded, free draining stone, with a particle size of ½" – 2 ½" diameter is recommended.	AASHTO M 145-A-1 or AASHTO M 43 - 3, 4	Material shall be worked into the pipe haunches by means of shovel-slicing, rodding, air-tamper, vibratory rod, or other effective methods. Compaction of all placed fill material is necessary and shall be considered adequate when no further yielding of the material is observed under the compactor, or under foot, and the Project Engineer or his representative is satisfied with the level of compaction"
3 Bedding Stone	Well graded granular bedding material w/maximum particle size of 3"	AASHTO M43 - 3,357,4,467, 5, 56, 57	For soil aggregates larger than 3/8" a dedicated bedding layer is not required for CMP. Pipe may be placed on the trench bottom comprised of native suitable well graded & granular material. For Arch pipes it is recommended to be shaped to a relatively flat bottom or fine-grade the foundation to a slight v-shape. Soil aggregates less than 3/8" and unsuitable material should be over-excavated and re-placed with a 4"-6" layer of well graded & granular stone per the material designation.
A Geotextile Layer	None	None	Contech does not recommend geotextiles be placed under the invert of Infiltration systems due to the propensity for geotextiles to clog over time.
* Note: The listed AASHTO designations are for gradation only. The stone must also be angular and clean.			

1 MINIMUM WIDTH DEPENDS ON SITE CONDITIONS AND ENGINEERING JUDGEMENT.

FOUNDATION/BEDDING PREPARATION

2 PRIOR TO PLACING THE BEDDING, THE FOUNDATION MUST BE CONSTRUCTED TO A UNIFORM AND STABLE GRADE. IN THE EVENT THAT UNSUITABLE FOUNDATION MATERIALS ARE ENCOUNTERED DURING EXCAVATION, THEY SHALL BE REMOVED AND BROUGHT BACK TO THE GRADE WITH A FILL MATERIAL AS APPROVED BY THE ENGINEER.

5 HAUNCH ZONE MATERIAL SHALL BE PLACED AND UNIFORMLY COMPACTED WITHOUT SOFT SPOTS.

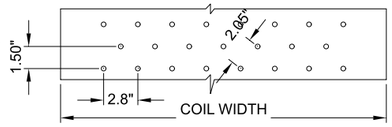
BACKFILL

MATERIAL SHALL BE PLACED IN 8"-10" MAXIMUM LIFTS. INADEQUATE COMPACTION CAN LEAD TO EXCESSIVE DEFLECTIONS WITHIN THE SYSTEM AND SETTLEMENT OF THE SOILS OVER THE SYSTEM. BACKFILL SHALL BE PLACED SUCH THAT THERE IS NO MORE THAN A TWO-LIFT DIFFERENTIAL BETWEEN THE SIDES OF ANY PIPE IN THE SYSTEM AT ALL TIMES DURING THE BACKFILL PROCESS. BACKFILL SHALL BE ADVANCED ALONG THE LENGTH OF THE SYSTEM AT THE SAME RATE TO AVOID DIFFERENTIAL LOADING ON ANY PIPES IN THE SYSTEM.

EQUIPMENT USED TO PLACE AND COMPACT THE BACKFILL SHALL BE OF A SIZE AND TYPE SO AS NOT TO DISTORT, DAMAGE, OR DISPLACE THE PIPE. ATTENTION MUST BE GIVEN TO PROVIDING ADEQUATE MINIMUM COVER FOR SUCH EQUIPMENT. MAINTAIN BALANCED LOADING ON ALL PIPES IN THE SYSTEM DURING ALL SUCH OPERATIONS.

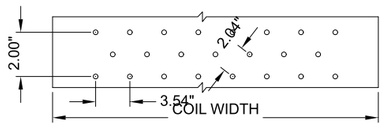
OTHER ALTERNATE BACKFILL MATERIAL MAY BE ALLOWED DEPENDING ON SITE SPECIFIC CONDITIONS. REFER TO TYPICAL BACKFILL DETAIL FOR MATERIAL REQUIRED.

2 2/3" x 1/2" CORRUGATION - STEEL AND ALUMINUM CMP EDGE SPACING EQUAL ON BOTH SIDES



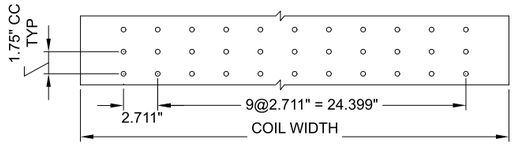
OPEN AREA = 3.76 SQ IN/SQ FT

3" x 1" CORRUGATION - STEEL AND ALUMINUM CMP (COIL PROVIDED FROM CONTECH LANTANA, FL PLANT)



OPEN AREA = 4.16 SQ IN/SQ FT

5" x 1" CORRUGATION - STEEL ONLY
EDGE SPACING EQUAL ON BOTH SIDES



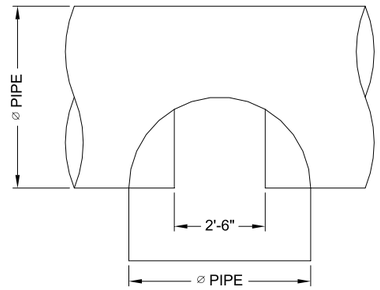
OPEN AREA = 3.33 SQ IN/SQ FT

NOTES:

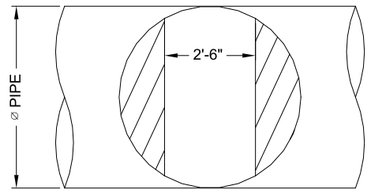
1. PERFORATIONS MEET AASHTO AND ASTM SPECIFICATIONS.
2. PERFORATION OPEN AREA PER SQUARE FOOT OF PIPE IS BASED ON THE NOMINAL DIAMETER AND LENGTH OF PIPE.
3. ALL DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES.
4. ALL HOLES ⌀3/8".

TYPICAL PERFORATION DETAIL

SCALE: N.T.S.



PLAN

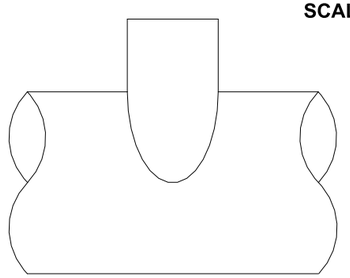


FRONT

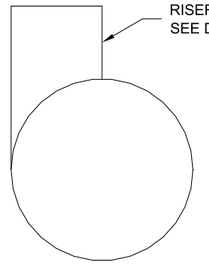
TYPICAL MANWAY DETAIL

SCALE: N.T.S.

NOTE:
MANWAY DETAIL APPLICABLE FOR CMP SYSTEMS WITH DIAMETERS 48" AND LARGER. MANWAYS MAY BE REQUIRED ON SMALLER SYSTEMS DEPENDING ON ACTUAL SITE SPECIFIC CONDITIONS.



ELEVATION

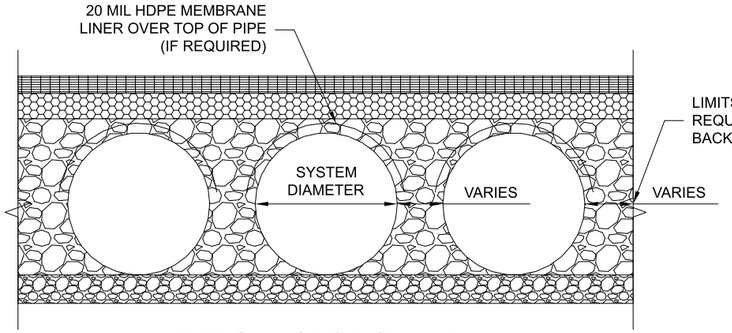


END

NOTE:
LADDERS ARE OPTIONAL AND ARE NOT REQUIRED FOR ALL SYSTEMS.

TYPICAL RISER DETAIL

SCALE: N.T.S.



TYPICAL SECTION VIEW

LINER OVER ROWS
SCALE: N.T.S.

NOTE: IF SALTING AGENTS FOR SNOW AND ICE REMOVAL ARE USED ON OR NEAR THE PROJECT, AN HDPE MEMBRANE LINER IS RECOMMENDED WITH THE SYSTEM. THE IMPERMEABLE LINER IS INTENDED TO HELP PROTECT THE SYSTEM FROM THE POTENTIAL ADVERSE EFFECTS THAT MAY RESULT FROM A CHANGE IN THE SURROUNDING ENVIRONMENT OVER A PERIOD OF TIME. PLEASE REFER TO THE CORRUGATED METAL PIPE DETENTION DESIGN GUIDE FOR ADDITIONAL INFORMATION.

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CONTECH CMP DETENTION SYSTEMS
CONTECH DYODS DRAWING

DYO10865 Warmington, Palm Ave
Retention/Infiltration System
Fontana, CA
DETENTION SYSTEM

PROJECT No.:	SEQ. No.:	DATE:
6763	10865	10/7/2021
DESIGNED: DYO	DRAWN: DYO	
CHECKED: DYO	APPROVED: DYO	
SHEET NO.: D2		

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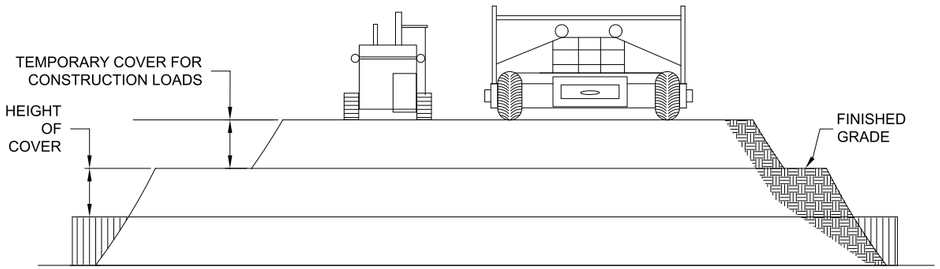


CONSTRUCTION LOADS

FOR TEMPORARY CONSTRUCTION VEHICLE LOADS, AN EXTRA AMOUNT OF COMPACTED COVER MAY BE REQUIRED OVER THE TOP OF THE PIPE. THE HEIGHT-OF-COVER SHALL MEET THE MINIMUM REQUIREMENTS SHOWN IN THE TABLE BELOW. THE USE OF HEAVY CONSTRUCTION EQUIPMENT NECESSITATES GREATER PROTECTION FOR THE PIPE THAN FINISHED GRADE COVER MINIMUMS FOR NORMAL HIGHWAY TRAFFIC.

PIPE SPAN, INCHES	AXLE LOADS (kips)			
	18-50	50-75	75-110	110-150
	MINIMUM COVER (FT)			
12-42	2.0	2.5	3.0	3.0
48-72	3.0	3.0	3.5	4.0
78-120	3.0	3.5	4.0	4.0
126-144	3.5	4.0	4.5	4.5

*MINIMUM COVER MAY VARY, DEPENDING ON LOCAL CONDITIONS. THE CONTRACTOR MUST PROVIDE THE ADDITIONAL COVER REQUIRED TO AVOID DAMAGE TO THE PIPE. MINIMUM COVER IS MEASURED FROM THE TOP OF THE PIPE TO THE TOP OF THE MAINTAINED CONSTRUCTION ROADWAY SURFACE.

CONSTRUCTION LOADING DIAGRAM

SCALE: N.T.S.

SPECIFICATION FOR DESIGNED DETENTION SYSTEM:

SCOPE
THIS SPECIFICATION COVERS THE MANUFACTURE AND INSTALLATION OF THE DESIGNED DETENTION SYSTEM DETAILED IN THE PROJECT PLANS.

MATERIAL
THE MATERIAL SHALL CONFORM TO THE APPLICABLE REQUIREMENTS LISTED BELOW:

ALUMINIZED TYPE 2 STEEL COILS SHALL CONFORM TO THE APPLICABLE REQUIREMENTS OF AASHTO M-274 OR ASTM A-92.

THE GALVANIZED STEEL COILS SHALL CONFORM TO THE APPLICABLE REQUIREMENTS OF AASHTO M-218 OR ASTM A-929.

THE POLYMER COATED STEEL COILS SHALL CONFORM TO THE APPLICABLE REQUIREMENTS OF AASHTO M-246 OR ASTM A-742.

THE ALUMINUM COILS SHALL CONFORM TO THE APPLICABLE REQUIREMENTS OF AASHTO M-197 OR ASTM B-744.

CONSTRUCTION LOADS
CONSTRUCTION LOADS MAY BE HIGHER THAN FINAL LOADS. FOLLOW THE MANUFACTURER'S OR NCSPA GUIDELINES.

PIPE
THE PIPE SHALL BE MANUFACTURED IN ACCORDANCE TO THE APPLICABLE REQUIREMENTS LISTED BELOW:

ALUMINIZED TYPE 2: AASHTO M-36 OR ASTM A-760

GALVANIZED: AASHTO M-36 OR ASTM A-760

POLYMER COATED: AASHTO M-245 OR ASTM A-762

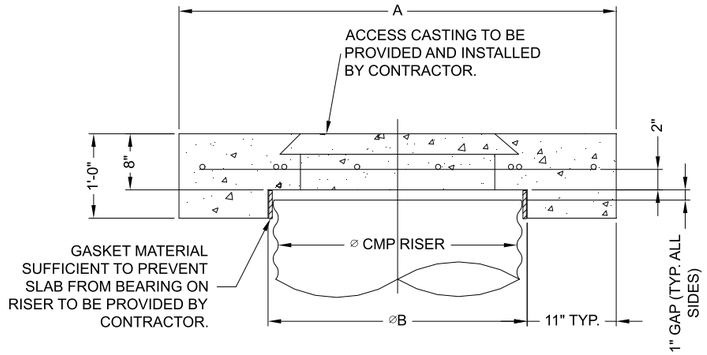
ALUMINUM: AASHTO M-196 OR ASTM B-745

HANDLING AND ASSEMBLY
SHALL BE IN ACCORDANCE WITH NCSP'S (NATIONAL CORRUGATED STEEL PIPE ASSOCIATION) FOR ALUMINIZED TYPE 2, GALVANIZED OR POLYMER COATED STEEL. SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS FOR ALUMINUM PIPE.

INSTALLATION
SHALL BE IN ACCORDANCE WITH AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, SECTION 26, DIVISION II DIVISION II OR ASTM A-798 (FOR ALUMINIZED TYPE 2, GALVANIZED OR POLYMER COATED STEEL) OR ASTM B-788 (FOR ALUMINUM PIPE) AND IN CONFORMANCE WITH THE PROJECT PLANS AND SPECIFICATIONS. IF THERE ARE ANY INCONSISTENCIES OR CONFLICTS THE CONTRACTOR SHOULD DISCUSS AND RESOLVE WITH THE SITE ENGINEER.

IT IS ALWAYS THE RESPONSIBILITY OF THE CONTRACTOR TO FOLLOW OSHA GUIDELINES FOR SAFE PRACTICES.

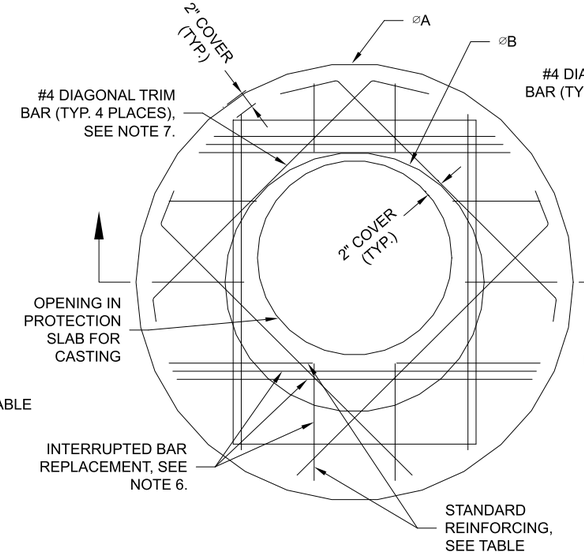
NOTE:
THESE DRAWINGS ARE FOR CONCEPTUAL PURPOSES AND DO NOT REFLECT ANY LOCAL PREFERENCES OR REGULATIONS. PLEASE CONTACT YOUR LOCAL CONTECH REP FOR MODIFICATIONS.



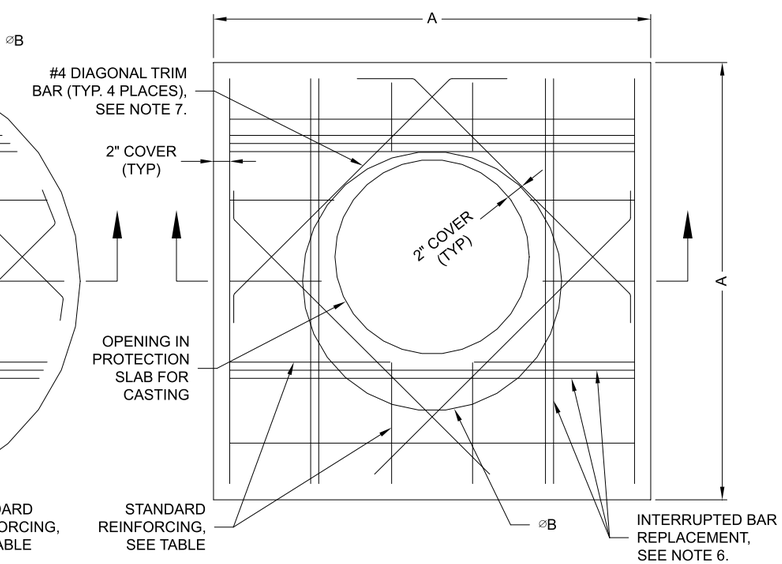
SECTION VIEW

REINFORCING TABLE				
⌀ CMP RISER	A	⌀ B	REINFORCING	**BEARING PRESSURE (PSF)
24"	⌀ 4' 4'X4'	26"	#5 @ 12" OCEW #5 @ 12" OCEW	2,410 1,780
30"	⌀ 4'-6" 4'-6" X 4'-6"	32"	#5 @ 12" OCEW #5 @ 12" OCEW	2,120 1,530
36"	⌀ 5' 5' X 5'	38"	#5 @ 10" OCEW #5 @ 10" OCEW	1,890 1,350
42"	⌀ 5'-6" 5'-6" X 5'-6"	44"	#5 @ 10" OCEW #5 @ 9" OCEW	1,720 1,210
48"	⌀ 6' 6' X 6'	50"	#5 @ 9" OCEW #5 @ 8" OCEW	1,600 1,100

** ASSUMED SOIL BEARING CAPACITY



ROUND OPTION PLAN VIEW



SQUARE OPTION PLAN VIEW

NOTES:

1. DESIGN IN ACCORDANCE WITH AASHTO, 17th EDITION.
2. DESIGN LOAD HS25.
3. EARTH COVER = 1' MAX.
4. CONCRETE STRENGTH = 3,500 psi
5. REINFORCING STEEL = ASTM A615, GRADE 60.
6. PROVIDE ADDITIONAL REINFORCING AROUND OPENINGS EQUAL TO THE BARS INTERRUPTED, HALF EACH SIDE. ADDITIONAL BARS TO BE IN THE SAME PLANE.
7. TRIM OPENING WITH DIAGONAL #4 BARS, EXTEND BARS A MINIMUM OF 12" BEYOND OPENING, BEND BARS AS REQUIRED TO MAINTAIN BAR COVER.
8. PROTECTION SLAB AND ALL MATERIALS TO BE PROVIDED AND INSTALLED BY CONTRACTOR.
9. DETAIL DESIGN BY DELTA ENGINEERING, BINGHAMTON, NY.

MANHOLE CAP DETAIL

SCALE: N.T.S.

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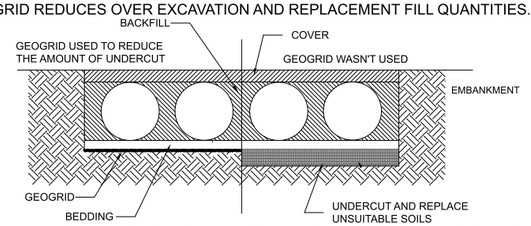
CMP DETENTION INSTALLATION GUIDE

PROPER INSTALLATION OF A FLEXIBLE UNDERGROUND DETENTION SYSTEM WILL ENSURE LONG-TERM PERFORMANCE. THE CONFIGURATION OF THESE SYSTEMS OFTEN REQUIRES SPECIAL CONSTRUCTION PRACTICES THAT DIFFER FROM CONVENTIONAL FLEXIBLE PIPE CONSTRUCTION. CONTECH ENGINEERED SOLUTIONS STRONGLY SUGGESTS SCHEDULING A PRE-CONSTRUCTION MEETING WITH YOUR LOCAL SALES ENGINEER TO DETERMINE IF ADDITIONAL MEASURES, NOT COVERED IN THIS GUIDE, ARE APPROPRIATE FOR YOUR SITE.

FOUNDATION

CONSTRUCT A FOUNDATION THAT CAN SUPPORT THE DESIGN LOADING APPLIED BY THE PIPE AND ADJACENT BACKFILL WEIGHT AS WELL AS MAINTAIN ITS INTEGRITY DURING CONSTRUCTION.

IF SOFT OR UNSUITABLE SOILS ARE ENCOUNTERED, REMOVE THE POOR SOILS DOWN TO A SUITABLE DEPTH AND THEN BUILD UP TO THE APPROPRIATE ELEVATION WITH A COMPETENT BACKFILL MATERIAL. THE STRUCTURAL FILL MATERIAL GRADATION SHOULD NOT ALLOW THE MIGRATION OF FINES, WHICH CAN CAUSE SETTLEMENT OF THE DETENTION SYSTEM OR PAVEMENT ABOVE. IF THE STRUCTURAL FILL MATERIAL IS NOT COMPATIBLE WITH THE UNDERLYING SOILS AN ENGINEERING FABRIC SHOULD BE USED AS A SEPARATOR. IN SOME CASES, USING A STIFF REINFORCING GEOGRID REDUCES OVER EXCAVATION AND REPLACEMENT FILL QUANTITIES.

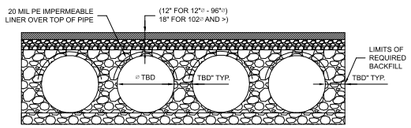


GRADE THE FOUNDATION SUBGRADE TO A UNIFORM OR SLIGHTLY SLOPING GRADE. IF THE SUBGRADE IS CLAY OR RELATIVELY NON-POROUS AND THE CONSTRUCTION SEQUENCE WILL LAST FOR AN EXTENDED PERIOD OF TIME, IT IS BEST TO SLOPE THE GRADE TO ONE END OF THE SYSTEM. THIS WILL ALLOW EXCESS WATER TO DRAIN QUICKLY, PREVENTING SATURATION OF THE SUBGRADE.

GEOMEMBRANE BARRIER

A SITE'S RESISTIVITY MAY CHANGE OVER TIME WHEN VARIOUS TYPES OF SALTING AGENTS ARE USED, SUCH AS ROAD SALTS FOR DEICING AGENTS. IF SALTING AGENTS ARE USED ON OR NEAR THE PROJECT SITE, A GEOMEMBRANE BARRIER IS RECOMMENDED WITH THE SYSTEM. THE GEOMEMBRANE LINER IS INTENDED TO HELP PROTECT THE SYSTEM FROM THE POTENTIAL ADVERSE EFFECTS THAT MAY RESULT FROM THE USE OF SUCH AGENTS INCLUDING PREMATURE CORROSION AND REDUCED ACTUAL SERVICE LIFE.

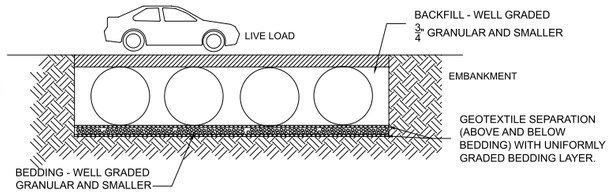
THE PROJECT'S ENGINEER OF RECORD IS TO EVALUATE WHETHER SALTING AGENTS WILL BE USED ON OR NEAR THE PROJECT SITE, AND USE HIS/HER BEST JUDGEMENT TO DETERMINE IF ANY ADDITIONAL PROTECTIVE MEASURES ARE REQUIRED. BELOW IS A TYPICAL DETAIL SHOWING THE PLACEMENT OF A GEOMEMBRANE BARRIER FOR PROJECTS WHERE SALTING AGENTS ARE USED ON OR NEAR THE PROJECT SITE.



IN-SITU TRENCH WALL

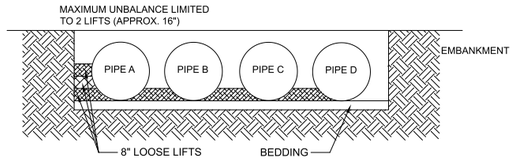
IF EXCAVATION IS REQUIRED, THE TRENCH WALL NEEDS TO BE CAPABLE OF SUPPORTING THE LOAD THAT THE PIPE SHEDS AS THE SYSTEM IS LOADED. IF SOILS ARE NOT CAPABLE OF SUPPORTING THESE LOADS, THE PIPE CAN DEFLECT. PERFORM A SIMPLE SOIL PRESSURE CHECK USING THE APPLIED LOADS TO DETERMINE THE LIMITS OF EXCAVATION BEYOND THE SPRING LINE OF THE OUTER MOST PIPES.

IN MOST CASES THE REQUIREMENTS FOR A SAFE WORK ENVIRONMENT AND PROPER BACKFILL PLACEMENT AND COMPACTION TAKE CARE OF THIS CONCERN.



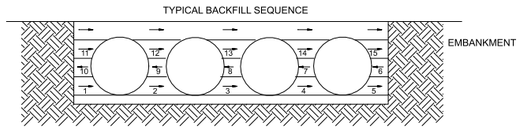
BACKFILL PLACEMENT

MATERIAL SHALL BE WORKED INTO THE PIPE HAUNCHES BY MEANS OF SHOVEL-SLICING, RODDING, AIR TAMPER, VIBRATORY ROD, OR OTHER EFFECTIVE METHODS.

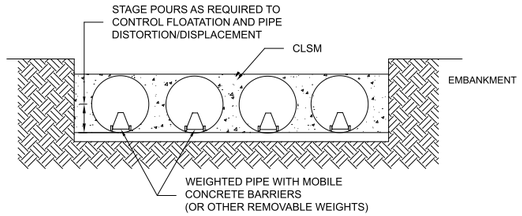


IF AASHTO T99 PROCEDURES ARE DETERMINED INFEASIBLE BY THE GEOTECHNICAL ENGINEER OF RECORD, COMPACTION IS CONSIDERED ADEQUATE WHEN NO FURTHER YIELDING OF THE MATERIAL IS OBSERVED UNDER THE COMPACTOR, OR UNDER FOOT, AND THE GEOTECHNICAL ENGINEER OF RECORD (OR REPRESENTATIVE THEREOF) IS SATISFIED WITH THE LEVEL OF COMPACTION.

FOR LARGE SYSTEMS, CONVEYOR SYSTEMS, BACKHOES WITH LONG REACHES OR DRAGLINES WITH STONE BUCKETS MAY BE USED TO PLACE BACKFILL. ONCE MINIMUM COVER FOR CONSTRUCTION LOADING ACROSS THE ENTIRE WIDTH OF THE SYSTEM IS REACHED, ADVANCE THE EQUIPMENT TO THE END OF THE RECENTLY PLACED FILL, AND BEGIN THE SEQUENCE AGAIN UNTIL THE SYSTEM IS COMPLETELY BACKFILLED. THIS TYPE OF CONSTRUCTION SEQUENCE PROVIDES ROOM FOR STOCKPILED BACKFILL DIRECTLY BEHIND THE BACKHOE, AS WELL AS THE MOVEMENT OF CONSTRUCTION TRAFFIC. MATERIAL STOCKPILES ON TOP OF THE BACKFILLED DETENTION SYSTEM SHOULD BE LIMITED TO 8- TO 10-FEET HIGH AND MUST PROVIDE BALANCED LOADING ACROSS ALL BARRELS. TO DETERMINE THE PROPER COVER OVER THE PIPES TO ALLOW THE MOVEMENT OF CONSTRUCTION EQUIPMENT SEE TABLE 1, OR CONTACT YOUR LOCAL CONTECH SALES ENGINEER.



WHEN FLOWABLE FILL IS USED, YOU MUST PREVENT PIPE FLOATATION. TYPICALLY, SMALL LIFTS ARE PLACED BETWEEN THE PIPES AND THEN ALLOWED TO SET-UP PRIOR TO THE PLACEMENT OF THE NEXT LIFT. THE ALLOWABLE THICKNESS OF THE CLSM LIFT IS A FUNCTION OF A PROPER BALANCE BETWEEN THE UPLIFT FORCE OF THE CLSM, THE OPPOSING WEIGHT OF THE PIPE, AND THE EFFECT OF OTHER RESTRAINING MEASURES. THE PIPE CAN CARRY LIMITED FLUID PRESSURE WITHOUT PIPE DISTORTION OR DISPLACEMENT, WHICH ALSO AFFECTS THE CLSM LIFT THICKNESS. YOUR LOCAL CONTECH SALES ENGINEER CAN HELP DETERMINE THE PROPER LIFT THICKNESS.

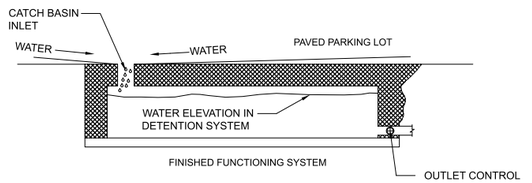


CONSTRUCTION LOADING

TYPICALLY, THE MINIMUM COVER SPECIFIED FOR A PROJECT ASSUMES H-20 LIVE LOAD. BECAUSE CONSTRUCTION LOADS OFTEN EXCEED DESIGN LIVE LOADS, INCREASED TEMPORARY MINIMUM COVER REQUIREMENTS ARE NECESSARY. SINCE CONSTRUCTION EQUIPMENT VARIES FROM JOB TO JOB, IT IS BEST TO ADDRESS EQUIPMENT SPECIFIC MINIMUM COVER REQUIREMENTS WITH YOUR LOCAL CONTECH SALES ENGINEER DURING YOUR PRE-CONSTRUCTION MEETING.

ADDITIONAL CONSIDERATIONS

BECAUSE MOST SYSTEMS ARE CONSTRUCTED BELOW-GRADE, RAINFALL CAN RAPIDLY FILL THE EXCAVATION; POTENTIALLY CAUSING FLOATATION AND MOVEMENT OF THE PREVIOUSLY PLACED PIPES. TO HELP MITIGATE POTENTIAL PROBLEMS, IT IS BEST TO START THE INSTALLATION AT THE DOWNSTREAM END WITH THE OUTLET ALREADY CONSTRUCTED TO ALLOW A ROUTE FOR THE WATER TO ESCAPE. TEMPORARY DIVERSION MEASURES MAY BE REQUIRED FOR HIGH FLOWS DUE TO THE RESTRICTED NATURE OF THE OUTLET PIPE.



CMP DETENTION SYSTEM INSPECTION AND MAINTENANCE

UNDERGROUND STORMWATER DETENTION AND INFILTRATION SYSTEMS MUST BE INSPECTED AND MAINTAINED AT REGULAR INTERVALS FOR PURPOSES OF PERFORMANCE AND LONGEVITY.

INSPECTION

INSPECTION IS THE KEY TO EFFECTIVE MAINTENANCE OF CMP DETENTION SYSTEMS AND IS EASILY PERFORMED. CONTECH RECOMMENDS ONGOING, ANNUAL INSPECTIONS. SITES WITH HIGH TRASH LOAD OR SMALL OUTLET CONTROL ORIFICES MAY NEED MORE FREQUENT INSPECTIONS. THE RATE AT WHICH THE SYSTEM COLLECTS POLLUTANTS WILL DEPEND MORE ON SITE SPECIFIC ACTIVITIES RATHER THAN THE SIZE OR CONFIGURATION OF THE SYSTEM.

INSPECTIONS SHOULD BE PERFORMED MORE OFTEN IN EQUIPMENT WASHDOWN AREAS, IN CLIMATES WHERE SANDING AND/OR SALTING OPERATIONS TAKE PLACE, AND IN OTHER VARIOUS INSTANCES IN WHICH ONE WOULD EXPECT HIGHER ACCUMULATIONS OF SEDIMENT OR ABRASIVE/ CORROSIVE CONDITIONS. A RECORD OF EACH INSPECTION IS TO BE MAINTAINED FOR THE LIFE OF THE SYSTEM

MAINTENANCE

CMP DETENTION SYSTEMS SHOULD BE CLEANED WHEN AN INSPECTION REVEALS ACCUMULATED SEDIMENT OR TRASH IS CLOGGING THE DISCHARGE ORIFICE.

ACCUMULATED SEDIMENT AND TRASH CAN TYPICALLY BE EVACUATED THROUGH THE MANHOLE OVER THE OUTLET ORIFICE. IF MAINTENANCE IS NOT PERFORMED AS RECOMMENDED, SEDIMENT AND TRASH MAY ACCUMULATE IN FRONT OF THE OUTLET ORIFICE. MANHOLE COVERS SHOULD BE SECURELY SEATED FOLLOWING CLEANING ACTIVITIES. CONTECH SUGGESTS THAT ALL SYSTEMS BE DESIGNED WITH AN ACCESS/INSPECTION MANHOLE SITUATED AT OR NEAR THE INLET AND THE OUTLET ORIFICE. SHOULD IT BE NECESSARY TO GET INSIDE THE SYSTEM TO PERFORM MAINTENANCE ACTIVITIES, ALL APPROPRIATE PRECAUTIONS REGARDING CONFINED SPACE ENTRY AND OSHA REGULATIONS SHOULD BE FOLLOWED.

ANNUAL INSPECTIONS ARE BEST PRACTICE FOR ALL UNDERGROUND SYSTEMS. DURING THIS INSPECTION, IF EVIDENCE OF SALTING/DE-ICING AGENTS IS OBSERVED WITHIN THE SYSTEM, IT IS BEST PRACTICE FOR THE SYSTEM TO BE RINSED, INCLUDING ABOVE THE SPRING LINE SOON AFTER THE SPRING THAW AS PART OF THE MAINTENANCE PROGRAM FOR THE SYSTEM.

MAINTAINING AN UNDERGROUND DETENTION OR INFILTRATION SYSTEM IS EASIEST WHEN THERE IS NO FLOW ENTERING THE SYSTEM. FOR THIS REASON, IT IS A GOOD IDEA TO SCHEDULE THE CLEANOUT DURING DRY WEATHER.

THE FOREGOING INSPECTION AND MAINTENANCE EFFORTS HELP ENSURE UNDERGROUND PIPE SYSTEMS USED FOR STORMWATER STORAGE CONTINUE TO FUNCTION AS INTENDED BY IDENTIFYING RECOMMENDED REGULAR INSPECTION AND MAINTENANCE PRACTICES. INSPECTION AND MAINTENANCE RELATED TO THE STRUCTURAL INTEGRITY OF THE PIPE OR THE SOUNDNESS OF PIPE JOINT CONNECTIONS IS BEYOND THE SCOPE OF THIS GUIDE.

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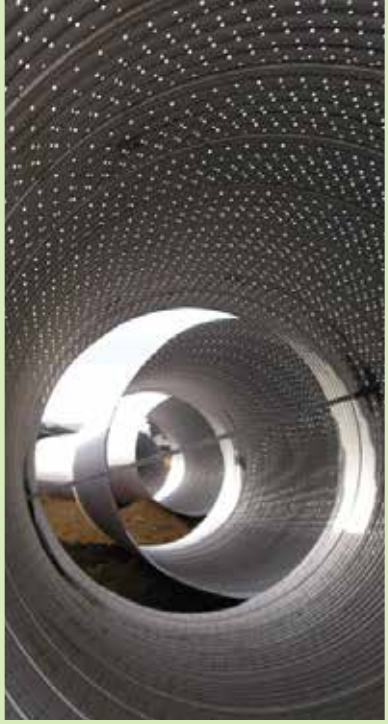


CONTECH®
ENGINEERED SOLUTIONS

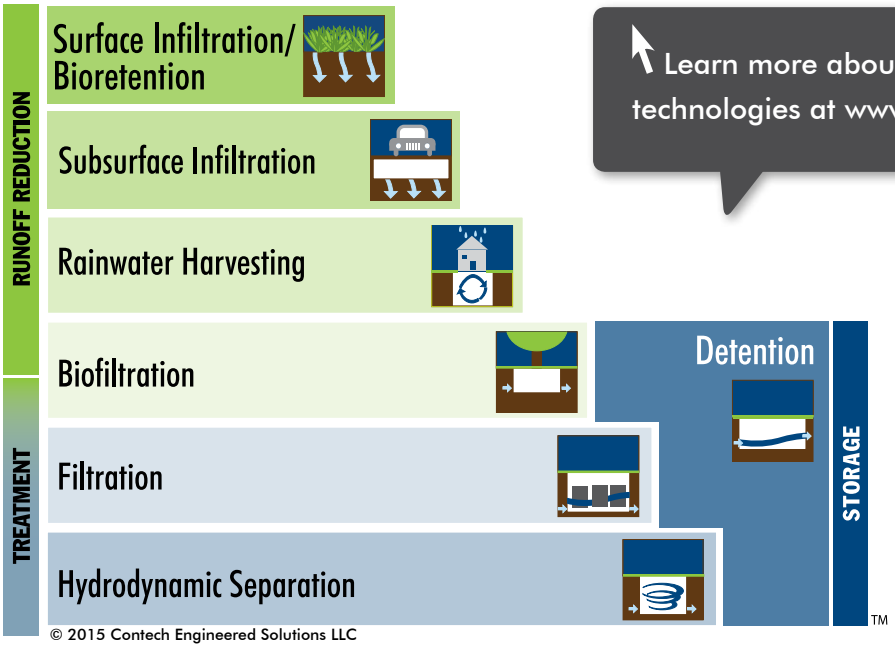
Corrugated Metal Pipe Infiltration System

Solutions Guide

Stormwater Solutions from Contech

Selecting the Right Stormwater Solution Just Got Easier...

It's simple to choose the right stormwater solution to achieve your goals with the Contech Stormwater Solutions Staircase. First, select the runoff reduction practices that are most appropriate for your site, paying particular attention to pretreatment needs. If the entire design storm cannot be retained, select a treatment best management practice (BMP) for the balance. Finally, select a detention system to address any outstanding downstream erosion.



Learn more about all of our stormwater technologies at www.ContechES.com/stormwater

DYODS

Design Your Own Detention or Infiltration System

The Contech Design Your Own Detention System (DYODS®) tool fully automates the layout process for stormwater detention and infiltration systems and produces CAD and PDF files that can be used for creating plans and specs, and for estimating total installed costs.

To use the *Design Your Own Detention or Infiltration System* tool, visit: www.ContechES.com/dyods

Subsurface Infiltration as a Stormwater Management Strategy

The only sure way to eliminate stormwater pollution is to eliminate stormwater runoff. In recognition of this fact, Green Infrastructure and Low Impact Development based stormwater management regulations prioritizing runoff reduction have proliferated throughout the United States.

Where site conditions allow, infiltration is typically the most cost effective and reliable runoff reduction approach. In urban environments where there are competing demands for land, subsurface infiltration can provide many of the benefits of landscape based systems but without requiring dedicated land area. Infiltration systems are commonly comprised of a pretreatment component designed to remove sediment, trash, and oil, followed by plastic, metal or concrete storage units surrounded by permeable stone creating a high voids storage gallery. Infiltration systems are typically designed to support vehicular loading and to withstand lateral pressures from surrounding soil that allows the overlying land to be used for virtually any non-building application.

Subsurface infiltration meets the objectives of LID by reducing runoff with the added benefit of saving land space in urban environments.

LID benefits include runoff volume reduction, peak flow control, ground water recharge, and water quality improvement.

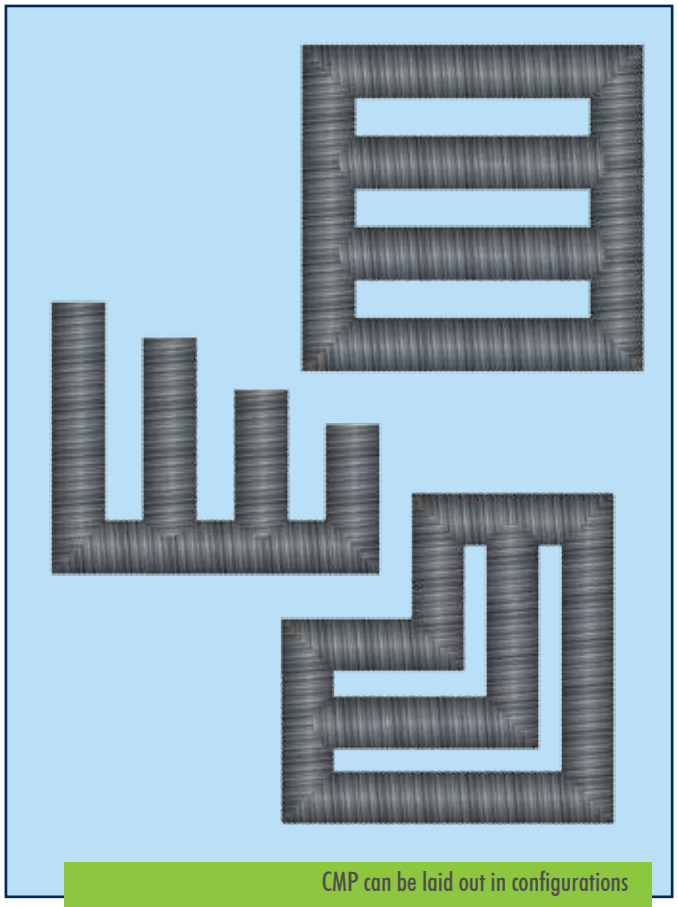
CMP infiltration is used at Pitzer College in Claremont, California.

CMP – the "Go To" Material for Subsurface Infiltration

The purpose of the storage vessel is to hold stormwater runoff underground while allowing it to infiltrate the surrounding soil. For the majority of applications, corrugated metal pipe (CMP) is the "go to" material for subsurface infiltration.

- 75+ year service life guidance for certain materials/coatings in recommended environments.* Please refer to the Corrugated Metal Pipe Detention Design Guide for additional information.
- Various pipe coatings and materials are available to accommodate site-specific needs: Aluminized Steel Type 2 (ALT2), Galvanized, CORLIX® Aluminum, and Polymer Coated.
- Wide range of gages, corrugations, and shapes, in diameters 12" – 144".
- Pipe can be fully or partially perforated for infiltration, retention, or groundwater recharge applications.
- Custom access risers and manifolds provide direct access for maintenance.
- Outlet control devices can be incorporated within the system, eliminating the need for a separate structure.
- Customizable - a variety of fittings allow CMP to match most layout configurations.
- May be designed for heavy loading and high maximum cover.
- Contributes to LEED points.
- Available locally; quick turnaround time.
- The most economical installed solution.

With its low cost, a wide variety of diameters, layout configurations, and materials, no other material can match CMP's flexibility and versatility.



CMP can be laid out in configurations not achievable with other materials.

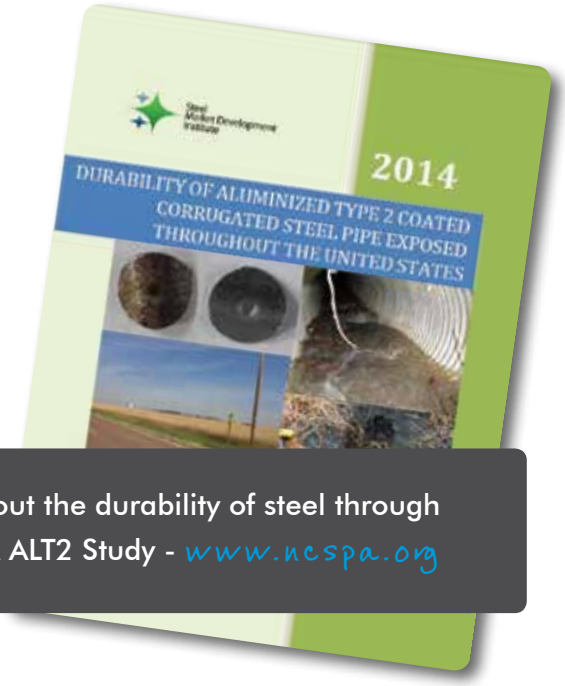
A wide range of CMP diameters and coatings are available to meet site specific needs.

* Service life guidance provided by National Corrugated Steel Pipe Association (NCSPA) and/or AK Steel Corporation. See NCSPA.org website or consult your engineer of record for additional information on service life, recommended environments and field studies on various materials and coatings. Corrosive environments, such as seawater and road/de-icing salt infiltration, and other environments with pH and resistivity outside of the recommended range may cause premature corrosion and reduce actual service life. Because site conditions vary, Contech does not guaranty or warrant service life guidance for materials and coatings.

Addressing the Question of Longevity

Some engineers are hesitant to use corrugated metal pipe (CMP) for infiltration because they have heard about CMP drainage culverts that have corroded due to abrasion. Factors affecting longevity differ between culvert and infiltration applications. Culverts experience high velocity flows carrying abrasive sediment, which can wear off galvanized coatings used in older CMP culverts. Infiltration systems are designed for storage rather than conveyance, so velocity and abrasive forces are minimized. In addition, improved CMP coatings, such as Aluminized Type 2 (ALT2), are more abrasion resistant and have demonstrated superior in-ground performance against abrasion in long-term durability studies. Field studies also have indicated that ALT2 coating may extend service life in wider pH and resistivity ranges than galvanized coatings. Confirming and maintaining recommended environmental conditions helps ensure system longevity projected by the long term studies. Finally, properly designed infiltration systems include pretreatment, flow control and a stone backfill envelope that can reduce exposure to abrasion.

CMP has a proven service life



Learn more about the durability of steel through the recent NCSPA ALT2 Study - www.ncspa.org

- National Corrugated Steel Pipe Association (NCSPA) service life guidance of 75+ years for certain materials/coatings in recommended environments.
- CMP infiltration systems can be designed to meet HS-20 or greater load requirements with proper depths of cover.
- With low flows, CMP infiltration systems have little susceptibility to abrasion inside the pipe that holds stormwater runoff.
- Various pipe coatings and materials are available to accommodate site-specific needs: Aluminized Steel Type 2 (ALT2), Galvanized, CORLIX® Aluminum, and Polymer Coated.
- CMP infiltration systems are to be surrounded by clean crushed rock to provide increased storage capacity and reduce contact with native soils. The entire system may be wrapped with fabric or liner on the sides and top to help further reduce contact with native soils.
- CMP infiltration systems may be used in wide range of recommended environments. AK Steel Corporation's field studies and technical guidance indicate 75 year service life guidance for 16 gage ALT2 for pH of 5-9 and resistivity greater than 1,500 ohm-cm and 100 year service life guidance for 16 gage ALT2 for pH of 6-8 and resistivity greater than 5,000 ohm-cm.
- Corrosive environments, such as seawater and road/de-icing salt infiltration, acidic minewater, and sanitary sewage, and other environments with pH and resistivity outside of the recommended range may cause premature corrosion and reduce actual service life.
- Infiltration systems are to be inspected and maintained in accordance with Contech's guidelines. See Corrugated Metal Pipe Detention Design Guide for additional information on CMP infiltration systems.

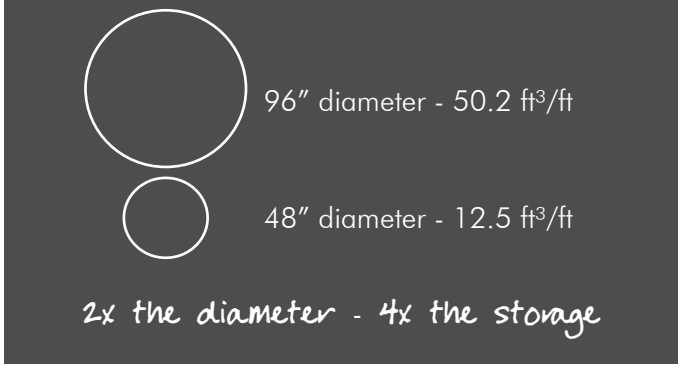
Learn more at www.ContechES.com/cmp-detention

Maximizing Vertical Space: Every Inch Counts

One of the most overlooked advantages of CMP is its ability to maximize vertical storage space.

Increasing the depth of a CMP infiltration system allows for more water storage in the same footprint. For example, doubling the diameter of pipe yields four times as much storage volume in the pipe. This provides a significant cost savings per cubic foot of storage. In addition, more vertical storage space means a smaller footprint, less excavation, and lower project costs.

Contech's Corrugated Metal Pipe Detention systems maximize vertical storage space.



Sizing

Round Pipe – CMP → 6-in to 144-in

Diameter (inches)	Volume (ft³/ft)	Min. Cover Height	Diameter (inches)	Volume (ft³/ft)	Min. Cover Height
12	.78	12″	78	33.2	12″
15	1.22	12″	84	38.5	12″
18	1.76	12″	90	44.2	12″
21	2.40	12″	96	50.3	12″
24	3.14	12″	102	56.8	18″
30	4.9	12″	108	63.6	18″
36	7.1	12″	114	70.9	18″
42	9.6	12″	120	78.5	18″
48	12.6	12″	126	86.6	18″
54	15.9	12″	132	95.0	18″
60	19.6	12″	138	103.9	18″
66	23.8	12″	144	113.1	18″
72	28.3	12″			

The Need for Effective Pretreatment

Infiltration systems have multiple components, and one of the most important is pretreatment. The purpose of a pretreatment device is to prolong the life of the infiltration system by removing debris and sediment that can collect on the invert and within the stone backfill voids. Pretreatment will maintain the efficiency of an infiltration system as well as extend the life cycle, therefore preventing a premature replacement. Pretreatment also offers these additional benefits:

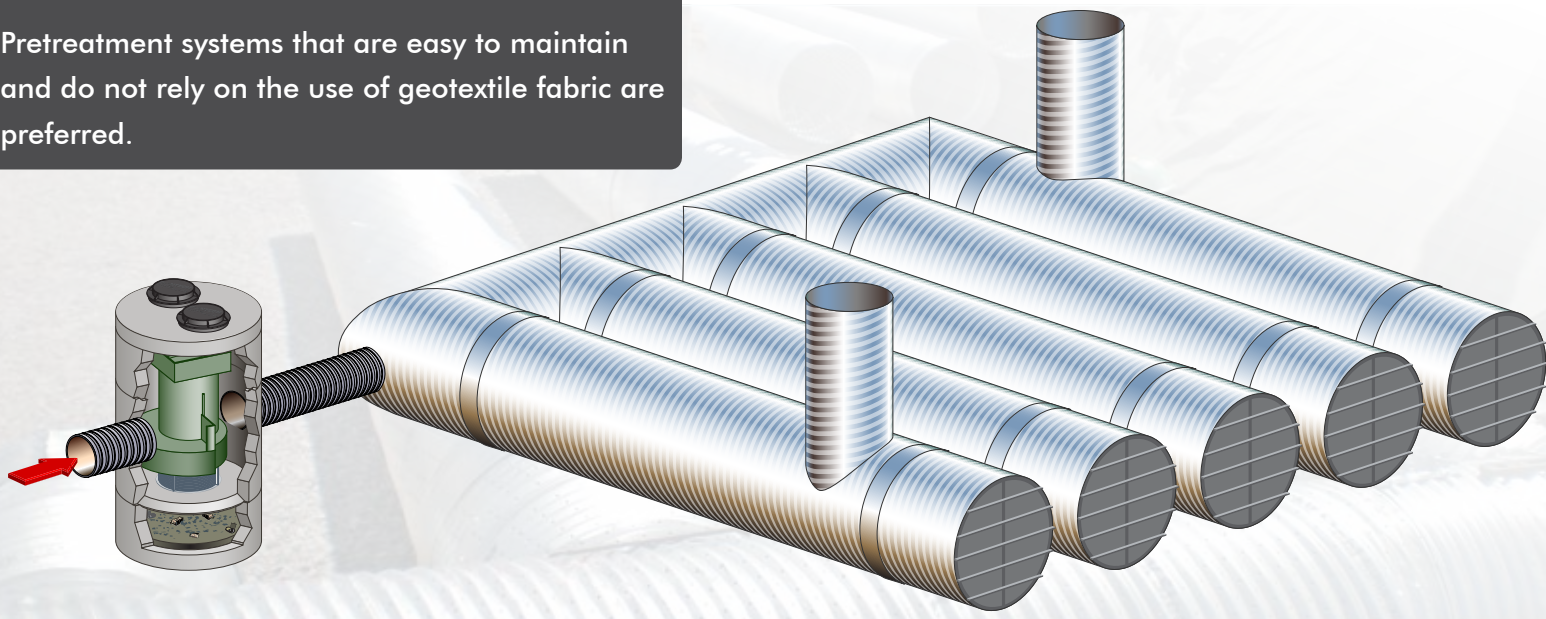
- Easier to clean and maintain compared to the infiltration system itself.
- Cost savings due to the extended service life of the system.
- Removing trash and debris protects downstream outlet control structures from clogging.

Pretreatment Design Considerations

When choosing a pretreatment system, it is important to consider the following:

- Downstream outlet control structures may require protection from a pretreatment device that screens trash and debris.
- Pretreatment system selection depends on pollutant targets. Trash, debris, and larger particles can be removed with hydrodynamic separators. Removing high percentages of fine particles and associated heavy metals and nutrients requires filtration.
- Reduced long term maintenance or replacement cost of the infiltration system can help justify pretreatment construction costs.
- Inlet and pipe layout will influence the number and type of pretreatment systems used. A combination of different systems may be appropriate for the various inlet locations and flows.

Pretreatment systems that are easy to maintain and do not rely on the use of geotextile fabric are preferred.



Learn more at www.ContechES.com/cmp-detention

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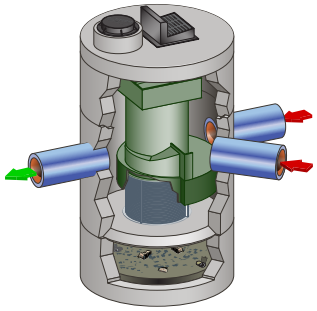
Pretreatment Options

Contech offers a number of pretreatment options, all of which will extend the life of subsurface infiltration systems and improve water quality. The type of system chosen will depend on a number of factors including footprint, soil conditions, local regulations, and the desired level of pretreatment.

CDS provides direct access to cleaning, and the built-in high flow bypass weir eliminates the need for a separate bypass structure.

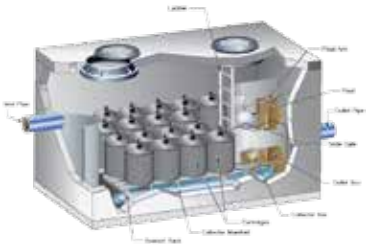


Hydrodynamic Separation

Hydrodynamic Separation (HDS) provides a basic level of pretreatment by capturing and retaining trash and debris, sediment, and oil from stormwater runoff.

CDS®

The CDS uses a combination of swirl concentration and indirect screening and is the only non-blocking screening technology available in an HDS system.



Filtration

Filtration provides a higher level of pretreatment and improved water quality by removing trash and debris, oil, fine solids, and dissolved pollutants such as metals, hydrocarbons, and nutrients.

Filterra® Bioretention System

Filterra is an engineered bioretention system that has been optimized for high volume/flow treatment and high pollutant removal.

The Stormwater Management StormFilter®

The StormFilter system is comprised of a structure that houses rechargeable, media-filled cartridges. The media can be customized to target site-specific pollutants.

Jellyfish® Filter

The Jellyfish filter uses membrane filtration in a compact footprint to remove a high level and a wide variety of stormwater pollutants such as fine particulates, oil, trash and debris, metals, and nutrients.

Alternative Materials for Subsurface Infiltration

There may be instances where alternative materials are needed for subsurface infiltration due to site specific needs.

Plastic Chambers

Plastic chambers are best suited to shallow depth applications; minimum cover is 18 inches, and maximum cover is 96 inches. Some benefits of chambers are:

- Chambers may be beneficial for sites with limited vertical storage.
- Lightweight and installed by hand.
- Heavy equipment is not required to set units into place.
- Centralized stocking locations for short lead times.

Concrete Structures/Vaults

Some concrete structures and vaults are best suited for high loading applications such as railroads or airports. Concrete units are also ideal in corrosive environments or areas with high salinity. Some benefits of concrete structures are:

- Wide range of spans and heights.
- Greater underground infiltration storage in a smaller footprint.
- Ample and easy maintenance access.
- Fast installation.

Project Profiles: CMP Infiltration Systems in Action

Edie and Lew Wasserman Building, UCLA

Westwood, California

- The new six-story, 100,000 square foot Edie and Lew Wasserman Building was built on a very dense site that needed to meet sustainability requirements.
- The design needed to maximize infiltration volume, match existing inverts, and work around existing utilities.
- The stormwater management systems included a CDS pretreatment system and a CMP infiltration system using 57′ of 72″ perforated CMP.
- Perforated CMP was selected to avoid utilities, minimize excavation, meet the City of LA LID requirements, contribute to the building's LEED certification, and to provide space for the buildings "outdoor room" and gardens.

Creative Office Space

El Segundo, California

- A stormwater infiltration solution was needed for a new group of office buildings.
- The owner wanted to maximize the use of the parking area in the urban setting.
- The site had a tight footprint and multiple utility constraints, requiring the design of five separate systems.
- A total of 860 LF of perforated CMP was installed providing of 25,265 CF of storage.
- Perforated CMP was selected for its design flexibility, cost effectiveness, and ease of installation.

City Center Regional Stormwater Facility

Mountlake Terrace, Washington

- The city of Mountlake Terrace, Washington needed a new stormwater retention facility to provide stormwater treatment and downstream flood control.
- There was limited footprint for 80,000 CF of runoff, and the system was required to be very deep, with about 15′ of cover.
- Engineers designed a system consisting of a CDS pretreatment system in front of 800 linear feet of 120″ diameter, perforated, aluminized type 2 CMP that allows the runoff to slowly infiltrate the surrounding soil.
- Perforated CMP was selected for its ability to accommodate the deep bury, the relatively small footprint, and cost effectiveness.

The Right Partner Can Make All the Difference

Regardless of your project's objectives and constraints, our team of stormwater design engineers, regulatory managers, and local stormwater consultants are here to provide you with expert advice and assistance. If your goal is to eliminate or detain runoff, you can rely on Contech for a wide range of subsurface infiltration, detention, and rainwater harvesting solutions. If treatment is needed, our landscape-based biofiltration or subsurface filtration designs can fit into virtually any site and can be tailored to address specific pollutants.

At every stage of your project, count on Contech to provide engineering services including:

- Regulatory guidance and permitting assistance
- Preliminary standard details and/or site specific final CAD drawings and specifications
- Low Impact Development design assistance
- Engineering calculations for hydraulics/hydrology, rainwater harvesting, and detention/retention
- Online "Design Your Own" tools
- Review of preliminary site design, feasibility screening, and layout assistance
- Value engineering – cost estimates and options analysis
- Pre-construction support, project scheduling, and contractor coordination
- Installation and construction support
- Maintenance support:
  - » Guidance manuals
  - » Demonstrations
  - » Qualified contractor identification

The result: an efficient design process, the right product, greater land space savings, and faster permitting. The entire Contech stormwater team welcomes the opportunity to work with you on your stormwater projects.

To get started, please visit www.conteches.com/localresources or call us at 800-338-1122.

Dig Deeper

Find all the information you need at www.ContechES.com, including field and laboratory test results, approvals, brochures, design guides, standard details, and specifications within the product section of our site.

Connect with Us

We're here to make your job easier – and that includes being able to get in touch with us when you need to. Go to www.ContechES.com/ConnectwithContech.

While you're there, be sure to check out our upcoming seminar schedule or request an in-house technical presentation.

Start a Project

If you are ready to begin a project, contact your local representative to get started. Or you can check out our design toolbox for all our online resources at www.ContechES.com/designtoolbox.

Links to Stormwater Tools:

To use the Land Value Calculator, visit:
www.ContechES.com/lvc
(Look under the Stormwater Management section to download the Land Value Calculator)

To use the Design Your Own Detention System tool, visit:
www.ContechES.com/dyods

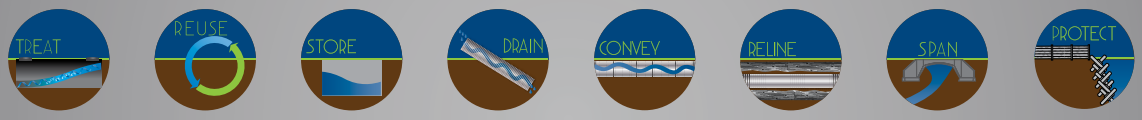
To use the Design Your Own Hydrodynamic Separator tool, visit: www.ContechES.com/dyohds

To use the Rainwater Harvesting Runoff Reduction Calculator tool, visit: www.ContechES.com/rwh-calculator

To use the LID Site Planner , visit:
www.ContechES.com/LIDsiteplanner

CONTECH® ENGINEERED SOLUTIONS

COMPLETE SITE SOLUTIONS



Stormwater Solutions
Helping to satisfy stormwater management requirements on land development projects
- Stormwater Treatment
- Detention/Infiltration
- Rainwater Harvesting
- Biofiltration/Bioretention

Pipe Solutions
Meeting project needs for durability, hydraulics, corrosion resistance, and stiffness
- Corrugated Metal Pipe (CMP)
- Steel Reinforced Polyethylene (SRPE)
- High Density Polyethylene (HDPE)
- Polyvinyl Chloride (PVC)

Structures Solutions
Providing innovative options and support for crossings, culverts, and bridges
- Plate, Precast & Truss bridges
- Hard Armor
- Retaining Walls
- Tunnel Liner Plate

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CMP Infiltration Bro 5M 2/17

CONTECH® ENGINEERED SOLUTIONS

We print our brochures entirely on Forest Stewardship Council certified paper. FSC certification ensures that the paper in our brochures contain fiber from well-managed and responsibly harvested forests that meet strict environmental and socioeconomic standards.

FSC

Retention/Irrigation TC-12

Description

Retention/irrigation refers to the capture of stormwater runoff in a holding pond and subsequent use of the captured volume for irrigation of landscape of natural pervious areas. This technology is very effective as a stormwater quality practice in that, for the captured water quality volume, it provides virtually no discharge to receiving waters and high stormwater constituent removal efficiencies. This technology mimics natural undeveloped watershed conditions wherein the vast majority of the rainfall volume during smaller rainfall events is infiltrated through the soil profile. Their main advantage over other infiltration technologies is the use of an irrigation system to spread the runoff over a larger area for infiltration. This allows them to be used in areas with low permeability soils.

Capture of stormwater can be accomplished in almost any kind of runoff storage facility, ranging from dry, concrete-lined ponds to those with vegetated basins and permanent pools. The pump and wet well should be automated with a rainfall sensor to provide irrigation only during periods when required infiltration rates can be realized. Generally, a spray irrigation system is required to provide an adequate flow rate for distributing the water quality volume (LCRA, 1998). Collection of roof runoff for subsequent use (rainwater harvesting) also qualifies as a retention/irrigation practice.

This technology is still in its infancy and there are no published reports on its effectiveness, cost, or operational requirements. The guidelines presented below should be considered tentative until additional data are available.

California Experience

This BMP has never been implemented in California, only in the Austin, Texas area. The use there is limited to watersheds where no increase in pollutant load is allowed because of the sensitive nature of the watersheds.

Advantages

- Pollutant removal effectiveness is high, accomplished primarily by: (1) sedimentation in the primary storage facility; (2) physical filtration of particulates through the soil profile; (3) dissolved constituents uptake in the vegetative root zone by the soil-resident microbial community.

Design Considerations

- Soil for Infiltration
- Area Required
- Slope
- Environmental Side-effects

Targeted Constituents

☑ Sediment	■
☑ Nutrients	■
☑ Trash	■
☑ Metals	■
☑ Bacteria	■
☑ Oil and Grease	■
☑ Organics	■

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

FLEXSTORM® INLET FILTERS CATCH-IT®

ADS

FLEXSTORM® CATCH-IT® REUSABLE INLET PROTECTION

SPECIFY WITH CONFIDENCE

State DOTs and Municipalities across the country now have a universal structural BMP to address the issue of storm sewer inlet protection: FLEXSTORM CATCH-IT Inlet Filters–the temporary *and* reusable solution.

The FLEXSTORM CATCH-IT system is the preferred choice for temporary inlet protection and storm water runoff control. FLEXSTORM CATCH-IT Inlet Filters will fit any drainage structure and are equipped with high-efficiency filter bags. Whether you're the specifier or the user, it's clear to see how FLEXSTORM CATCH-IT Inlet Filters outperform the competition.

APPLICATIONS:

DOT	Road Construction
Commercial	Parking Lots
Industrial	Maintenance
Residential Developments	

FEATURES:

- **Configurable:** steel frames configured and guaranteed to fit ANY storm drainage structure
- **Adjustable:** although shipped to fit your inlet, rectangular framing may be field adjusted in 1/2" increments if necessary
- **Reusable:** galvanized framing will last year after year in harsh conditions, while geotextile filter bags are easily replaced after several years of use
- **Effective:** works below grade; overflow feature allows streets to drain with full bag; third party testing results of the FX filter bag show 82% Filtration Efficiency
- **Affordable:** low per-unit cost; installs in seconds; easily maintained with Universal Removal Tool (no machinery required)

BENEFITS:

- Reduce jobsite flooding and keep projects running
- Minimize residential complaints with cleaner, dryer streets during all construction phases
- Prevent hazardous road icing conditions by eliminating ponding at curb inlets
- Significantly reduce cleanup costs
- Prevent siltation and pollution of rivers, lakes, and ponds
- Helps prevent fines; NPDES PHASE II Compliant
- Lowest cost alternative for the highest level of Inlet Protection
- Available through 5,000 ADS distributors nationwide
- Ships within 48 hours

ADS Service:
ADS representatives are committed to providing you with the answers to all your questions, including selecting the proper filter, specifications, installation and more. Also try the ADS FLEXSTORM Online Product Configurator at www.inletfilters.com

*The Most **Advanced** Name in Drainage Systems®*

FLEXSTORM CATCH-IT INLET FILTERS SPECIFICATION

IDENTIFICATION

The installer shall inspect the plans and/or worksite to determine the quantity of each drainage structure casting type. The foundry casting number, exact grate size and clear opening size, or other information will be necessary to finalize the FLEXSTORM part number and dimensions. The units are shipped to the field configured precisely to fit the identified drainage structure.

MATERIAL AND PERFORMANCE

The FLEXSTORM Inlet Filter system is comprised of a corrosion resistant steel frame and a replaceable geotextile filter bag attached to the frame with a stainless steel locking band. The filter bag hangs suspended at a distance below the grate that shall allow full water flow into the drainage structure if the bag is completely filled with sediment. The standard Woven Polypropylene FX filter bags are rated for 200 gpm/sqft with a removal efficiency of 82% when filtering a USDA Sandy Loam sediment load. The Post Construction PC filter bags are rated for 137 gpm/sqft and have been 3rd party tested at 99% TSS removal to 110 micron and 97% TPH removal of used motor oil hydrocarbon mix.

INSTALLATION

Remove the grate from the casting or concrete drainage structure. Clean the ledge (lip) of the casting frame or drain- age structure to ensure it is free of stone and dirt. Drop in the FLEXSTORM Inlet Filter through the clear opening and be sure the suspension hangers rest firmly on the inside ledge (lip) of the casting. Replace the grate and confirm it is elevated no more than 1/8", which is the thickness of the steel hangers. For wall mount units, follow instructions for attaching the stainless steel mounting brackets using the provided concrete fasteners.

INSPECTION FREQUENCY

Construction site inspection should occur following each 1/2" or more rain event. Post Construction inspections should occur three times per year (every four months) in areas with mild year round rainfall and four times per year (every three months Feb-Nov) in areas with summer rains before and after the winter snowfall season. Industrial application site inspections (loading ramps, wash racks, maintenance facilities) should occur on a regularly scheduled basis no less than three times per year.

MAINTENANCE GUIDELINES

Empty the filter bag if more than half filled with sediment and debris, or as directed by the Engineer. Remove the grate, engage the lifting bars or handles with the FLEXSTORM Removal Tool, and lift from the drainage structure. Dispose of the sediment or debris as directed by the Engineer or Maintenance Contract in accordance with EPA guidelines.

As an alternative, an industrial vacuum may be used to collect the accumulated sediment. Remove any caked on silt from the sediment bag and reverse flush the bag with medium spray for optimal filtration. Replace the bag if torn or punctured to 1/2" diameter or greater on the lower half of the bag.

FILTER BAG REPLACEMENT

Remove the bag by loosening or cutting off the clamping band. Take the new filter bag, which is equipped with a stainless steel worm drive clamping band, and use a screw driver to tighten the bag around the frame channel. Ensure the bag is secure and that there is no slack around the perimeter of the band.

Lift Handles ease installation and maintenance

Replaceable Sediment Bag

1/8" thick steel hangers& channels; precision stampings **configured to fit each individual casting**

CAD drawings, work instructions and test reports on website: ***www.inletfilters.com***

For more information on FLEXSTORM Inlet Filters and other ADS products, please contact our Customer Service Representatives at 1-800-821-6710
Try the ADS FLEXSTORM Online Product Configurator at www.inletfilters.com.

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- Area Required
- Slope
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☑ Nutrients	■
☑ Trash	■
☑ Metals	■
☑ Bacteria	■
☑ Oil and Grease	■
☑ Organics	■

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

Site Design & Landscape Planning SD-10

Design Objectives

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

Description

Each project site possesses unique topographic, hydrologic, and vegetative features, some of which are more suitable for development than others. Integrating and incorporating appropriate landscape planning methodologies into the project design is the most effective action that can be done to minimize surface and groundwater contamination from stormwater.

Approach

Landscape planning should couple consideration of land suitability for urban uses with consideration of community goals and projected growth. Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Suitable Applications

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

Design Considerations

Design requirements for site design and landscapes planning should conform to applicable standards and specifications of agencies with jurisdiction and be consistent with applicable General Plan and Local Area Plan policies.

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Designing New Installations

Begin the development of a plan for the landscape unit with attention to the following general principles:

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.
- Map and assess land suitability for urban uses. Include the following landscape features in the assessment: wooded land, open unwooded land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a scenic area, recreational area, threatened species habitat, farmland, fish run). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Conserve Natural Areas during Landscape Planning

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.
- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

- Evaluating infiltration opportunities by referring to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination, poor soils, and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas.

Protection of Slopes and Channels during Landscape Design

- Convey runoff safely from the tops of slopes.
- Avoid disturbing steep or unstable slopes.
- Avoid disturbing natural channels.
- Stabilize disturbed slopes as quickly as possible.
- Vegetate slopes with native or drought tolerant vegetation.
- Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
- Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in run-off velocity and frequency caused by the project do not erode the channel.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.
- Line on-site conveyance channels where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. If velocities in the channel are high enough to erode grass or other vegetative linings, riprap, concrete, soil cement, or geo-grid stabilization are other alternatives.
- Consider other design principles that are comparable and equally effective.

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.

Redevelopment may present significant opportunity to add features which had not previously been implemented. Examples include incorporation of depressions, areas of permeable soils, and swales in newly redeveloped areas. While some site constraints may exist due to the status of already existing infrastructure, opportunities should not be missed to maximize infiltration, slow runoff, reduce impervious areas, disconnect directly connected impervious areas.

Other Resources

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

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

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.

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.

Storm Drain Signage SD-13

Design Objectives

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

Description

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

Approach

The stencil or affixed sign contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

Suitable Applications

Stencils and signs alert the public to the destination of pollutants discharged to the storm drain. Signs are appropriate in residential, commercial, and industrial areas, as well as any other area where contributions or dumping to storm drains is likely.

Design Considerations

Storm drain message markers or placards are recommended at all storm drain inlets within the boundary of a development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side. All storm drain inlet locations should be identified on the development site map.

Designing New Installations

The following methods should be considered for inclusion in the project design and show on project plans:

- Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language. Examples include "NO DUMPING

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– DRAINS TO OCEAN" and/or other graphical icons to discourage illegal dumping.

- Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

Note - Some local agencies have approved specific signage and/or storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

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. If the project meets the definition of "redevelopment", then the requirements stated under " designing new installations" above should be included in all project design plans.

Additional Information

Maintenance Considerations

- Legibility of markers and signs should be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner's association should enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards or signs.

Placement

- Signage on top of curbs tends to weather and fade.

- Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.

Supplemental Information

Examples

- Most MS4 programs have storm drain signage programs. Some MS4 programs will provide stencils, or arrange for volunteers to stencil storm drains as part of their outreach program.

Other Resources

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

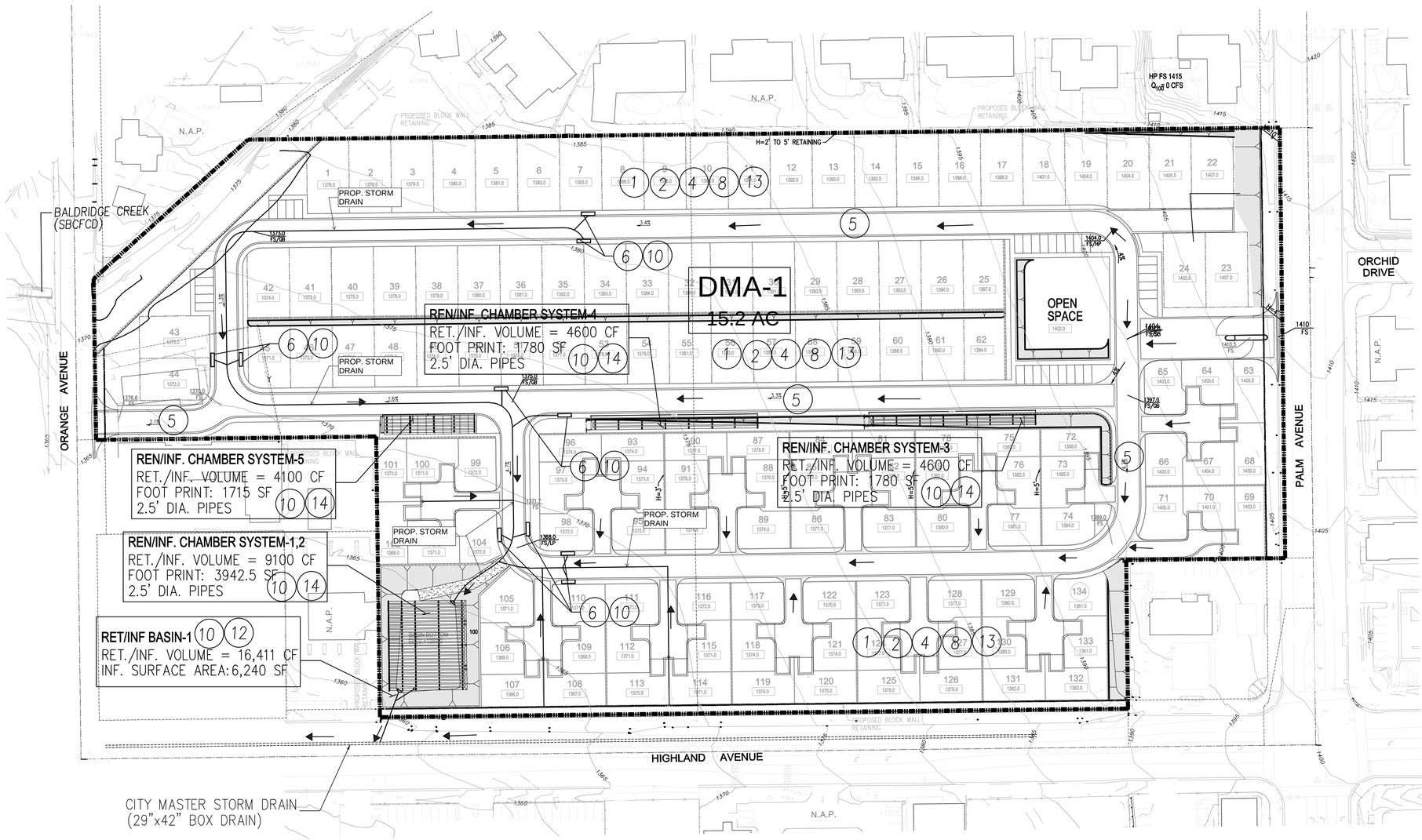
Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

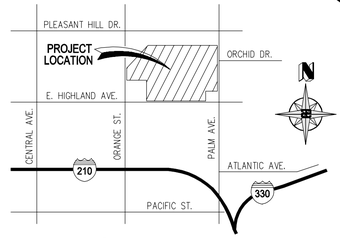
Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

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

Site Plan

(WQMP Exhibit)





VICINITY MAP
NOT TO SCALE

BMP LIST:

1. EDUCATION OF PROPERTY OWNERS
2. HARDSCAPE AREA (CONCRETE PAVING)
3. LANDSCAPE AREA
4. TRAINING/EDUCATION PROGRAM
5. STREET/DRIVE WAY SWEEPING/VACUUMING
6. COMMON AREA CATCH BASIN INSPECTION
7. LANDSCAPE PLANNING (SD-10)
8. ROOF RUNOFF CONTROLS (SD-11)
9. EFFICIENT IRRIGAION (SD-12)
10. STORM DRAIN SIGNAGE (SD-13) PER CASQA STANDARD. DETAIL ON THIS SHEET.
11. TRASH STORAGE AREAS (SD-32) PER DETAIL ON SHEET-2
12. RETENTION/INFILTRATION BASIN-1 (2.5' WATER DEPTH, 0' ROCK DEPTH, 3:1 SIDE)
13. GRATE INLET WITH FILTER INSERT- ADS FLEXSTORM FILTER INSERT. REFER TO DETAIL ON SHEET 2.
14. BELOW SURFACE CONTECH RET/INF CHAMBER SYSTEM-1 TO 5
15. ONSITE STORM DRAIN SYSTEM

DRAINAGE AREA	PROPOSED BMP	AREA (AC)	DESIGN CAPTURE VOL. (CF)	PROVIDED VOL. (CF)	TOTAL MITIGATED VOLUME (CF)
DMA-1	RET/INF BASIN BASIN-1	15.2	40,637	16,411	47,911
	RET/INF CHAMBER SYSTEM-1 TO 5			31,500	

DCV ACHEIVED WITH PROPOSED BMPs: 118%

SCALE: 1"= 60'

GRAPHIC SCALE
60 0 30 60 120 240
(IN FEET)
1 INCH = 60'

PLOT DATE: October 22, 2021 ashafiq

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CITY OF SAN BERNARDINO, CA

WQMP EXHIBIT

HIGHLAND & PALM AVENUE RESIDENTIAL
APN: 0285-211-21 & 0285-211-23

Filename: I:\Warmington Homes\Palm Avenue San Bernardino\DWG's\ENTITLEMENT\EXHIBIT\WQMP\PRELEM WQMP EXHI