City of Victorville

Preliminary Project

Water Quality Management Plan

MOJAVE RIVER WATERSHED

San Bernardino County

For:

Tentative Tract Map No. 20280

Prepared for:

Victorville 88 Estate Partners, LLC.

12671 High Bluff Dr. # 150

San Diego, CA 92130

858-699-7440

Prepared by:

DAVID EVANS
AND ASSOCIATES INC.

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Victorville, CA 92392-2335

(760) 524-9100

1st Submittal Date: July 16, 2019

Revision No. and Date: January 2020

Final Approval Date:_____

Project Owner's Certification

This Mojave River Watershed Water Quality Management Plan (WQMP) has been prepared for Victorville 88 Estate Partners, LLC. , by David Evans & Associates, Inc.. The WQMP is intended to comply with the requirements of the City of Victorville and the Phase II Small MS4 General Permit for the Mojave River Watershed. 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 the Phase II Small MS4 Permit and the intent of San Bernardino County (unincorporated areas of Phelan, Oak Hills, Spring Valley Lake and Victorville) and the incorporated cities of Hesperia and Victorville and the Town of Apple Valley. Once the undersigned transfers its interest in the property, its successors in interest and the city/county/town 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):	xxx-xxxx	Grading Permit Number(s):	TBD
Tract/Parcel Map Number(s):	Tract no. 20280	Building Permit Number(s):	TBD
APN : 0395-221-10; 0395-234-01, 02, 03, ; 0395-245-04,07; 0395-246-07,08; 0395-254-02,03			

Owner's Signature		
Owner Name: Casey Malone		
Title	Manager	
Company	Victorville 88 Estate partners, LLC	
Address	12671 High Bluff Dr. #150, San Diego, CA 92130	
Email	mailto:cmalone@landsingcompanies.com	
Telephone #	858-523-0719	
Signature	Date	

Preparer's Certification

Project Data			
Permit/Application Number(s):	TBD	Grading Permit Number(s):	TBD
Tract/Parcel Map Number(s):	Tract No. 20280	Building Permit Number(s):	TBD
APN : 0395-221-10; 0395-234-01, 02, 03, ; 0395-245-04,07; 0395-246-07,08; 0395-254-02,03			

"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 the California State Water Resources Control Board Order No. 2013-0001-DWQ.

Engineer: Hong Zhang		PE Stamp Below
Title	Sr. Project Engineer	
Company	David Evans & Associates, Inc.	
Address	14297 Cajon Avenue, Suite 101	
Email	hong.zhang@deainc.com	
Telephone #	(760) 524-9100	
Signature		
Date		

Table of Contents

Forms

Section I – Introduction

This WQMP template has been prepared specifically for the Phase II Small MS4 General Permit in the Mojave River Watershed. This location is within the jurisdiction of the Lahontan Regional Water Quality Control Board (LRWQCB). This document should not be confused with the WQMP template for the Santa Ana Phase I area of San Bernardino County.

WQMP preparers must refer to the MS4 Permit for the Mojave Watershed WQMP template and Technical Guidance (TGD) document found at: http://cms.sbcounty.gov/dpw/Land/NPDES.aspx to find pertinent arid region and Mojave River Watershed specific references and requirements.

Section 1 Discretionary Permit(s)

Form 1-1 Project Information

Project Name	Victorville TTM 20280				
Project Owner Contact Name:	Casey Malone				
Mailing Address:	12671 High Bluff Dr. #150 San Diego, CA 92130	E-mail Address:	mailto:cmalone@landsingcompanies.com	Telephone:	858-523-0719
Permit/Application Number(s):	TBD		Tract/Parcel Map Number(s):	Tract No. 20280	
Additional Information/ Comments:					
Description of Project:	The project is located within the City of Victorville, southeast corner of Hopland street and Cahuenga Road. Latitude - 34d 32' 24", Longitude – 117d 20' 17" The project site is proposed to develop as a 74 unit single-family residential housing tract. The development will include both one-and two-story single family houses, construction of streets, driveways, landscape areas, utilities and other appurtenant facilities usually associated with such development. The Project is a "Priority Project and will require a WQMP.				
Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	The Project site is 20.6 acres gross on-site area. Currently, the site is vacant, relatively flat and covered with scattered debris, vegetation consisting of native desert scrub brush, sparse grasses, and scattered Yucca trees. The topography of the site consists of a ridge trending northeast – southwest on the southeast portion of the site with drainage to the northwest. For the proposed condition, the development will be a single family residential tract, will associated with streets, driveways and landscaped areas. The proposed on-site grading will consist of existing drainage pattern. The roof runoff of each lot will directed to the landscaped area, via area drains or swales then leave the lot to the proposed streets. The site runoff will be directed to the curb gutter and collected into the proposed catch basins through insert filters then via storm drain pipe routed to the proposed infiltration/detention basin. The basin is located at the northwest of the development site. It is the existing site runoff outlet location. The proposed infiltration/detention basin will capture and treat storm water runoff for the site, as well as the BMP's practice in this project, the proposed landscaped areas, trees also employed to the accommodate the storm water treatment strategies.				

Section 2 Project Description

2.1 Project Information

The WQMP shall 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.

2.1.1 Project Sizing Categorization

If the Project is greater than 5,000 square feet, and not on the excluded list as found on Section 1.4 of the TGD, the Project is a Regulated Development Project.

If the Project is creating and/or replacing greater than 2,500 square feet but less than 5,000 square feet of impervious surface area, then it is considered a Site Design Only project. This criterion is applicable to all development types including detached single family homes that create and/or replace greater than 2,500 square feet of impervious area and are not part of a larger plan of development.

Form 2.1-1 Description of Proposed Project

1 Regulated Development Project Category (Select all that apply):

☒ #1 New development involving the creation of 5,000 ft² or more of impervious surface collectively over entire site	☐ #2 Significant re-development involving the addition or replacement of 5,000 ft² or more of impervious surface on an already developed site	☐ #3 Road Project – any road, sidewalk, or bicycle lane project that creates greater than 5,000 square feet of contiguous impervious surface	☐ #4 LUPs – linear underground/overhead projects that has a discrete location with 5,000 sq. ft. or more new constructed impervious surface

☐ Site Design Only (Project Total Square Feet > 2,500 but < 5,000 sq.ft.) *Will require source control Site Design Measures. Use the "PCMP" Template. Do not use this WQMP Template.*

2 Project Area (ft2):	897,336	**3** Number of Dwelling Units:	74	**4** SIC Code:	1521

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.*

2.2 Property Ownership/Management

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

Form 2.2-1 Property Ownership/Management

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

Ownership of the project will be held with Victorville 88 Eastate Partners, LLC. Long term maintenance will be the responsibility of the owners. This includes BMP maintenance of efficient irrigation, landscape area and trash, etc until the property is sold or transferred.

Victorville 88 Eastate Partners, LLC.

12671 High Bluff Dr. #150

San Diego, CA 9213

Tel: (858) 523-0719

Contact: Casey Malone

The city of victorville will be formed for long-term maintenance of project stormwater facilites and BMP maintenance which includes catch basin inspection, replacement of insert fillters, and the basin maintenaces.

Refer to Section 5 and Attachment E of this WQMP report for detailed maintenance activities.

2.3 Potential Stormwater Pollutants

Best Management Practices (BMP) measures for pollutant generating activities and sources shall be designed consistent with recommendations from the CASQA Stormwater BMP Handbook for New Development and Redevelopment (or an equivalent manual). Pollutant generating activities must be considered when determining the overall pollutants of concern for the Project as presented in Form 2.3-1.

Determine and describe expected stormwater pollutants of concern based on land uses and site activities (refer to Table 3-2 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 ☐	Wild Bird and Pet Waste, Garbage, Food Waste, Animals, Restroom
Nutrients - Phosphorous	E ☒	N ☐	Fertilizers, Waste, & Garbage, Landscaped area
Nutrients - Nitrogen	E ☒	N ☐	Potential Source – Landscape, Fertilizer, Food Waste, Garbage
Noxious Aquatic Plants	E ☐	N ☒	n/a
Sediment	E ☒	N ☐	Solid materials/ suspended solids from land surface is expected in addition to sediments from erosion, Landscaped area & Undeveloped pads.
Metals	E ☒	N ☐	Metal pollutants expected from vehicles in the street & driveways
Oil and Grease	E ☒	N ☐	Surface area of parking lot and drive-thru will contribute to pollution from leaking vehicles and grease for production
Trash/Debris	E ☒	N ☐	Surface area of streett and driveway will contribute to pollution from leaking vehicles and grease for production
Pesticides / Herbicides	E ☒	N ☐	Expected pollutants from maintenance of the site landscape area is expected.
Organic Compounds	E ☒	N ☐	Use of cleaning solvents/chemicals and maintenace of landscape area will contribute to pollution from organic compounds.
Other: Toxic Organic Compounds	E ☒	N ☐	Expected from parking on the street in general.
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	

Section 3 Site and Watershed Description

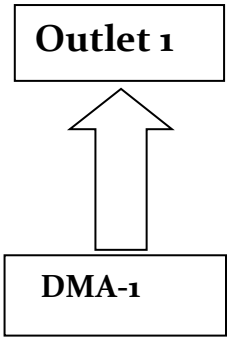
This development has one drainage outlet point at the corner of Cahuenga Road & Hopland Street. An infiltration basin is proposed for the on-site stormwater treatment LID devices. The site will be one Drainage Manage Area (DMA 1), the runoff will be conveyance through catch Basin, storm drain pipe then drain to the infiltration basin. The first treatment BMP's will be the catch basin filter inserts. All runoff will through catch basin, pass the filter inserts then drain to the infiltration basin. The required stormwater treatment volume will be infiltrated to the underground and high flow will be overflow through a CMP Riser to the public storm drain system which is on the Cahuenga Road. For the BMP's & LID locations & details see WQMP Exhibit in Appendix **VI**.

Form 3-1 Site Location and Hydrologic Features

Site coordinates *take GPS measurement at approximate center of site*	Latitude 34°32'24"N	Longitude 117°20'17"W	Thomas Bros Map page

1 San Bernardino County climatic region: ☒ Desert

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	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA
DA1 DMA C flows to DA1 DMA A	*Ex. Bioretention overflow to vegetated bioswale with 4' bottom width, 5:1 side slopes and bed slope of 0.01. Conveys runoff for 1000' through DMA 1 to existing catch basin on SE corner of property*
DA1 DMA 1 to Outlet 1	***Site surface runoff will be directed into proposed catch basins. All catch Basin design with filter inserts for first treatment, after though the filter insert the runoff will drain to the on-site storm drain pipe then flow to the proposed Infiltration basin, which is the proposed LID devices for the development. The high flow will overflow to a CMP Standing pipe then flow to public storm drain system on Cahuenga Road, the storm drain connecting point- outlet 1.*** ***For high flow hydrologic analysis referred to Hydrology Study of the project.***

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1

For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA C	DMA D
1 DMA drainage area (ft^2)	8979,336			
2 Existing site impervious area (ft^2)	0			
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	2			
4 Hydrologic soil group *Refer to County Hydrology Manual Addendum for Arid Regions – http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf*	C & B			
5 Longest flowpath length (ft)	1,860			
6 Longest flowpath slope (ft/ft)	0.023			
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Natural Cover 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***	Poor			

Form 3-3 Watershed Description for Drainage Area

Receiving waters Refer to SWRCB site: http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml	Mojave River
Applicable TMDLs *http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml*	None
303(d) listed impairments *http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml*	Mojave River Mojave Forks Reservoir Outlet to Upper Narrows • Fluoride
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool –* *http://sbcounty.permitrack.com/WAP*	• Southwestern Willow Flycatcher • Desert Tortoise Habitat Cat 3 • Mojave Ground Squirrel
Hydromodification Assessment	☒ Yes *Complete Hydromodification Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-9 in submittal* ☐ No

Section 4 Best Management Practices (BMP)

4.1 Source Control BMPs and Site Design BMP Measures

The information and data in this section are required for both Regulated Development and Site Design Only Projects. Source Control BMPs and Site Design BMP Measures are the basis of site-specific pollution management.

4.1.1 Source Control BMPs

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.

The identified list of source control BMPs correspond to the CASQA Stormwater BMP Handbook for New Development and Redevelopment.

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	☒	☐	General information will be provided to the owner on housekeeping practices that contribute to the protection of storm water. The property owners will be familiar with the contents of this document and the BMPs used on the site. The owners will provide education materials to tenants (if applicable) on BMPs and housekeeping practices that contribute to the protection of storm water
N2	Activity Restrictions	☒	☐	The property owner shall control the discharge of the stormwater pollutants from this site through activity restrictions. Restrictions shall be provided to all new occupants, or other mechanism upon first occupancy of the lease space and annually thereafter. Enforcement of activity restriction shall be on going during the operation of the project site
N3	Landscape Management BMPs	☒	☐	The property owner and landscape maintenance contractors will practice on going landscape maintenance BMPs consistent with applicable local ordinances and will regular inspect the irrigation system for signs of erosion or sediment debris buildup and clean/repair as needed.
N4	BMP Maintenance	☒	☐	The City of Victorville will maintain post construction public BMPs consistent with the O&M plan described in section 5 of this document (Form 5-1). The property owner shall maintain BMPs on lot.
N5	Title 22 CCR Compliance (How development will comply)	☒	☐	Storage of hazardous materials or waste on site must comply will all Title 22 CCR regulations
N6	Local Water Quality Ordinances	☒	☐	The owners shall comply with the City of Victorville's Stormwater Ordinance through the implementation of BMPs.

Form 4.1-1 Non-Structural Source Control BMPs				
N7	Spill Contingency Plan	☒	☐	Building operators shall prepare specific plans based on materials onsite for the cleanup of spills. Plans shall mandate stock piling of cleanup materials, notification of agencies, disposal, documentation, etc. Storage shall comply with Hazmat Regulations and any required contingency plans
N8	Underground Storage Tank Compliance	☐	☒	N/A
N9	Hazardous Materials Disclosure Compliance	☐	☒	N/A

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	☒	☐	The site shall conform to the building code requirements for fire safety implementation and all fire code requirements, regardless of product stored.
N11	Litter/Debris Control Program	☒	☐	The owner shall be responsible for trash and litter to be swept from the site and dumped into a City approved dumpster with lids. The owner shall contract with the city of Victorville or local trash collector to empty dumpsters on a weekly basis. Additionally ground maintenance personnel shall police the grounds for any litter
N12	Employee Training	☒	☐	The owners will ensure and familiar with onsite BMPs and necessary maintenance required by the city. Owner will check with the City and county at least once a year to obtain new updated educational materials and provide these materials to tenants (if applicable).
N13	Housekeeping of Loading Docks	☐	☒	No Loading Docks in this project
N14	Catch Basin Inspection Program	☒	☐	Catch basins shall be inspected visually on a monthly basis; the entire storm drain system shall be inspected and cleaned prior to the start of the rainy season by the city of Victorville.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	Street & Parking areas will be swept regularly using a vacuum assisted sweeper. Frequency will depend on waste accumulations with a minimum of once per month and prior to the start of the rainy season.
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	Project is not classified as a public agency project

N17	Comply with all other applicable NPDES permits	☒	☐	The developer will comply with the California statewide Construction General Permit during construction and all future occupants of the site shall comply with the requirements of the statewide General Stormwater Permit.

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)	☒	☐	All storm drain inlets shall have Stenciling illustrating an anti-dumping message.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	This development does not include the storage of materials outdoors.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	Trash storage areas shall be located away from storm drain inlets. All trash dumpsters/containers will be required to have a lid on at all times to prevent direct precipitation and prevent any rainfall from entering containers.
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☒	☐	Irrigation systems will be designed to each landscaped area's specific water need. Irrigation controls shall include rain-triggered shutoff devices to prevent irrigation after precipitation.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	Landscaped areas shall be below a minimum of 1" to 2" below the top of curb or walk.
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☐	☒	No protect slopes proposed within new development
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	No docks proposed within new development
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	No vehicle wash areas proposed within new development
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No processing areas proposed within new development

S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☒	☐	Cover of enclose area that would be most significant sources of pollutants would likely contribute to the street and the storm conveyance system.

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 wash area on site. Owner will not allow outdoor processing area on this site
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	No fueling area onsite. Owner will not allow fueling area on this site.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	Not a hillside project
S14	Wash water control for food preparation areas	☐	☒	No food preparation area on site
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	No community car wash racks on site

4.1.2 Site Design BMPs

As part of the planning phase of a project, the site design practices associated with new LID requirements in the Phase II Small MS4 Permit must be considered. Site design BMP measures can result in smaller Design Capture Volume (DCV) to be managed by both LID and hydromodification control BMPs by reducing runoff generation.

As is stated in the Permit, it is necessary to evaluate site conditions such as soil type(s), existing vegetation and flow paths will influence the overall site design.

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 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: Landscaped areas and trees are increase the pervious area and decrease impervious areas.
Maximize natural infiltration capacity; Including improvement and maintenance of soil: Yes ☒ No ☐ Explanation: Infiltration/detention basin system bottom with natural soils, no compaction.
Preserve existing drainage patterns and time of concentration: Yes ☐ No ☒ Explanation: After development the time of concentration direction will flow the proposed design drainage Patten.
Disconnect impervious areas. Including rerouting of rooftop drainage pipes to drain stormwater to storage or infiltration BMPs instead of to storm drain : Yes ☒ No ☐ Explanation: Landscaped area next to buildings are disconnect the impervious areas.
Use of Porous Pavement.: Yes ☐ No ☒ Explanation: This project is not proposed porous pavement.
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation: There is no significant existing vegetation and sensitive areas to protect.
Re-vegetate disturbed areas. Including planting and preservation of drought tolerant vegetation. : Yes ☐ No ☒ Explanation: There is no re-vegetation areas on site.

Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: There is no compactions under the bottom of underground infiltration system.
Utilize naturalized/rock-lined drainage swales in place of underground piping or imperviously lined swales: Yes ☐ No ☒ Explanation: Not apply to this project
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☐ No ☒ Explanation: The landscaped areas are too small.
Use of Rain Barrels and Cisterns, Including the use of on-site water collection systems.: Yes ☐ No ☒ Explanation: Using basin for LID devices, No Barrels are signed to the system.
Stream Setbacks. Includes a specified distance from an adjacent steam: : Yes ☐ No ☒ Explanation: No streams near the project.

It is noted that, in the Phase II Small MS4 Permit, site design elements for green roofs and vegetative swales are required. Due to the local climatology in the Mojave River Watershed, proactive measures are taken to maximize the amount of drought tolerant vegetation. It is not practical in this region to have green roofs or vegetative swales. As part of site design the project proponent should utilize locally recommended vegetation types for landscaping. Typical landscaping recommendations are found in following local references:

San Bernardino County Special Districts:

Guide to High Desert Landscaping -
http://www.specialdistricts.org/Modules/ShowDocument.aspx?documentid=795

Recommended High-Desert Plants -
http://www.specialdistricts.org/modules/showdocument.aspx?documentid=553

Mojave Water Agency:

Desert Ranch: http://www.mojavewater.org/files/desertranchgardenprototype.pdf

Summertree: http://www.mojavewater.org/files/Summertree-Native-Plant-Brochure.pdf

Thornless Garden: http://www.mojavewater.org/files/thornlessgardenprototype.pdf

Mediterranean Garden: http://www.mojavewater.org/files/mediterraneangardenprototype.pdf

Lush and Efficient Garden: http://www.mojavewater.org/files/lushandefficientgardenprototype.pdf

Alliance for Water Awareness and Conservation (AWAC) outdoor tips – http://hdawac.org/save-outdoors.html

4.2 Treatment BMPs

After implementation and design of both Source Control BMPs and Site Design BMP measures, any remaining runoff from impervious DMAs must be directed to one or more on-site, treatment BMPs (LID or biotreatment) designed to infiltrate, evaportranspire, and/or bioretain the amount of runoff specified in Permit Section E.12.e (ii)(c) Numeric Sizing Criteria for Storm Water Retention and Treatment.

4.2.1 Project Specific Hydrology Characterization

The purpose of this section of the Project WQMP is to establish targets for post-development hydrology based on performance criteria specified in Section E.12.e.ii.c and Section E.12.f of the Phase II Small 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 from hydromodification.

If the project has more than one outlet for stormwater runoff, then complete additional versions of these forms for each DA / outlet.

It is noted that in the Phase II Small MS4 Permit jurisdictions, the LID BMP Design Capture Volume criteria is based on the 2-year rain event. The hydromodification performance criterion is based on the 10-year rain event.

Methods applied in the following forms include:

- For LID BMP Design Capture Volume (DCV), San Bernardino County requires use of the P_6 method (Form 4.2-1) For pre- and post-development hydrologic calculation, San Bernardino County 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 hydromodification performance criteria.

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

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1)		
[1] Project area DA 1 (ft^2): 897,336	[2] Imperviousness after applying preventative site design practices (Imp%): 50%	[3] Runoff Coefficient (Rc): _0.339 *$R_c = 0.858(Imp\%)^{\wedge 3} - 0.78(Imp\%)^{\wedge 2} + 0.774(Imp\%) + 0.04$*
[4] Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.37 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
[5] Compute P_6, Mean 6-hr Precipitation (inches): 0.46 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (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): 22,780 ft^3 *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*		

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

Is the change in post- and pre- condition flows captured on-site? : Yes ☒ No ☐

If "Yes", then complete Hydromodification assessment of site hydrology for 10yr 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- Addendum 1)*

If "No," then proceed to Section 4.3 BMP Selection and Sizing

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	[1] 79,932	[2] 15.55	[3] 13.01
Post-developed	[4] 86,859	[5] 11.96	[6] 14.87
Difference	[7] *6,927* *Item 4 – Item 1*	[8] *3.59* *Item 2 – Item 5*	[9] *1.86* *Item 6 – Item 3*
Difference (as % of pre-developed)	[10] *8.7%* *Item 7 / Item 1*	[11] *23.1%* *Item 8 / Item 2*	[12] *14.3%* *Item 9 / Item 3*

Note: This table results based on the CivilD computer analysis. For hydromodification Assessment detail & calculation See Appendix I of this report.

4.3 BMP Selection and Sizing

Complete the following forms for each project site DA to document that the proposed treatment (LID/Bioretention) BMPs conform to the project DCV developed to meet performance criteria specified in the Phase II Small 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 Phase II Small MS4 Permit (see Section 5.3 in the TGD for WQMP). The forms compute the following for on-site LID BMP:

- Site Design Measures (Form 4.3-2)
- Retention and Infiltration BMPs (Form 4.3-3) or
- Biotreatment BMPs (Form 4.3-4).

> Please note that the selected BMPs may also be used as dual purpose for on-site, hydromodification mitigation and management.

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 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 Form 4.3-2 to determine the feasibility of applicable Site Design 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 Site Design 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 site design, retention and/or infiltration BMPs is unable to mitigate the entire DCV, then the remainder of the volume-based performance criteria that cannot be achieved with site design, retention and/or infiltration BMPs must be managed through biotreatment BMPs. If biotreatment BMPs are used, then they must be sized to provide equivalent effectiveness based on Template Section 4.3.4.

4.3.1 Exceptions to Requirements for Bioretention Facilities

Contingent on a demonstration that use of bioretention or a facility of equivalent effectiveness is infeasible, other types of biotreatment or media filters (such as tree-box-type biofilters or in-vault media filters) may be used for the following categories of Regulated Projects:

1) Projects creating or replacing an acre or less of impervious area, and located in a designated pedestrian-oriented commercial district (i.e., smart growth projects), and having at least 85% of the entire project site covered by permanent structures;

2) Facilities receiving runoff solely from existing (pre-project) impervious areas; and

3) Historic sites, structures or landscapes that cannot alter their original configuration in order to maintain their historic integrity.

Form 4.3-1 Infiltration BMP Feasibility (DA 1)

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

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

If Yes, Provide basis: (attach)

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

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

If Yes, Provide basis: (attach)

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

If Yes, Provide basis: (attach)

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

If Yes, Provide basis: (attach)

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

If Yes, Provide basis: (attach)

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

If Yes, Provide basis: (attach)

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

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

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

4.3.2 Site Design BMP

Section E.12.e. of the Small Phase II MS4 Permit emphasizes the use of LID preventative measures; and the use of Site Design Measures reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable Site Design Measures 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 Site Design BMPs. If a project cannot feasibly meet BMP sizing requirements or cannot fully address hydromodification, feasibility of all applicable Site Design BMPs 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 BMP. Refer to Section 5.4 in the TGD for more detailed guidance.

Form 4.3-2 Site Design BMPs (DA 1)

1 Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP: Yes ☒ No ☐ *If yes, complete Items 2-5; If no, proceed to Item 6*	DA 1 DMA A 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)	448,668		
3 Ratio of pervious area receiving runoff to impervious area	0.50		
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*	9,347		
5 Sum of retention volume achieved from impervious area dispersion (ft^3): 9,347 *$V_{retention}$ =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) (min. 0.5 ft.)			
9 Surface area of amended soil/gravel (ft^2)			
10 Average depth of amended soil/gravel (ft) (min. 1 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 BMPs (DA 1)

14 Implementation of Street Trees: Yes ☒ No ☐ *If yes, complete Items 14-18. If no, proceed to Item 19*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
15 Number of Street Trees	250		
16 Average canopy cover over impervious area (ft^2)	7,065		
17 Runoff volume retention from street trees (ft^3) $V_{retention}$ *= Item 15 * Item 16 * (0.05/12) assume runoff retention of 0.05 inches*	7,359		
18 Runoff volume retention from street tree BMPs (ft^3): 7,359 $V_{retention}$ *= Sum of Item 17 for all BMPs*			
19 Total Retention Volume from Site Design BMPs: 16,706 ft^3 *Sum of Items 5, 13 and 18*			

4.3.3 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 C 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 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).

4.3.3.1 Allowed Variations for Special Site Conditions

The bioretention system design parameters of this Section may be adjusted for the following special site conditions:

1) Facilities located within 10 feet of structures or other potential geotechnical hazards established by the geotechnical expert for the project may incorporate an impervious cutoff wall between the bioretention facility and the structure or other geotechnical hazard.

2) Facilities with documented high concentrations of pollutants in underlying soil or groundwater, facilities located where infiltration could contribute to a geotechnical hazard, and facilities located on elevated plazas or other structures may incorporate an impervious liner and may locate the underdrain discharge at the bottom of the subsurface drainage/storage layer (this configuration is commonly known as a “flow-through planter”).

3) Facilities located in areas of high groundwater, highly infiltrative soils or where connection of underdrain to a surface drain or to a subsurface storm drain are infeasible, may omit the underdrain.

4) Facilities serving high-risk areas such as fueling stations, truck stops, auto repairs, and heavy industrial sites may be required to provide adequate pretreatment to address pollutants of concern unless these high-risk areas are isolated from storm water runoff or bioretention areas with no chance of spill migration.

.

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

1 Remaining LID DCV not met by site design BMP (ft^3): *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item19*

BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs*	DA 1 DMA 1 BMP Type Infiltration Basin	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix C of the TGD for WQMP for minimum requirements for assessment methods*	2.02		
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*	2		
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*	1.01		
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*	48		
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*	4		
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*	2.2		
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*	7,344		
9 Amended soil depth, d_{media} (ft) *Only included in certain BMP types,*	0		
10 Amended soil porosity	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		
12 Gravel porosity	0		
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*	3		
14 Above Ground Retention Volume (ft^3) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*	25,520*		
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*	n/a		

16 Total Retention Volume from LID Infiltration BMPs: 25,520 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 100% *Retention% = Item 16 / Form 4.2-1 Item 7*

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

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

** Per Basin Design Volume*

4.3.4 Biotreatment BMP N/A

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

Use Form 4.3-4 to summarize the potential for volume based and/or flow based biotreatment options to biotreat the remaining unmet LID DCV. Biotreatment computations are included as follows:

- Use Form 4.3-5 to compute biotreatment in small volume based biotreatment BMP (e.g. bioretention w/underdrains);
- Use Form 4.3-6 to compute biotreatment in large volume based biotreatment BMP (e.g. constructed wetlands);
- Use Form 4.3-7 to compute sizing criteria for flow-based biotreatment BMP (e.g. bioswales)

Form 4.3-4 Selection and Evaluation of Biotreatment BMP (DA 1)

1 Remaining LID DCV not met by site design , or infiltration, BMP for potential biotreatment (ft^3): *Form 4.2-1 Item 7 - Form 4.3-2 Item 19 – Form 4.3-3 Item 16*	List pollutants of concern *Copy from Form 2.3-1.*	
2 Biotreatment BMP Selected *(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)*	Volume-based biotreatment *Use Forms 4.3-5 and 4.3-6 to compute treated volume*	Flow-based biotreatment *Use Form 4.3-7 to compute treated flow*
	☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention	☐ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment
3 Volume biotreated in volume based biotreatment BMP (ft^3): *Form 4.3-5 Item 15 + Form 4.3-6 Item 13*	**4** Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft^3): *Item 1 – Item 3*	**5** Remaining fraction of LID DCV for sizing flow based biotreatment BMP: % *Item 4 / Item 1*
6 Flow-based biotreatment BMP capacity provided (cfs): *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)*		
7 Metrics for MEP determination: • Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.*		

4.3.5 Conformance Summary

Complete Form 4.3-8 to demonstrate how on-site LID DCV is met with proposed site design, infiltration, 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 4.3-8 Conformance Summary and Alternative Compliance Volume Estimate (DA 1)

1 Total LID DCV for the Project DA-1 (ft^3): 22,780 *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design BMP (ft^3): 16,706 *Copy Item18 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): 25,520 *Copy Item 16 in Form 4.3-3*

4 On-site biotreatment with volume based biotreatment BMP (ft^3): 0 *Copy Item 3 in Form 4.3-4*

5 Flow capacity provided by flow based biotreatment BMP (cfs): 0 *Copy Item 6 in Form 4.3-4*

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

- Full retention of LID DCV with site design or infiltration 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; therefore biotreatment BMP provides 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

7 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 Site Design, retention and infiltration, , and biotreatment BMPs provide less than full LID DCV capture: ☐
  Checked yes if Form 4.3-4 Item 7is checked yes, Form 4.3-4 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)%*

- Facilities, or a combination of facilities, of a different design than in Section E.12.e.(ii)(f) may be permitted if all of the following Phase II Small MS4 General Permit 2013-0001-DWQ 55 February 5, 2013 measures of equivalent effectiveness are demonstrated:
  1) Equal or greater amount of runoff infiltrated or evapotranspired; ☐
  2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment; ☐
  3) Equal or greater protection against shock loadings and spills; ☐
  4) Equal or greater accessibility and ease of inspection and maintenance. ☐

4.3.6 Hydromodification Control BMP

Use Form 4.3-9 to compute the remaining runoff volume retention, after Site Design BMPs are implemented, needed to address hydromodification, and the increase in time of concentration and decrease in peak runoff necessary to meet targets for protection of waterbodies with a potential hydromodification. Describe the proposed hydromodification treatment control BMP. Section 5.6 of the TGD for WQMP provides additional details on selection and evaluation of hydromodification control BMP.

Form 4.3-9 Hydromodification Control BMPs (DA 1)

1 Volume reduction needed for hydromodification performance criteria (ft^3): *0* *(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1*	**2** On-site retention with site design and infiltration, BMP (ft^3): 25,520 *Sum of Form 4.3-8 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 hydromodification volume reduction*
3 Remaining volume for hydromodification volume capture (ft^3): 0 *Item 1 – Item 2*	**4** Volume capture provided by incorporating additional on-site BMPs (ft^3):

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

If yes, hydromodification 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 BMP ☐
- 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 ☐

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

If yes, hydromodification 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 retention BMPs ☐

4.4 Alternative Compliance Plan (if applicable)

Describe an alternative compliance plan (if applicable) for projects not fully able to infiltrate, 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 Designs — Facilities, or a combination of facilities, of a different design than in Permit Section E.12.e.(ii)(f) may be permitted if all of the following measures of equivalent effectiveness are demonstrated:

1) Equal or greater amount of runoff infiltrated or evapotranspired;

2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment;

3) Equal or greater protection against shock loadings and spills;

4) Equal or greater accessibility and ease of inspection and maintenance.

The Project Proponent will need to obtain written approval for an alternative design from the Lahontan Regional Water Board Executive Officer (see Section 6 of the TGD for WQMP).

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

All BMPs 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 a Maintenance Agreement. The Maintenance Agreement must also be attached to the WQMP.

Note that at time of Project construction completion, the Maintenance Agreement must be completed, signed, notarized and submitted to the County Stormwater Department

Form 5-1 BMP Inspection and Maintenance
(List BMP's Below will be maintened by the City of Victorwill DWP)

BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
Infiltration/ Detention Basin	By the City of Victorville	Inspect the basin, for accumulated sediment and debris levels and cleanout solids when > 6" build up occurs. Inspect for standing water with 48 hours of heavy rain events to ensure proper drawdown. Clean and flush outlet pipe to restore free drainage.	Annually, and after heavy rains
Signage & Stencil	By the City of Victorville	Clean the stencil/signage surface to remove any excess dirt. Re-paint if necessary.	Annually
Catch basins /Insert filter	By the City of Victorville	Inspect catchment area for an excessive sediment, trash, and/or debris accumulation on surface. Inspect inlet for excessive sediments, trash, and/or debris accumulation. Litter, leaves and debris should be removed from the insert filter reduce risk of outlet clogging, replace the insert filters as needed	Annually, and after heavy rai
Litter Control	By the City of Victorville	Vacuum-sweep streets to remove potential stormwater contamination before anticipated storm events.	Weekly/Monthly

Form 5-1 BMP Inspection and Maintenance (List BMP's Below will be maintened by the Hom Owners)			
BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
Landscape Areas	By owner & future owner	Implement - Mowing, Trimming, Pruning practices to prevent discharges of landscape waste into on-site retention structures. Control fertilizer, herbicide & pesticide applications to prevent stormwater contamination	Weekly
Irrigation System	By owner & future owner	Check and repair the irrigation system property functioning and verify there are no leaks or runoff from landscape areas. Adjust irrigation heads and system run time as necessary to prevent overwatering of vegetation, overspray or run-off from landscape	Weekly
Trash Enclosures	By owner & future owner	Empty trash receptacles. Clean the areas around enclosures by sweeping and /or mopping to prevent discharges of cleanup water.	Weekly

Section 6 WQMP Attachments

6.1. Site Plan and Drainage Plan

(See WQMP Exhibit In Appedix IV)

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 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

Appendix I

Hydromodification Calculations

10-Year, 24-hour Hydromodification Assessment Summary Table:

Condition	Drainage area (ac)	Ap	Curve Number CN	Soil Group (HSG)	Rainfall (10-yr. 24-hr.)	Land Cover Type	Tc (min.)	Peak flow (cfs)	Runoff Volume (cu-ft)
Pre-Development	19.7	1	86.00	C & B	2.16"	Barren	15.55	13.01	79,932
Post-Developemnt	19.7	0.5	69.00	C & B	2.16"	Residential (5-7 dew/ac)	11.96	14.87	86,859
Defference			-	-	-	-	3.59	1.86	6,927
Defference (as % of pre-development)			-	-	-	-	23.1%	14.3%	8.7%

Note: Runoff Increased volume 6,927 cu-ft is less than DCV volume 22,780 cu-ft, so the DCV volume is governing the stormwater treatment volume for the LID requirement.

Rational Hydrology Method for Time of Concentration Calculation

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

Study date 01/30/20

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

Program License Serial Number 4009

UN METHOD FOR HCOC CALCULATION
TRACT NO. 20280
POST-DEVELOPMENT CONDITION
10-YEAR, 24-HOUR STORM

Storm Event Year = 10

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 10		
19.70	1	0.63
Rainfall data for year 10		
19.70	6	1.28
Rainfall data for year 10		
19.70	24	2.16

++

******** 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)
86.0	86.0	19.70	1.000	0.265	1.000	0.265

Area-averaged adjusted loss rate Fm (In/Hr) = 0.265

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

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC2)	S	Pervious Yield Fr
19.70	1.000	86.0	86.0	1.63	0.450

Area-averaged catchment yield fraction, Y = 0.450
Area-averaged low loss fraction, Yb = 0.550
User entry of time of concentration = 0.263 (hours)
++
Watershed area = 19.70(Ac.)
Catchment Lag time = 0.210 hours
Unit interval = 15.000 minutes
Unit interval percentage of lag time = 118.8213
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.265(In/Hr)
Average low loss rate fraction (Yb) = 0.550 (decimal)
VALLEY UNDEVELOPED S-Graph Selected
Computed peak 5-minute rainfall = 0.298(In)
Computed peak 30-minute rainfall = 0.511(In)
Specified peak 1-hour rainfall = 0.629(In)
Computed peak 3-hour rainfall = 0.972(In)
Specified peak 6-hour rainfall = 1.280(In)
Specified peak 24-hour rainfall = 2.160(In)

Rainfall depth area reduction factors:
Using a total area of 19.70(Ac.) (Ref: fig. E-4)

5-minute factor = 0.999 Adjusted rainfall = 0.298(In)
30-minute factor = 0.999 Adjusted rainfall = 0.510(In)
1-hour factor = 0.999 Adjusted rainfall = 0.628(In)
3-hour factor = 1.000 Adjusted rainfall = 0.972(In)
6-hour factor = 1.000 Adjusted rainfall = 1.280(In)
24-hour factor = 1.000 Adjusted rainfall = 2.160(In)

U n i t H y d r o g r a p h
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Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 79.42 (CFS))	
1	24.857	19.740
2	73.609	38.717
3	87.022	10.652
4	93.107	4.832
5	96.510	2.703
6	98.482	1.566
7	100.000	1.206

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.4146	0.0475
2	0.5104	0.0272
3	0.5765	0.0200
4	0.6284	0.0162

5	0.6867	0.0186
6	0.7383	0.0166
7	0.7849	0.0151
8	0.8276	0.0139
9	0.8673	0.0129
10	0.9043	0.0121
11	0.9392	0.0114
12	0.9723	0.0108
13	1.0036	0.0103
14	1.0336	0.0098
15	1.0623	0.0094
16	1.0898	0.0091
17	1.1163	0.0087
18	1.1419	0.0084
19	1.1667	0.0082
20	1.1906	0.0079
21	1.2139	0.0077
22	1.2365	0.0075
23	1.2585	0.0073
24	1.2799	0.0071
25	1.2998	0.0066
26	1.3192	0.0064
27	1.3381	0.0063
28	1.3566	0.0061
29	1.3747	0.0060
30	1.3924	0.0059
31	1.4097	0.0057
32	1.4267	0.0056
33	1.4434	0.0055
34	1.4598	0.0054
35	1.4758	0.0053
36	1.4916	0.0052
37	1.5071	0.0051
38	1.5224	0.0051
39	1.5374	0.0050
40	1.5521	0.0049
41	1.5667	0.0048
42	1.5810	0.0047
43	1.5951	0.0047
44	1.6090	0.0046
45	1.6227	0.0045
46	1.6362	0.0045
47	1.6495	0.0044
48	1.6627	0.0044
49	1.6757	0.0043
50	1.6885	0.0043
51	1.7012	0.0042
52	1.7137	0.0042
53	1.7261	0.0041
54	1.7383	0.0041
55	1.7504	0.0040
56	1.7623	0.0040
57	1.7741	0.0039
58	1.7858	0.0039
59	1.7974	0.0038
60	1.8088	0.0038
61	1.8201	0.0038
62	1.8313	0.0037
63	1.8424	0.0037

64	1.8534	0.0036
65	1.8643	0.0036
66	1.8751	0.0036
67	1.8857	0.0035
68	1.8963	0.0035
69	1.9068	0.0035
70	1.9172	0.0035
71	1.9275	0.0034
72	1.9377	0.0034
73	1.9478	0.0034
74	1.9578	0.0033
75	1.9678	0.0033
76	1.9776	0.0033
77	1.9874	0.0033
78	1.9971	0.0032
79	2.0067	0.0032
80	2.0163	0.0032
81	2.0258	0.0032
82	2.0352	0.0031
83	2.0445	0.0031
84	2.0538	0.0031
85	2.0630	0.0031
86	2.0721	0.0030
87	2.0812	0.0030
88	2.0902	0.0030
89	2.0991	0.0030
90	2.1080	0.0030
91	2.1168	0.0029
92	2.1255	0.0029
93	2.1342	0.0029
94	2.1428	0.0029
95	2.1514	0.0029
96	2.1599	0.0028

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0085	0.0047	0.0038
2	0.0086	0.0047	0.0039
3	0.0087	0.0048	0.0039
4	0.0088	0.0048	0.0040
5	0.0089	0.0049	0.0040
6	0.0090	0.0049	0.0040
7	0.0091	0.0050	0.0041
8	0.0092	0.0050	0.0041
9	0.0093	0.0051	0.0042
10	0.0094	0.0052	0.0042
11	0.0095	0.0052	0.0043
12	0.0096	0.0053	0.0043
13	0.0097	0.0053	0.0044
14	0.0098	0.0054	0.0044
15	0.0100	0.0055	0.0045
16	0.0101	0.0055	0.0045
17	0.0102	0.0056	0.0046
18	0.0103	0.0057	0.0047
19	0.0105	0.0058	0.0047
20	0.0106	0.0058	0.0048
21	0.0108	0.0059	0.0049

22	0.0109	0.0060	0.0049
23	0.0111	0.0061	0.0050
24	0.0113	0.0062	0.0051
25	0.0115	0.0063	0.0052
26	0.0116	0.0064	0.0052
27	0.0118	0.0065	0.0053
28	0.0120	0.0066	0.0054
29	0.0122	0.0067	0.0055
30	0.0124	0.0068	0.0056
31	0.0127	0.0070	0.0057
32	0.0129	0.0071	0.0058
33	0.0132	0.0072	0.0059
34	0.0134	0.0074	0.0060
35	0.0137	0.0076	0.0062
36	0.0140	0.0077	0.0063
37	0.0143	0.0079	0.0065
38	0.0147	0.0081	0.0066
39	0.0150	0.0083	0.0068
40	0.0154	0.0085	0.0069
41	0.0158	0.0087	0.0071
42	0.0162	0.0089	0.0073
43	0.0167	0.0092	0.0075
44	0.0172	0.0095	0.0077
45	0.0177	0.0098	0.0080
46	0.0183	0.0101	0.0082
47	0.0190	0.0104	0.0085
48	0.0197	0.0108	0.0088
49	0.0215	0.0118	0.0097
50	0.0223	0.0123	0.0100
51	0.0233	0.0128	0.0105
52	0.0244	0.0134	0.0110
53	0.0257	0.0141	0.0116
54	0.0271	0.0149	0.0122
55	0.0288	0.0158	0.0130
56	0.0307	0.0169	0.0138
57	0.0332	0.0183	0.0150
58	0.0361	0.0198	0.0162
59	0.0400	0.0220	0.0180
60	0.0448	0.0247	0.0202
61	0.0523	0.0288	0.0235
62	0.0528	0.0291	0.0238
63	0.0690	0.0380	0.0311
64	0.1477	0.0663	0.0814
65	0.3597	0.0663	0.2934
66	0.0566	0.0312	0.0255
67	0.0442	0.0243	0.0199
68	0.0357	0.0196	0.0161
69	0.0304	0.0167	0.0137
70	0.0269	0.0148	0.0121
71	0.0242	0.0133	0.0109
72	0.0222	0.0122	0.0100
73	0.0196	0.0108	0.0088
74	0.0182	0.0100	0.0082
75	0.0171	0.0094	0.0077
76	0.0162	0.0089	0.0073
77	0.0153	0.0084	0.0069
78	0.0146	0.0080	0.0066
79	0.0140	0.0077	0.0063
80	0.0134	0.0074	0.0060

81	0.0129	0.0071	0.0058
82	0.0124	0.0068	0.0056
83	0.0120	0.0066	0.0054
84	0.0116	0.0064	0.0052
85	0.0112	0.0062	0.0051
86	0.0109	0.0060	0.0049
87	0.0106	0.0058	0.0048
88	0.0103	0.0057	0.0046
89	0.0101	0.0055	0.0045
90	0.0098	0.0054	0.0044
91	0.0096	0.0053	0.0043
92	0.0094	0.0051	0.0042
93	0.0092	0.0050	0.0041
94	0.0090	0.0049	0.0040
95	0.0088	0.0048	0.0039
96	0.0086	0.0047	0.0039

Total soil rain loss = 1.04(In)
Total effective rainfall = 1.12(In)
Peak flow rate in flood hydrograph = 13.01(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 15 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	5.0	10.0	15.0	20.0
0+15	0.0016	0.08	Q	|	|	|	|
0+30	0.0062	0.23	Q	|	|	|	|
0+45	0.0118	0.27	Q	|	|	|	|
1+ 0	0.0177	0.29	Q	|	|	|	|
1+15	0.0240	0.30	Q	|	|	|	|
1+30	0.0304	0.31	Q	|	|	|	|
1+45	0.0370	0.32	Q	|	|	|	|
2+ 0	0.0437	0.32	Q	|	|	|	|
2+15	0.0505	0.33	QV	|	|	|	|
2+30	0.0573	0.33	QV	|	|	|	|
2+45	0.0642	0.33	QV	|	|	|	|
3+ 0	0.0712	0.34	QV	|	|	|	|
3+15	0.0782	0.34	QV	|	|	|	|
3+30	0.0854	0.35	QV	|	|	|	|
3+45	0.0926	0.35	Q V	|	|	|	|
4+ 0	0.0999	0.35	Q V	|	|	|	|
4+15	0.1074	0.36	Q V	|	|	|	|
4+30	0.1149	0.36	Q V	|	|	|	|
4+45	0.1225	0.37	Q V	|	|	|	|
5+ 0	0.1302	0.37	Q V	|	|	|	|
5+15	0.1380	0.38	Q V	|	|	|	|
5+30	0.1460	0.38	Q V	|	|	|	|
5+45	0.1540	0.39	Q V	|	|	|	|
6+ 0	0.1622	0.40	Q V	|	|	|	|
6+15	0.1705	0.40	Q V	|	|	|	|
6+30	0.1789	0.41	Q V	|	|	|	|
6+45	0.1875	0.41	Q V	|	|	|	|
7+ 0	0.1962	0.42	Q V	|	|	|	|

```
 7+15       0.2050      0.43  Q   V     |          |          |          |
 7+30       0.2140      0.44  Q   V     |          |          |          |
 7+45       0.2232      0.44  Q   V     |          |          |          |
 8+ 0       0.2325      0.45  Q    V    |          |          |          |
 8+15       0.2420      0.46  Q    V    |          |          |          |
 8+30       0.2517      0.47  Q    V    |          |          |          |
 8+45       0.2615      0.48  Q    V    |          |          |          |
 9+ 0       0.2716      0.49  Q    V    |          |          |          |
 9+15       0.2819      0.50  Q     V   |          |          |          |
 9+30       0.2925      0.51  |Q    V   |          |          |          |
 9+45       0.3032      0.52  |Q    V   |          |          |          |
10+ 0       0.3143      0.53  |Q    V   |          |          |          |
10+15       0.3256      0.55  |Q     V  |          |          |          |
10+30       0.3372      0.56  |Q     V  |          |          |          |
10+45       0.3491      0.58  |Q     V  |          |          |          |
11+ 0       0.3613      0.59  |Q     V  |          |          |          |
11+15       0.3739      0.61  |Q      V |          |          |          |
11+30       0.3870      0.63  |Q      V |          |          |          |
11+45       0.4004      0.65  |Q      V |          |          |          |
12+ 0       0.4143      0.67  |Q       V|          |          |          |
12+15       0.4289      0.71  |Q       V|          |          |          |
12+30       0.4444      0.75  |Q       V|          |          |          |
12+45       0.4607      0.79  |Q        V          |          |          |
13+ 0       0.4778      0.82  |Q        V          |          |          |
13+15       0.4956      0.86  |Q        V          |          |          |
13+30       0.5144      0.91  |Q         V         |          |          |
13+45       0.5342      0.96  |Q        |V         |          |          |
14+ 0       0.5553      1.02  | Q       | V        |          |          |
14+15       0.5778      1.09  | Q       | V        |          |          |
14+30       0.6020      1.17  | Q       |  V       |          |          |
14+45       0.6284      1.28  | Q       |  V       |          |          |
15+ 0       0.6576      1.41  | Q       |   V      |          |          |
15+15       0.6905      1.59  |  Q      |    V     |          |          |
15+30       0.7270      1.77  |  Q      |    V     |          |          |
15+45       0.7678      1.97  |  Q      |     V    |          |          |
16+ 0       0.8355      3.28  |     Q   |       V  |          |          |
16+15       1.0320      9.51  |         |        Q| V        |          |
16+30       1.3007     13.01  |         |          |     Q V  |          |
16+45       1.4050      5.05  |         Q          |         V          |
17+ 0       1.4686      3.07  |     Q   |          |          | V        |
17+15       1.5137      2.19  |   Q     |          |          | V        |
17+30       1.5481      1.66  |  Q      |          |          |  V       |
17+45       1.5760      1.35  | Q       |          |          |   V      |
18+ 0       1.5951      0.92  |Q        |          |          |   V      |
18+15       1.6120      0.82  |Q        |          |          |    V     |
18+30       1.6272      0.74  |Q        |          |          |    V     |
18+45       1.6412      0.68  |Q        |          |          |    V     |
19+ 0       1.6542      0.63  |Q        |          |          |     V    |
19+15       1.6664      0.59  |Q        |          |          |     V    |
19+30       1.6780      0.56  |Q        |          |          |     V    |
19+45       1.6890      0.53  |Q        |          |          |     V    |
20+ 0       1.6995      0.51  |Q        |          |          |      V   |
20+15       1.7095      0.49  Q         |          |          |      V   |
20+30       1.7192      0.47  Q         |          |          |      V   |
20+45       1.7284      0.45  Q         |          |          |      V   |
21+ 0       1.7374      0.43  Q         |          |          |      V   |
21+15       1.7461      0.42  Q         |          |          |       V  |
21+30       1.7544      0.41  Q         |          |          |       V  |
21+45       1.7626      0.39  Q         |          |          |       V  |
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   22+ 0       1.7705      0.38  Q         |          |          |       V |
   22+15       1.7782      0.37  Q         |          |          |       V |
   22+30       1.7857      0.36  Q         |          |          |       V |
   22+45       1.7930      0.35  Q         |          |          |        V|
   23+ 0       1.8001      0.34  Q         |          |          |        V|
   23+15       1.8070      0.34  Q         |          |          |        V|
   23+30       1.8138      0.33  Q         |          |          |        V|
   23+45       1.8205      0.32  Q         |          |          |        V|
   24+ 0       1.8270      0.32  Q         |          |          |        V|
   24+15       1.8319      0.23  Q         |          |          |        V|
   24+30       1.8336      0.08  Q         |          |          |        V|
   24+45       1.8344      0.04  Q         |          |          |        V|
   25+ 0       1.8349      0.02  Q         |          |          |        V|
   25+15       1.8351      0.01  Q         |          |          |        V|
   25+30       1.8352      0.00  Q         |          |          |         V
-------------------------------------------------------------------------
```

37	0.0146	0.0071	0.0075
38	0.0150	0.0073	0.0076
39	0.0153	0.0075	0.0078
40	0.0157	0.0077	0.0080
41	0.0161	0.0079	0.0082
42	0.0165	0.0081	0.0084
43	0.0170	0.0083	0.0087
44	0.0175	0.0085	0.0089
45	0.0180	0.0088	0.0092
46	0.0186	0.0091	0.0095
47	0.0193	0.0094	0.0099
48	0.0199	0.0097	0.0102
49	0.0207	0.0101	0.0106
50	0.0215	0.0105	0.0110
51	0.0225	0.0110	0.0115
52	0.0235	0.0115	0.0120
53	0.0248	0.0121	0.0127
54	0.0262	0.0128	0.0134
55	0.0279	0.0136	0.0142
56	0.0297	0.0145	0.0152
57	0.0322	0.0157	0.0165
58	0.0350	0.0171	0.0179
59	0.0389	0.0190	0.0199
60	0.0436	0.0213	0.0223
61	0.0510	0.0249	0.0261
62	0.0524	0.0256	0.0268
63	0.0690	0.0337	0.0353
64	0.1477	0.0685	0.0792
65	0.3597	0.0685	0.2912
66	0.0558	0.0272	0.0285
67	0.0430	0.0210	0.0220
68	0.0346	0.0169	0.0177
69	0.0295	0.0144	0.0151
70	0.0260	0.0127	0.0133
71	0.0234	0.0114	0.0120
72	0.0214	0.0104	0.0109
73	0.0198	0.0097	0.0101
74	0.0185	0.0090	0.0095
75	0.0174	0.0085	0.0089
76	0.0165	0.0080	0.0084
77	0.0156	0.0076	0.0080
78	0.0149	0.0073	0.0076
79	0.0143	0.0070	0.0073
80	0.0137	0.0067	0.0070
81	0.0132	0.0064	0.0067
82	0.0127	0.0062	0.0065
83	0.0123	0.0060	0.0063
84	0.0119	0.0058	0.0061
85	0.0115	0.0056	0.0059
86	0.0112	0.0055	0.0057
87	0.0109	0.0053	0.0056
88	0.0106	0.0052	0.0054
89	0.0103	0.0050	0.0053
90	0.0101	0.0049	0.0052
91	0.0098	0.0048	0.0050
92	0.0096	0.0047	0.0049
93	0.0094	0.0046	0.0048
94	0.0092	0.0045	0.0047
95	0.0090	0.0044	0.0046
96	0.0089	0.0043	0.0045

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

Study date 01/30/20

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

Program License Serial Number 4009

UN METHOD CALCULATION FOR HCOC
TRACT NO 20280
POST-DEVELOPMENT CONDITION, ON-SITE AREA
10-YEAR, 24-HOUR STORM

Storm Event Year = 10

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

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19.70	1	0.63
Rainfall data for year 10		
19.70	6	1.26
Rainfall data for year 10		
19.70	24	2.16

++

******** 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)
69.0	69.0	19.70	1.000	0.548	0.500	0.274

Area-averaged adjusted loss rate Fm (In/Hr) = 0.274

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

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC2)	S	Pervious Yield Fr
9.85	0.500	69.0	69.0	4.49	0.128
9.85	0.500	98.0	98.0	0.20	0.895

Area-averaged catchment yield fraction, Y = 0.511
Area-averaged low loss fraction, Yb = 0.489
User entry of time of concentration = 0.200 (hours)
++
Watershed area = 19.70(Ac.)
Catchment Lag time = 0.160 hours
Unit interval = 15.000 minutes
Unit interval percentage of lag time = 156.2500
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.274(In/Hr)
Average low loss rate fraction (Yb) = 0.489 (decimal)
VALLEY DEVELOPED S-Graph Selected
Computed peak 5-minute rainfall = 0.298(In)
Computed peak 30-minute rainfall = 0.511(In)
Specified peak 1-hour rainfall = 0.629(In)
Computed peak 3-hour rainfall = 0.963(In)
Specified peak 6-hour rainfall = 1.260(In)
Specified peak 24-hour rainfall = 2.160(In)

Rainfall depth area reduction factors:
Using a total area of 19.70(Ac.) (Ref: fig. E-4)

5-minute factor = 0.999 Adjusted rainfall = 0.298(In)
30-minute factor = 0.999 Adjusted rainfall = 0.510(In)
1-hour factor = 0.999 Adjusted rainfall = 0.628(In)
3-hour factor = 1.000 Adjusted rainfall = 0.963(In)
6-hour factor = 1.000 Adjusted rainfall = 1.260(In)
24-hour factor = 1.000 Adjusted rainfall = 2.160(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 = 79.42 (CFS))	
1	36.372	28.885
2	96.012	47.363
3	100.000	3.167

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.4146	0.0475
2	0.5104	0.0272
3	0.5765	0.0200
4	0.6284	0.0162
5	0.6853	0.0181
6	0.7356	0.0162
7	0.7810	0.0147
8	0.8226	0.0135
9	0.8611	0.0125
10	0.8971	0.0117
11	0.9309	0.0111
12	0.9629	0.0105
13	0.9933	0.0100

14	1.0223	0.0095
15	1.0500	0.0091
16	1.0766	0.0088
17	1.1022	0.0084
18	1.1269	0.0081
19	1.1508	0.0079
20	1.1739	0.0076
21	1.1963	0.0074
22	1.2181	0.0072
23	1.2393	0.0070
24	1.2599	0.0068
25	1.2801	0.0067
26	1.2998	0.0065
27	1.3190	0.0064
28	1.3377	0.0062
29	1.3561	0.0061
30	1.3741	0.0060
31	1.3918	0.0058
32	1.4090	0.0057
33	1.4260	0.0056
34	1.4427	0.0055
35	1.4590	0.0054
36	1.4751	0.0053
37	1.4909	0.0052
38	1.5064	0.0052
39	1.5217	0.0051
40	1.5368	0.0050
41	1.5516	0.0049
42	1.5662	0.0048
43	1.5806	0.0048
44	1.5948	0.0047
45	1.6088	0.0046
46	1.6226	0.0046
47	1.6362	0.0045
48	1.6497	0.0045
49	1.6629	0.0044
50	1.6760	0.0044
51	1.6890	0.0043
52	1.7018	0.0043
53	1.7145	0.0042
54	1.7270	0.0042
55	1.7393	0.0041
56	1.7516	0.0041
57	1.7637	0.0040
58	1.7756	0.0040
59	1.7875	0.0039
60	1.7992	0.0039
61	1.8108	0.0039
62	1.8223	0.0038
63	1.8336	0.0038
64	1.8449	0.0037
65	1.8561	0.0037
66	1.8671	0.0037
67	1.8781	0.0036
68	1.8889	0.0036
69	1.8997	0.0036
70	1.9103	0.0035
71	1.9209	0.0035
72	1.9314	0.0035
73	1.9417	0.0035
74	1.9520	0.0034
75	1.9623	0.0034

76	1.9724	0.0034
77	1.9824	0.0033
78	1.9924	0.0033
79	2.0023	0.0033
80	2.0121	0.0033
81	2.0219	0.0032
82	2.0315	0.0032
83	2.0411	0.0032
84	2.0507	0.0032
85	2.0601	0.0031
86	2.0695	0.0031
87	2.0788	0.0031
88	2.0881	0.0031
89	2.0973	0.0031
90	2.1064	0.0030
91	2.1155	0.0030
92	2.1245	0.0030
93	2.1334	0.0030
94	2.1423	0.0030
95	2.1512	0.0029
96	2.1599	0.0029

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0088	0.0043	0.0045
2	0.0089	0.0043	0.0045
3	0.0090	0.0044	0.0046
4	0.0090	0.0044	0.0046
5	0.0091	0.0045	0.0047
6	0.0092	0.0045	0.0047
7	0.0093	0.0046	0.0048
8	0.0094	0.0046	0.0048
9	0.0095	0.0047	0.0049
10	0.0096	0.0047	0.0049
11	0.0098	0.0048	0.0050
12	0.0099	0.0048	0.0050
13	0.0100	0.0049	0.0051
14	0.0101	0.0049	0.0052
15	0.0102	0.0050	0.0052
16	0.0103	0.0051	0.0053
17	0.0105	0.0051	0.0054
18	0.0106	0.0052	0.0054
19	0.0108	0.0053	0.0055
20	0.0109	0.0053	0.0056
21	0.0111	0.0054	0.0057
22	0.0112	0.0055	0.0057
23	0.0114	0.0056	0.0058
24	0.0115	0.0056	0.0059
25	0.0117	0.0057	0.0060
26	0.0119	0.0058	0.0061
27	0.0121	0.0059	0.0062
28	0.0123	0.0060	0.0063
29	0.0125	0.0061	0.0064
30	0.0127	0.0062	0.0065
31	0.0130	0.0063	0.0066
32	0.0132	0.0065	0.0068
33	0.0135	0.0066	0.0069
34	0.0137	0.0067	0.0070
35	0.0140	0.0068	0.0072
36	0.0143	0.0070	0.0073

Total soil rain loss = 0.94(In)
Total effective rainfall = 1.22(In)
Peak flow rate in flood hydrograph = 14.87(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 15 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0 5.0 10.0 15.0 20.0
0+15	0.0027	0.13	Q
0+30	0.0098	0.34	Q
0+45	0.0172	0.36	Q
1+ 0	0.0248	0.36	Q
1+15	0.0324	0.37	Q
1+30	0.0401	0.37	Q
1+45	0.0479	0.38	Q
2+ 0	0.0557	0.38	QV
2+15	0.0637	0.38	QV
2+30	0.0717	0.39	QV
2+45	0.0798	0.39	QV
3+ 0	0.0880	0.40	QV
3+15	0.0963	0.40	QV
3+30	0.1047	0.41	Q V
3+45	0.1133	0.41	Q V
4+ 0	0.1219	0.42	Q V
4+15	0.1306	0.42	Q V
4+30	0.1394	0.43	Q V
4+45	0.1484	0.43	Q V
5+ 0	0.1574	0.44	Q V
5+15	0.1666	0.45	Q V
5+30	0.1760	0.45	Q V
5+45	0.1854	0.46	Q V
6+ 0	0.1950	0.46	Q V
6+15	0.2048	0.47	Q V
6+30	0.2147	0.48	Q V
6+45	0.2247	0.49	Q V
7+ 0	0.2349	0.49	Q V
7+15	0.2453	0.50	|Q V
7+30	0.2559	0.51	|Q V
7+45	0.2666	0.52	|Q V
8+ 0	0.2776	0.53	|Q V
8+15	0.2887	0.54	|Q V
8+30	0.3001	0.55	|Q V
8+45	0.3117	0.56	|Q V
9+ 0	0.3236	0.57	|Q V
9+15	0.3357	0.59	|Q V
9+30	0.3480	0.60	|Q V
9+45	0.3607	0.61	|Q V
10+ 0	0.3736	0.63	|Q V
10+15	0.3869	0.64	|Q V
10+30	0.4005	0.66	|Q V
10+45	0.4145	0.68	|Q V
11+ 0	0.4289	0.70	|Q V
11+15	0.4437	0.72	|Q V
11+30	0.4590	0.74	|Q V
11+45	0.4748	0.76	|Q V
12+ 0	0.4912	0.79	|Q V
12+15	0.5081	0.82	|Q V

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  12+30       0.5257      0.85  |Q        V          |          |          |
  12+45       0.5440      0.89  |Q        V          |          |          |
  13+ 0       0.5632      0.93  |Q        |V         |          |          |
  13+15       0.5833      0.97  |Q        |V         |          |          |
  13+30       0.6045      1.03  | Q       | V        |          |          |
  13+45       0.6269      1.09  | Q       | V        |          |          |
  14+ 0       0.6508      1.16  | Q       |  V       |          |          |
  14+15       0.6765      1.24  | Q       |  V       |          |          |
  14+30       0.7043      1.35  | Q       |   V      |          |          |
  14+45       0.7347      1.47  | Q       |   V      |          |          |
  15+ 0       0.7686      1.64  |  Q      |    V     |          |          |
  15+15       0.8074      1.87  |  Q      |     V    |          |          |
  15+30       0.8504      2.08  |   Q     |      V   |          |          |
  15+45       0.8993      2.37  |   Q     |       V  |          |          |
  16+ 0       0.9829      4.05  |       Q |        V |          |          |
  16+15       1.2366     12.28  |         |          |   Q      |          |
  16+30       1.5438     14.87  |         |          |       QV           |
  16+45       1.6039      2.91  |    Q    |          |         | V        |
  17+ 0       1.6378      1.64  |  Q      |          |         | V        |
  17+15       1.6656      1.34  | Q       |          |         |  V       |
  17+30       1.6894      1.15  | Q       |          |         |  V       |
  17+45       1.7105      1.02  | Q       |          |         |   V      |
  18+ 0       1.7296      0.92  |Q        |          |         |   V      |
  18+15       1.7472      0.85  |Q        |          |         |    V     |
  18+30       1.7635      0.79  |Q        |          |         |    V     |
  18+45       1.7787      0.74  |Q        |          |         |    V     |
  19+ 0       1.7931      0.69  |Q        |          |         |    V     |
  19+15       1.8067      0.66  |Q        |          |         |     V    |
  19+30       1.8196      0.63  |Q        |          |         |     V    |
  19+45       1.8319      0.60  |Q        |          |         |     V    |
  20+ 0       1.8437      0.57  |Q        |          |         |     V    |
  20+15       1.8551      0.55  |Q        |          |         |      V   |
  20+30       1.8660      0.53  |Q        |          |         |      V   |
  20+45       1.8765      0.51  |Q        |          |         |      V   |
  21+ 0       1.8867      0.49  Q         |          |         |      V   |
  21+15       1.8966      0.48  Q         |          |         |       V  |
  21+30       1.9062      0.46  Q         |          |         |       V  |
  21+45       1.9155      0.45  Q         |          |         |       V  |
  22+ 0       1.9246      0.44  Q         |          |         |       V  |
  22+15       1.9334      0.43  Q         |          |         |       V  |
  22+30       1.9420      0.42  Q         |          |         |       V  |
  22+45       1.9504      0.41  Q         |          |         |        V|
  23+ 0       1.9586      0.40  Q         |          |         |        V|
  23+15       1.9666      0.39  Q         |          |         |        V|
  23+30       1.9745      0.38  Q         |          |         |        V|
  23+45       1.9821      0.37  Q         |          |         |        V|
  24+ 0       1.9897      0.36  Q         |          |         |        V|
  24+15       1.9944      0.23  Q         |          |         |        V|
  24+30       1.9947      0.01  Q         |          |         |         V
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U n i t H y d r o g r a p h A n a l y s i s

Study date 01/30/20

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

Program License Serial Number 4009

UN METHOD FOR HCOC CALCULATION
TRACT NO. 20280
POST-DEVELOPMENT CONDITION
10-YEAR, 24-HOUR STORM

Storm Event Year = 10

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 10		
19.70	1	0.63
Rainfall data for year 10		
19.70	6	1.28
Rainfall data for year 10		
19.70	24	2.16

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******** 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)
86.0	86.0	19.70	1.000	0.265	1.000	0.265

Area-averaged adjusted loss rate Fm (In/Hr) = 0.265

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

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC2)	S	Pervious Yield Fr
19.70	1.000	86.0	86.0	1.63	0.450

Area-averaged catchment yield fraction, Y = 0.450
Area-averaged low loss fraction, Yb = 0.550
User entry of time of concentration = 0.263 (hours)
++
Watershed area = 19.70(Ac.)
Catchment Lag time = 0.210 hours
Unit interval = 15.000 minutes
Unit interval percentage of lag time = 118.8213
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.265(In/Hr)
Average low loss rate fraction (Yb) = 0.550 (decimal)
VALLEY UNDEVELOPED S-Graph Selected
Computed peak 5-minute rainfall = 0.298(In)
Computed peak 30-minute rainfall = 0.511(In)
Specified peak 1-hour rainfall = 0.629(In)
Computed peak 3-hour rainfall = 0.972(In)
Specified peak 6-hour rainfall = 1.280(In)
Specified peak 24-hour rainfall = 2.160(In)

Rainfall depth area reduction factors:
Using a total area of 19.70(Ac.) (Ref: fig. E-4)

5-minute factor = 0.999 Adjusted rainfall = 0.298(In)
30-minute factor = 0.999 Adjusted rainfall = 0.510(In)
1-hour factor = 0.999 Adjusted rainfall = 0.628(In)
3-hour factor = 1.000 Adjusted rainfall = 0.972(In)
6-hour factor = 1.000 Adjusted rainfall = 1.280(In)
24-hour factor = 1.000 Adjusted rainfall = 2.160(In)

U n i t H y d r o g r a p h
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Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 79.42 (CFS))	
1	24.857	19.740
2	73.609	38.717
3	87.022	10.652
4	93.107	4.832
5	96.510	2.703
6	98.482	1.566
7	100.000	1.206

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.4146	0.0475
2	0.5104	0.0272
3	0.5765	0.0200
4	0.6284	0.0162

5	0.6867	0.0186
6	0.7383	0.0166
7	0.7849	0.0151
8	0.8276	0.0139
9	0.8673	0.0129
10	0.9043	0.0121
11	0.9392	0.0114
12	0.9723	0.0108
13	1.0036	0.0103
14	1.0336	0.0098
15	1.0623	0.0094
16	1.0898	0.0091
17	1.1163	0.0087
18	1.1419	0.0084
19	1.1667	0.0082
20	1.1906	0.0079
21	1.2139	0.0077
22	1.2365	0.0075
23	1.2585	0.0073
24	1.2799	0.0071
25	1.2998	0.0066
26	1.3192	0.0064
27	1.3381	0.0063
28	1.3566	0.0061
29	1.3747	0.0060
30	1.3924	0.0059
31	1.4097	0.0057
32	1.4267	0.0056
33	1.4434	0.0055
34	1.4598	0.0054
35	1.4758	0.0053
36	1.4916	0.0052
37	1.5071	0.0051
38	1.5224	0.0051
39	1.5374	0.0050
40	1.5521	0.0049
41	1.5667	0.0048
42	1.5810	0.0047
43	1.5951	0.0047
44	1.6090	0.0046
45	1.6227	0.0045
46	1.6362	0.0045
47	1.6495	0.0044
48	1.6627	0.0044
49	1.6757	0.0043
50	1.6885	0.0043
51	1.7012	0.0042
52	1.7137	0.0042
53	1.7261	0.0041
54	1.7383	0.0041
55	1.7504	0.0040
56	1.7623	0.0040
57	1.7741	0.0039
58	1.7858	0.0039
59	1.7974	0.0038
60	1.8088	0.0038
61	1.8201	0.0038
62	1.8313	0.0037
63	1.8424	0.0037

64	1.8534	0.0036
65	1.8643	0.0036
66	1.8751	0.0036
67	1.8857	0.0035
68	1.8963	0.0035
69	1.9068	0.0035
70	1.9172	0.0035
71	1.9275	0.0034
72	1.9377	0.0034
73	1.9478	0.0034
74	1.9578	0.0033
75	1.9678	0.0033
76	1.9776	0.0033
77	1.9874	0.0033
78	1.9971	0.0032
79	2.0067	0.0032
80	2.0163	0.0032
81	2.0258	0.0032
82	2.0352	0.0031
83	2.0445	0.0031
84	2.0538	0.0031
85	2.0630	0.0031
86	2.0721	0.0030
87	2.0812	0.0030
88	2.0902	0.0030
89	2.0991	0.0030
90	2.1080	0.0030
91	2.1168	0.0029
92	2.1255	0.0029
93	2.1342	0.0029
94	2.1428	0.0029
95	2.1514	0.0029
96	2.1599	0.0028

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0085	0.0047	0.0038
2	0.0086	0.0047	0.0039
3	0.0087	0.0048	0.0039
4	0.0088	0.0048	0.0040
5	0.0089	0.0049	0.0040
6	0.0090	0.0049	0.0040
7	0.0091	0.0050	0.0041
8	0.0092	0.0050	0.0041
9	0.0093	0.0051	0.0042
10	0.0094	0.0052	0.0042
11	0.0095	0.0052	0.0043
12	0.0096	0.0053	0.0043
13	0.0097	0.0053	0.0044
14	0.0098	0.0054	0.0044
15	0.0100	0.0055	0.0045
16	0.0101	0.0055	0.0045
17	0.0102	0.0056	0.0046
18	0.0103	0.0057	0.0047
19	0.0105	0.0058	0.0047
20	0.0106	0.0058	0.0048
21	0.0108	0.0059	0.0049

22	0.0109	0.0060	0.0049
23	0.0111	0.0061	0.0050
24	0.0113	0.0062	0.0051
25	0.0115	0.0063	0.0052
26	0.0116	0.0064	0.0052
27	0.0118	0.0065	0.0053
28	0.0120	0.0066	0.0054
29	0.0122	0.0067	0.0055
30	0.0124	0.0068	0.0056
31	0.0127	0.0070	0.0057
32	0.0129	0.0071	0.0058
33	0.0132	0.0072	0.0059
34	0.0134	0.0074	0.0060
35	0.0137	0.0076	0.0062
36	0.0140	0.0077	0.0063
37	0.0143	0.0079	0.0065
38	0.0147	0.0081	0.0066
39	0.0150	0.0083	0.0068
40	0.0154	0.0085	0.0069
41	0.0158	0.0087	0.0071
42	0.0162	0.0089	0.0073
43	0.0167	0.0092	0.0075
44	0.0172	0.0095	0.0077
45	0.0177	0.0098	0.0080
46	0.0183	0.0101	0.0082
47	0.0190	0.0104	0.0085
48	0.0197	0.0108	0.0088
49	0.0215	0.0118	0.0097
50	0.0223	0.0123	0.0100
51	0.0233	0.0128	0.0105
52	0.0244	0.0134	0.0110
53	0.0257	0.0141	0.0116
54	0.0271	0.0149	0.0122
55	0.0288	0.0158	0.0130
56	0.0307	0.0169	0.0138
57	0.0332	0.0183	0.0150
58	0.0361	0.0198	0.0162
59	0.0400	0.0220	0.0180
60	0.0448	0.0247	0.0202
61	0.0523	0.0288	0.0235
62	0.0528	0.0291	0.0238
63	0.0690	0.0380	0.0311
64	0.1477	0.0663	0.0814
65	0.3597	0.0663	0.2934
66	0.0566	0.0312	0.0255
67	0.0442	0.0243	0.0199
68	0.0357	0.0196	0.0161
69	0.0304	0.0167	0.0137
70	0.0269	0.0148	0.0121
71	0.0242	0.0133	0.0109
72	0.0222	0.0122	0.0100
73	0.0196	0.0108	0.0088
74	0.0182	0.0100	0.0082
75	0.0171	0.0094	0.0077
76	0.0162	0.0089	0.0073
77	0.0153	0.0084	0.0069
78	0.0146	0.0080	0.0066
79	0.0140	0.0077	0.0063
80	0.0134	0.0074	0.0060

81	0.0129	0.0071	0.0058
82	0.0124	0.0068	0.0056
83	0.0120	0.0066	0.0054
84	0.0116	0.0064	0.0052
85	0.0112	0.0062	0.0051
86	0.0109	0.0060	0.0049
87	0.0106	0.0058	0.0048
88	0.0103	0.0057	0.0046
89	0.0101	0.0055	0.0045
90	0.0098	0.0054	0.0044
91	0.0096	0.0053	0.0043
92	0.0094	0.0051	0.0042
93	0.0092	0.0050	0.0041
94	0.0090	0.0049	0.0040
95	0.0088	0.0048	0.0039
96	0.0086	0.0047	0.0039

Total soil rain loss = 1.04(In)
Total effective rainfall = 1.12(In)
Peak flow rate in flood hydrograph = 13.01(CFS)

++

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

Hydrograph in 15 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	5.0	10.0	15.0	20.0
0+15	0.0016	0.08	Q	|	|	|	|
0+30	0.0062	0.23	Q	|	|	|	|
0+45	0.0118	0.27	Q	|	|	|	|
1+ 0	0.0177	0.29	Q	|	|	|	|
1+15	0.0240	0.30	Q	|	|	|	|
1+30	0.0304	0.31	Q	|	|	|	|
1+45	0.0370	0.32	Q	|	|	|	|
2+ 0	0.0437	0.32	Q	|	|	|	|
2+15	0.0505	0.33	QV	|	|	|	|
2+30	0.0573	0.33	QV	|	|	|	|
2+45	0.0642	0.33	QV	|	|	|	|
3+ 0	0.0712	0.34	QV	|	|	|	|
3+15	0.0782	0.34	QV	|	|	|	|
3+30	0.0854	0.35	QV	|	|	|	|
3+45	0.0926	0.35	Q V	|	|	|	|
4+ 0	0.0999	0.35	Q V	|	|	|	|
4+15	0.1074	0.36	Q V	|	|	|	|
4+30	0.1149	0.36	Q V	|	|	|	|
4+45	0.1225	0.37	Q V	|	|	|	|
5+ 0	0.1302	0.37	Q V	|	|	|	|
5+15	0.1380	0.38	Q V	|	|	|	|
5+30	0.1460	0.38	Q V	|	|	|	|
5+45	0.1540	0.39	Q V	|	|	|	|
6+ 0	0.1622	0.40	Q V	|	|	|	|
6+15	0.1705	0.40	Q V	|	|	|	|
6+30	0.1789	0.41	Q V	|	|	|	|
6+45	0.1875	0.41	Q V	|	|	|	|
7+ 0	0.1962	0.42	Q V	|	|	|	|

```
 7+15       0.2050      0.43  Q   V     |          |          |          |
 7+30       0.2140      0.44  Q   V     |          |          |          |
 7+45       0.2232      0.44  Q   V     |          |          |          |
 8+ 0       0.2325      0.45  Q    V    |          |          |          |
 8+15       0.2420      0.46  Q    V    |          |          |          |
 8+30       0.2517      0.47  Q    V    |          |          |          |
 8+45       0.2615      0.48  Q    V    |          |          |          |
 9+ 0       0.2716      0.49  Q    V    |          |          |          |
 9+15       0.2819      0.50  Q     V   |          |          |          |
 9+30       0.2925      0.51  |Q    V   |          |          |          |
 9+45       0.3032      0.52  |Q    V   |          |          |          |
10+ 0       0.3143      0.53  |Q    V   |          |          |          |
10+15       0.3256      0.55  |Q     V  |          |          |          |
10+30       0.3372      0.56  |Q     V  |          |          |          |
10+45       0.3491      0.58  |Q     V  |          |          |          |
11+ 0       0.3613      0.59  |Q     V  |          |          |          |
11+15       0.3739      0.61  |Q      V |          |          |          |
11+30       0.3870      0.63  |Q      V |          |          |          |
11+45       0.4004      0.65  |Q      V |          |          |          |
12+ 0       0.4143      0.67  |Q       V|          |          |          |
12+15       0.4289      0.71  |Q       V|          |          |          |
12+30       0.4444      0.75  |Q       V|          |          |          |
12+45       0.4607      0.79  |Q        V          |          |          |
13+ 0       0.4778      0.82  |Q        V          |          |          |
13+15       0.4956      0.86  |Q        V          |          |          |
13+30       0.5144      0.91  |Q         V         |          |          |
13+45       0.5342      0.96  |Q        |V         |          |          |
14+ 0       0.5553      1.02  | Q       | V        |          |          |
14+15       0.5778      1.09  | Q       | V        |          |          |
14+30       0.6020      1.17  | Q       |  V       |          |          |
14+45       0.6284      1.28  | Q       |  V       |          |          |
15+ 0       0.6576      1.41  | Q       |   V      |          |          |
15+15       0.6905      1.59  |  Q      |    V     |          |          |
15+30       0.7270      1.77  |  Q      |    V     |          |          |
15+45       0.7678      1.97  |  Q      |     V    |          |          |
16+ 0       0.8355      3.28  |     Q   |       V  |          |          |
16+15       1.0320      9.51  |         |        Q| V        |          |
16+30       1.3007     13.01  |         |          |     Q V  |          |
16+45       1.4050      5.05  |         Q          |         V          |
17+ 0       1.4686      3.07  |     Q   |          |          | V        |
17+15       1.5137      2.19  |   Q     |          |          | V        |
17+30       1.5481      1.66  |  Q      |          |          |  V       |
17+45       1.5760      1.35  | Q       |          |          |   V      |
18+ 0       1.5951      0.92  |Q        |          |          |   V      |
18+15       1.6120      0.82  |Q        |          |          |    V     |
18+30       1.6272      0.74  |Q        |          |          |    V     |
18+45       1.6412      0.68  |Q        |          |          |    V     |
19+ 0       1.6542      0.63  |Q        |          |          |     V    |
19+15       1.6664      0.59  |Q        |          |          |     V    |
19+30       1.6780      0.56  |Q        |          |          |     V    |
19+45       1.6890      0.53  |Q        |          |          |     V    |
20+ 0       1.6995      0.51  |Q        |          |          |      V   |
20+15       1.7095      0.49  Q         |          |          |      V   |
20+30       1.7192      0.47  Q         |          |          |      V   |
20+45       1.7284      0.45  Q         |          |          |      V   |
21+ 0       1.7374      0.43  Q         |          |          |      V   |
21+15       1.7461      0.42  Q         |          |          |       V  |
21+30       1.7544      0.41  Q         |          |          |       V  |
21+45       1.7626      0.39  Q         |          |          |       V  |
```

```
   22+ 0       1.7705      0.38  Q         |          |          |       V |
   22+15       1.7782      0.37  Q         |          |          |       V |
   22+30       1.7857      0.36  Q         |          |          |       V |
   22+45       1.7930      0.35  Q         |          |          |        V|
   23+ 0       1.8001      0.34  Q         |          |          |        V|
   23+15       1.8070      0.34  Q         |          |          |        V|
   23+30       1.8138      0.33  Q         |          |          |        V|
   23+45       1.8205      0.32  Q         |          |          |        V|
   24+ 0       1.8270      0.32  Q         |          |          |        V|
   24+15       1.8319      0.23  Q         |          |          |        V|
   24+30       1.8336      0.08  Q         |          |          |        V|
   24+45       1.8344      0.04  Q         |          |          |        V|
   25+ 0       1.8349      0.02  Q         |          |          |        V|
   25+15       1.8351      0.01  Q         |          |          |        V|
   25+30       1.8352      0.00  Q         |          |          |         V
-------------------------------------------------------------------------
```

Unit Hydrology Method for Runoff Volume & Peak Runoff Calculation

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2004 Version 7.0
Rational Hydrology Study Date: 01/30/20

TRACT NO. 20280
EXISTING CONDITION, ON-SITE AREA
10-YEAR, 24-Hours Storm

Program License Serial Number 4009

********* Hydrology Study Control Information **********

Rational hydrology study storm event year is 10.0
Computed rainfall intensity:
Storm year = 10.00 24 hour rainfall = 2.160 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 2

++

Process from Point/Station 101.000 to Point/Station 102.000
**** INITIAL AREA EVALUATION ****

UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 86.00
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.265(In/Hr)
Initial subarea data:
Initial area flow distance = 543.000(Ft.)
Top (of initial area) elevation = 2918.700(Ft.)
Bottom (of initial area) elevation = 2900.000(Ft.)
Difference in elevation = 18.700(Ft.)
Slope = 0.03444 s(%)= 3.44
TC = k(0.525)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 12.784 min.
Rainfall intensity = 6.375(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.863
Subarea runoff = 16.277(CFS)
Total initial stream area = 2.960(Ac.)
Pervious area fraction = 1.000
Initial area Fm value = 0.265(In/Hr)

++

Process from Point/Station 102.000 to Point/Station 103.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

```
Estimated mean flow rate at midpoint of channel =      0.000(CFS)
Depth of flow =   1.854(Ft.), Average velocity =  11.085(Ft/s)
!!Warning: Water is above left or right bank elevations
        ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              0.00
        2              0.00              0.50
        3              2.00              1.00
        4              3.00              2.00
        5              6.00              2.00
Manning's 'N' friction factor =   0.020
------------------------------------------------------------------
Sub-Channel flow  =     28.523(CFS)
  '     '        flow top width =      2.854(Ft.)
  '     '    velocity=   11.085(Ft/s)
  '     '        area =      2.573(Sq.Ft)
  '     '        Froude number =     2.058

Upstream point elevation =  2900.000(Ft.)
Downstream point elevation =  2891.500(Ft.)
Flow length =   229.500(Ft.)
Travel time  =    0.35 min.
Time of concentration =   13.13 min.
Depth of flow =   1.854(Ft.)
Average velocity =  11.085(Ft/s)
Total irregular channel flow =    28.523(CFS)
Irregular channel normal depth above invert elev. =   1.854(Ft.)
Average velocity of channel(s) =  11.085(Ft/s)
!!Warning: Water is above left or right bank elevations
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Rainfall intensity =      6.257(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.862
Subarea runoff =     24.441(CFS) for    4.590(Ac.)
Total runoff =     40.718(CFS)
Effective area this stream =        7.55(Ac.)
Total Study Area (Main Stream No. 1) =        7.55(Ac.)
Area averaged Fm value =    0.265(In/Hr)
Depth of flow =   2.179(Ft.), Average velocity =   9.992(Ft/s)
!!Warning: Water is above left or right bank elevations


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      104.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
________________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.000(CFS)
Depth of flow =   1.262(Ft.), Average velocity =   8.126(Ft/s)
        ******* Irregular Channel Data ***********
------------------------------------------------------------------
```

```
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              2.00
        2              3.00              1.00
        3              5.00              0.00
        4              9.00              0.00
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =     54.261(CFS)
  '     '        flow top width =      6.787(Ft.)
  '     '    velocity=    8.126(Ft/s)
  '     '        area =      6.678(Sq.Ft)
  '     '        Froude number =     1.444

Upstream point elevation =  2891.500(Ft.)
Downstream point elevation =  2884.600(Ft.)
Flow length =   535.000(Ft.)
Travel time  =    1.10 min.
Time of concentration =   14.23 min.
Depth of flow =   1.262(Ft.)
Average velocity =   8.126(Ft/s)
Total irregular channel flow =    54.261(CFS)
Irregular channel normal depth above invert elev. =   1.262(Ft.)
Average velocity of channel(s) =   8.126(Ft/s)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Rainfall intensity =      5.915(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.860
Subarea runoff =     27.019(CFS) for    5.770(Ac.)
Total runoff =     67.737(CFS)
Effective area this stream =       13.32(Ac.)
Total Study Area (Main Stream No. 1) =       13.32(Ac.)
Area averaged Fm value =    0.265(In/Hr)
Depth of flow =   1.429(Ft.), Average velocity =   8.628(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      104.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     13.320(Ac.)
Runoff from this stream =     67.737(CFS)
Time of concentration =   14.23 min.
Rainfall intensity =     5.915(In/Hr)
Area averaged loss rate (Fm) =    0.2651(In/Hr)
Area averaged Pervious ratio (Ap) = 1.0000


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      105.000 to Point/Station      106.000
**** INITIAL AREA EVALUATION ****
```

```
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Initial subarea data:
Initial area flow distance =   508.800(Ft.)
Top (of initial area) elevation =  2918.000(Ft.)
Bottom (of initial area) elevation =  2902.000(Ft.)
Difference in elevation =    16.000(Ft.)
Slope =    0.03145  s(%)=       3.14
TC = k(0.525)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   12.684 min.
Rainfall intensity =      6.410(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.863
Subarea runoff =     15.486(CFS)
Total initial stream area =        2.800(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.265(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      106.000 to Point/Station      104.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
------------------------------------------------------------------------
Depth of flow =   1.085(Ft.), Average velocity =   8.776(Ft/s)
        ******* Irregular Channel Data ***********
----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              2.00
        2              3.00              1.00
        3              6.00              0.00
Manning's 'N' friction factor =   0.020
----------------------------------------------------------------
Sub-Channel flow  =     15.486(CFS)
  '     '        flow top width =      3.254(Ft.)
  '     '    velocity=    8.776(Ft/s)
  '     '        area =      1.765(Sq.Ft)
  '     '        Froude number =     2.100

Upstream point elevation =  2902.000(Ft.)
Downstream point elevation =  2884.600(Ft.)
Flow length =   514.100(Ft.)
Travel time  =    0.98 min.
Time of concentration =   13.66 min.
Depth of flow =   1.085(Ft.)
Average velocity =   8.776(Ft/s)
Total irregular channel flow =    15.486(CFS)
Irregular channel normal depth above invert elev. =   1.085(Ft.)
Average velocity of channel(s) =   8.776(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      104.000
**** CONFLUENCE OF MINOR STREAMS ****
```

```
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      2.800(Ac.)
Runoff from this stream =     15.486(CFS)
Time of concentration =   13.66 min.
Rainfall intensity =     6.086(In/Hr)
Area averaged loss rate (Fm) =    0.2651(In/Hr)
Area averaged Pervious ratio (Ap) = 1.0000
Summary of stream data:

Stream  Area  Flow rate      TC     Fm       Rainfall Intensity
 No.    (Ac.)   (CFS)       (min) (In/Hr)     (In/Hr)


1     67.74    13.320     14.23    0.265      5.915
2     15.49     2.800     13.66    0.265      6.086
Qmax(1) =
           1.000 *    1.000 *    67.737) +
           0.971 *    1.000 *    15.486) + =      82.769
Qmax(2) =
           1.030 *    0.960 *    67.737) +
           1.000 *    1.000 *    15.486) + =      82.491

Total of 2 streams to confluence:
Flow rates before confluence point:
      67.737      15.486
Maximum flow rates at confluence using above data:
       82.769       82.491
Area of streams before confluence:
       13.320        2.800
Effective area values after confluence:
       16.120       15.590
Results of confluence:
Total flow rate =     82.769(CFS)
Time of concentration =    14.226 min.
Effective stream area after confluence =     16.120(Ac.)
Study area average Pervious fraction(Ap) =  1.000
Study area average soil loss rate(Fm) =    0.265(In/Hr)
Study area total (this main stream) =      16.12(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      107.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
------------------------------------------------------------------------
Estimated mean flow rate at midpoint of channel =      0.000(CFS)
Depth of flow =   2.532(Ft.), Average velocity =  14.841(Ft/s)
!!Warning: Water is above left or right bank elevations
        ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              1.00
        2              3.00              0.00
Manning's 'N' friction factor =   0.020
------------------------------------------------------------------
Sub-Channel flow  =     90.460(CFS)
  '     '        flow top width =      3.000(Ft.)
  '     '    velocity=   14.841(Ft/s)
```

```
  '     '        area =      6.095(Sq.Ft)
  '     '        Froude number =     1.835

Upstream point elevation =  2884.600(Ft.)
Downstream point elevation =  2872.000(Ft.)
Flow length =   757.600(Ft.)
Travel time  =    0.85 min.
Time of concentration =   15.08 min.
Depth of flow =   2.532(Ft.)
Average velocity =  14.841(Ft/s)
Total irregular channel flow =    90.460(CFS)
Irregular channel normal depth above invert elev. =   2.532(Ft.)
Average velocity of channel(s) =  14.841(Ft/s)
!!Warning: Water is above left or right bank elevations
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.450
Decimal fraction soil group C = 0.550
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 82.40
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.329(In/Hr)
Rainfall intensity =      5.680(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.856
Subarea runoff =     15.293(CFS) for    4.050(Ac.)
Total runoff =     98.062(CFS)
Effective area this stream =       20.17(Ac.)
Total Study Area (Main Stream No. 1) =       20.17(Ac.)
Area averaged Fm value =    0.278(In/Hr)
Depth of flow =   2.633(Ft.), Average velocity =  15.328(Ft/s)
!!Warning: Water is above left or right bank elevations
End of computations, Total Study Area =           20.17 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  85.3
```

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2004 Version 7.0
Rational Hydrology Study Date: 01/30/20

TRACT NO. 20280
PROPOSED CONDITION, ON-SITE AREA
10-Year, 24-Hours Storm

Program License Serial Number 4009

********* Hydrology Study Control Information **********

Rational hydrology study storm event year is 10.0
Computed rainfall intensity:
Storm year = 10.00 24 hour rainfall = 2.160 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 101.000 to Point/Station 102.000
**** INITIAL AREA EVALUATION ****

RESIDENTIAL(5 - 7 dwl/acre)
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 69.00
Pervious ratio(Ap) = 0.5000 Max loss rate(Fm)= 0.274(In/Hr)
Initial subarea data:
Initial area flow distance = 470.600(Ft.)
Top (of initial area) elevation = 2907.300(Ft.)
Bottom (of initial area) elevation = 2897.000(Ft.)
Difference in elevation = 10.300(Ft.)
Slope = 0.02189 s(%)= 2.19
TC = k(0.389)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 9.794 min.
Rainfall intensity = 7.682(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.868
Subarea runoff = 17.735(CFS)
Total initial stream area = 2.660(Ac.)
Pervious area fraction = 0.500
Initial area Fm value = 0.274(In/Hr)

++
Process from Point/Station 102.000 to Point/Station 103.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation = 2897.000(Ft.)
Downstream point/station elevation = 2892.700(Ft.)
Pipe length = 310.00(Ft.) Manning's N = 0.013

```
No. of pipes = 1  Required pipe flow  =    17.735(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    17.735(CFS)
Normal flow depth in pipe =   16.36(In.)
Flow top width inside pipe =   17.43(In.)
Critical Depth =   18.42(In.)
Pipe flow velocity =      8.83(Ft/s)
Travel time through pipe =    0.59 min.
Time of concentration (TC) =    10.38 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      103.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      2.660(Ac.)
Runoff from this stream =     17.735(CFS)
Time of concentration =   10.38 min.
Rainfall intensity =     7.376(In/Hr)
Area averaged loss rate (Fm) =    0.2740(In/Hr)
Area averaged Pervious ratio (Ap) = 0.5000
Summary of stream data:

Stream  Area  Flow rate      TC     Fm       Rainfall Intensity
 No.    (Ac.)   (CFS)       (min) (In/Hr)     (In/Hr)


1     17.74     2.660     10.38    0.274      7.376
Qmax(1) =
           1.000 *    1.000 *    17.735) + =      17.735

Total of 1 streams to confluence:
Flow rates before confluence point:
      17.735
Maximum flow rates at confluence using above data:
       17.735
Area of streams before confluence:
        2.660
Effective area values after confluence:
        2.660
Results of confluence:
Total flow rate =     17.735(CFS)
Time of concentration =    10.379 min.
Effective stream area after confluence =      2.660(Ac.)
Study area average Pervious fraction(Ap) =  0.500
Study area average soil loss rate(Fm) =    0.274(In/Hr)
Study area total (this main stream) =       2.66(Ac.)


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Process from Point/Station      103.100 to Point/Station      103.200
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
RESIDENTIAL(5 - 7 dwl/acre)
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 69.00
Pervious ratio(Ap) = 0.5000     Max loss rate(Fm)=     0.274(In/Hr)
Initial subarea data:
```

```
Initial area flow distance =   648.400(Ft.)
Top (of initial area) elevation =  2905.300(Ft.)
Bottom (of initial area) elevation =  2895.000(Ft.)
Difference in elevation =    10.300(Ft.)
Slope =    0.01589  s(%)=       1.59
TC = k(0.389)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   11.871 min.
Rainfall intensity =      6.715(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.863
Subarea runoff =     16.114(CFS)
Total initial stream area =        2.780(Ac.)
Pervious area fraction = 0.500
Initial area Fm value =    0.274(In/Hr)


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Process from Point/Station      103.200 to Point/Station      103.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
________________________________________________________________________
Upstream point/station elevation =  2895.000(Ft.)
Downstream point/station elevation =  2892.700(Ft.)
Pipe length  =    55.70(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    16.114(CFS)
Given pipe size =     18.00(In.)
Calculated individual pipe flow  =    16.114(CFS)
Normal flow depth in pipe =   11.68(In.)
Flow top width inside pipe =   17.18(In.)
Critical depth could not be calculated.
Pipe flow velocity =     13.27(Ft/s)
Travel time through pipe =    0.07 min.
Time of concentration (TC) =    11.94 min.


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Process from Point/Station      103.000 to Point/Station      103.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      2.780(Ac.)
Runoff from this stream =     16.114(CFS)
Time of concentration =   11.94 min.
Rainfall intensity =     6.687(In/Hr)
Area averaged loss rate (Fm) =    0.2740(In/Hr)
Area averaged Pervious ratio (Ap) = 0.5000
Summary of stream data:

Stream  Area  Flow rate      TC     Fm       Rainfall Intensity
 No.    (Ac.)   (CFS)       (min) (In/Hr)     (In/Hr)


1     17.74     2.660     10.38    0.274      7.376
2     16.11     2.780     11.94    0.274      6.687
Qmax(1) =
          1.000 *    1.000 *    17.735) +
          1.107 *    0.869 *    16.114) + =      33.248
Qmax(2) =
          0.903 *    1.000 *    17.735) +
          1.000 *    1.000 *    16.114) + =      32.128

Total of 2 streams to confluence:
Flow rates before confluence point:
      17.735      16.114
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```
Maximum flow rates at confluence using above data:
       33.248       32.128
Area of streams before confluence:
        2.660        2.780
Effective area values after confluence:
        5.076        5.440
Results of confluence:
Total flow rate =     33.248(CFS)
Time of concentration =    10.379 min.
Effective stream area after confluence =      5.076(Ac.)
Study area average Pervious fraction(Ap) =  0.500
Study area average soil loss rate(Fm) =    0.274(In/Hr)
Study area total (this main stream) =       5.44(Ac.)


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Process from Point/Station      103.000 to Point/Station      104.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =  2892.700(Ft.)
Downstream point/station elevation =  2888.300(Ft.)
Pipe length  =   290.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    33.248(CFS)
Nearest computed pipe diameter  =     27.00(In.)
Calculated individual pipe flow  =    33.248(CFS)
Normal flow depth in pipe =   19.50(In.)
Flow top width inside pipe =   24.19(In.)
Critical Depth =   23.69(In.)
Pipe flow velocity =     10.81(Ft/s)
Travel time through pipe =    0.45 min.
Time of concentration (TC) =    10.83 min.


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Process from Point/Station      104.000 to Point/Station      104.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      5.076(Ac.)
Runoff from this stream =     33.248(CFS)
Time of concentration =   10.83 min.
Rainfall intensity =     7.162(In/Hr)
Area averaged loss rate (Fm) =    0.2740(In/Hr)
Area averaged Pervious ratio (Ap) = 0.5000
Summary of stream data:

Stream  Area  Flow rate      TC     Fm       Rainfall Intensity
 No.    (Ac.)   (CFS)       (min) (In/Hr)     (In/Hr)


1     33.25     5.076     10.83    0.274      7.162
Qmax(1) =
           1.000 *    1.000 *    33.248) + =      33.248

Total of 1 streams to confluence:
Flow rates before confluence point:
      33.248
Maximum flow rates at confluence using above data:
       33.248
Area of streams before confluence:
        5.076
Effective area values after confluence:
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```
        5.076
Results of confluence:
Total flow rate =     33.248(CFS)
Time of concentration =    10.827 min.
Effective stream area after confluence =      5.076(Ac.)
Study area average Pervious fraction(Ap) =  0.500
Study area average soil loss rate(Fm) =    0.274(In/Hr)
Study area total (this main stream) =       5.08(Ac.)


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Process from Point/Station      104.100 to Point/Station      104.200
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
RESIDENTIAL(5 - 7 dwl/acre)
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 69.00
Pervious ratio(Ap) = 0.5000     Max loss rate(Fm)=     0.274(In/Hr)
Initial subarea data:
Initial area flow distance =   867.200(Ft.)
Top (of initial area) elevation =  2904.000(Ft.)
Bottom (of initial area) elevation =  2891.700(Ft.)
Difference in elevation =    12.300(Ft.)
Slope =    0.01418  s(%)=       1.42
TC = k(0.389)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   13.641 min.
Rainfall intensity =      6.092(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.860
Subarea runoff =     23.250(CFS)
Total initial stream area =        4.440(Ac.)
Pervious area fraction = 0.500
Initial area Fm value =    0.274(In/Hr)


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Process from Point/Station      104.200 to Point/Station      104.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
________________________________________________________________________
Upstream point/station elevation =  2891.700(Ft.)
Downstream point/station elevation =  2888.300(Ft.)
Pipe length  =    55.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    23.250(CFS)
Given pipe size =     18.00(In.)
Calculated individual pipe flow  =    23.250(CFS)
Normal flow depth in pipe =   13.22(In.)
Flow top width inside pipe =   15.90(In.)
Critical depth could not be calculated.
Pipe flow velocity =     16.70(Ft/s)
Travel time through pipe =    0.05 min.
Time of concentration (TC) =    13.70 min.


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Process from Point/Station      104.000 to Point/Station      104.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      4.440(Ac.)
Runoff from this stream =     23.250(CFS)
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```
Time of concentration =   13.70 min.
Rainfall intensity =     6.075(In/Hr)
Area averaged loss rate (Fm) =    0.2740(In/Hr)
Area averaged Pervious ratio (Ap) = 0.5000
Summary of stream data:

Stream  Area  Flow rate      TC     Fm       Rainfall Intensity
 No.    (Ac.)   (CFS)       (min) (In/Hr)     (In/Hr)


1     33.25     5.076     10.83    0.274      7.162
2     23.25     4.440     13.70    0.274      6.075
Qmax(1) =
           1.000 *    1.000 *    33.248) +
           1.187 *    0.791 *    23.250) + =      55.069
Qmax(2) =
           0.842 *    1.000 *    33.248) +
           1.000 *    1.000 *    23.250) + =      51.252

Total of 2 streams to confluence:
Flow rates before confluence point:
      33.248      23.250
Maximum flow rates at confluence using above data:
       55.069       51.252
Area of streams before confluence:
        5.076        4.440
Effective area values after confluence:
        8.586        9.516
Results of confluence:
Total flow rate =     55.069(CFS)
Time of concentration =    10.827 min.
Effective stream area after confluence =      8.586(Ac.)
Study area average Pervious fraction(Ap) =  0.500
Study area average soil loss rate(Fm) =    0.274(In/Hr)
Study area total (this main stream) =       9.52(Ac.)


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Process from Point/Station      104.000 to Point/Station      105.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =  2888.300(Ft.)
Downstream point/station elevation =  2883.800(Ft.)
Pipe length  =   298.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    55.069(CFS)
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    55.069(CFS)
Normal flow depth in pipe =   23.30(In.)
Flow top width inside pipe =   30.07(In.)
Critical Depth =   29.00(In.)
Pipe flow velocity =     12.27(Ft/s)
Travel time through pipe =    0.40 min.
Time of concentration (TC) =    11.23 min.


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Process from Point/Station      105.000 to Point/Station      105.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      8.586(Ac.)
Runoff from this stream =     55.069(CFS)
```

```
Time of concentration =   11.23 min.
Rainfall intensity =     6.980(In/Hr)
Area averaged loss rate (Fm) =    0.2740(In/Hr)
Area averaged Pervious ratio (Ap) = 0.5000
Summary of stream data:

Stream  Area  Flow rate      TC     Fm       Rainfall Intensity
 No.    (Ac.)   (CFS)       (min) (In/Hr)     (In/Hr)


1     55.07     8.586     11.23    0.274      6.980
Qmax(1) =
           1.000 *    1.000 *    55.069) + =      55.069

Total of 1 streams to confluence:
Flow rates before confluence point:
      55.069
Maximum flow rates at confluence using above data:
       55.069
Area of streams before confluence:
        8.586
Effective area values after confluence:
        8.586
Results of confluence:
Total flow rate =     55.069(CFS)
Time of concentration =    11.231 min.
Effective stream area after confluence =      8.586(Ac.)
Study area average Pervious fraction(Ap) =  0.500
Study area average soil loss rate(Fm) =    0.274(In/Hr)
Study area total (this main stream) =       8.59(Ac.)


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Process from Point/Station      105.100 to Point/Station      105.200
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
RESIDENTIAL(5 - 7 dwl/acre)
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 69.00
Pervious ratio(Ap) = 0.5000     Max loss rate(Fm)=     0.274(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  2906.800(Ft.)
Bottom (of initial area) elevation =  2904.100(Ft.)
Difference in elevation =     2.700(Ft.)
Slope =    0.00270  s(%)=       0.27
TC = k(0.389)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   20.122 min.
Rainfall intensity =      4.641(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.847
Subarea runoff =     11.633(CFS)
Total initial stream area =        2.960(Ac.)
Pervious area fraction = 0.500
Initial area Fm value =    0.274(In/Hr)


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Process from Point/Station      105.200 to Point/Station      105.300
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
```

Top of street segment elevation = 2904.100(Ft.)
End of street segment elevation = 2885.000(Ft.)
Length of street segment = 754.000(Ft.)
Height of curb above gutter flowline = 6.0(In.)
Width of half street (curb to crown) = 23.000(Ft.)
Distance from crown to crossfall grade break = 11.000(Ft.)
Slope from gutter to grade break (v/hz) = 1.000
Slope from grade break to crown (v/hz) = 1.000
Street flow is on [2] side(s) of the street
Distance from curb to property line = 5.000(Ft.)
Slope from curb to property line (v/hz) = 2.000
Gutter width = 2.000(Ft.)
Gutter hike from flowline = 2.000(In.)
Manning's N in gutter = 0.0150
Manning's N from gutter to grade break = 0.0130
Manning's N from grade break to crown = 0.0150
Estimated mean flow rate at midpoint of street = 16.717(CFS)
Depth of flow = 0.575(Ft.), Average velocity = 7.820(Ft/s)
Warning: depth of flow exceeds top of curb
Distance that curb overflow reaches into property = 0.04(Ft.)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width = 2.409(Ft.)
Flow velocity = 7.82(Ft/s)
Travel time = 1.61 min. TC = 21.73 min.
Adding area flow to street
RESIDENTIAL(5 - 7 dwl/acre)
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 69.00
Pervious ratio(Ap) = 0.5000 Max loss rate(Fm)= 0.274(In/Hr)
Rainfall intensity = 4.398(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.844
Subarea runoff = 10.004(CFS) for 2.870(Ac.)
Total runoff = 21.637(CFS)
Effective area this stream = 5.83(Ac.)
Total Study Area (Main Stream No. 1) = 15.71(Ac.)
Area averaged Fm value = 0.274(In/Hr)
Street flow at end of street = 21.637(CFS)
Half street flow at end of street = 10.819(CFS)
Depth of flow = 0.659(Ft.), Average velocity = 8.464(Ft/s)
Warning: depth of flow exceeds top of curb
Distance that curb overflow reaches into property = 0.08(Ft.)
Flow width (from curb towards crown)= 2.492(Ft.)

++
Process from Point/Station 105.300 to Point/Station 105.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 2885.000(Ft.)
Downstream point/station elevation = 2883.800(Ft.)
Pipe length = 55.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 21.637(CFS)
Given pipe size = 18.00(In.)
NOTE: Normal flow is pressure flow in user selected pipe size.
The approximate hydraulic grade line above the pipe invert is
2.064(Ft.) at the headworks or inlet of the pipe(s)
Pipe friction loss = 2.333(Ft.)

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 Minor friction loss =      0.931(Ft.)  K-factor =   0.40
Pipe flow velocity =     12.24(Ft/s)
Travel time through pipe =    0.07 min.
Time of concentration (TC) =    21.80 min.


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Process from Point/Station      105.000 to Point/Station      105.000
**** CONFLUENCE OF MINOR STREAMS ****
_____________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      5.830(Ac.)
Runoff from this stream =     21.637(CFS)
Time of concentration =   21.80 min.
Rainfall intensity =     4.387(In/Hr)
Area averaged loss rate (Fm) =    0.2740(In/Hr)
Area averaged Pervious ratio (Ap) = 0.5000
Summary of stream data:

Stream  Area  Flow rate      TC     Fm       Rainfall Intensity
 No.    (Ac.)   (CFS)       (min) (In/Hr)     (In/Hr)


1     55.07     8.586     11.23    0.274      6.980
2     21.64     5.830     21.80    0.274      4.387
Qmax(1) =
           1.000 *    1.000 *    55.069) +
           1.630 *    0.515 *    21.637) + =      73.241
Qmax(2) =
           0.613 *    1.000 *    55.069) +
           1.000 *    1.000 *    21.637) + =      55.414

Total of 2 streams to confluence:
Flow rates before confluence point:
      55.069      21.637
Maximum flow rates at confluence using above data:
       73.241       55.414
Area of streams before confluence:
        8.586        5.830
Effective area values after confluence:
       11.589       14.416
Results of confluence:
Total flow rate =     73.241(CFS)
Time of concentration =    11.231 min.
Effective stream area after confluence =     11.589(Ac.)
Study area average Pervious fraction(Ap) =  0.500
Study area average soil loss rate(Fm) =    0.274(In/Hr)
Study area total (this main stream) =      14.42(Ac.)


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Process from Point/Station      105.000 to Point/Station      106.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
_____________________________________________________________________________
Top of street segment elevation =  2883.800(Ft.)
End of street segment elevation =  2881.300(Ft.)
Length of street segment  =   166.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  23.000(Ft.)
Distance from crown to crossfall grade break  =  11.000(Ft.)
Slope from gutter to grade break (v/hz) =   1.000
Slope from grade break to crown (v/hz)  =   1.000
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Street flow is on [2] side(s) of the street
Distance from curb to property line  =   5.000(Ft.)
Slope from curb to property line (v/hz) =   2.000
Gutter width =   2.000(Ft.)
Gutter hike from flowline =  2.000(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0130
 Manning's N from grade break to crown =  0.0150
Estimated mean flow rate at midpoint of street =     75.598(CFS)
Depth of flow =   1.447(Ft.), Average velocity =  10.026(Ft/s)
Warning: depth of flow exceeds top of curb
Distance that curb overflow reaches into property =    0.47(Ft.)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =   3.280(Ft.)
Flow velocity =  10.03(Ft/s)
Travel time =    0.28 min.     TC =   11.51  min.
 Adding area flow to street
RESIDENTIAL(5 - 7 dwl/acre)
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 69.00
Pervious ratio(Ap) = 0.5000     Max loss rate(Fm)=     0.274(In/Hr)
Rainfall intensity =      6.863(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.864
Subarea runoff =      4.553(CFS) for    1.530(Ac.)
Total runoff =     77.793(CFS)
Effective area this stream =       13.12(Ac.)
Total Study Area (Main Stream No. 1) =       17.24(Ac.)
Area averaged Fm value =    0.274(In/Hr)
Street flow at end of street =     77.793(CFS)
Half street flow at end of street =     38.897(CFS)
Depth of flow =   1.468(Ft.), Average velocity =  10.103(Ft/s)
Warning: depth of flow exceeds top of curb
Distance that curb overflow reaches into property =    0.48(Ft.)
Flow width (from curb towards crown)=   3.301(Ft.)


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Process from Point/Station      106.000 to Point/Station      107.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =  2881.300(Ft.)
End of street segment elevation =  2877.200(Ft.)
Length of street segment  =   276.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  23.000(Ft.)
Distance from crown to crossfall grade break  =  11.000(Ft.)
Slope from gutter to grade break (v/hz) =   1.000
Slope from grade break to crown (v/hz)  =   1.000
Street flow is on [2] side(s) of the street
Distance from curb to property line  =   5.000(Ft.)
Slope from curb to property line (v/hz) =   2.000
Gutter width =   2.000(Ft.)
Gutter hike from flowline =  2.000(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0130
 Manning's N from grade break to crown =  0.0150
Estimated mean flow rate at midpoint of street =     81.216(CFS)
Depth of flow =   1.506(Ft.), Average velocity =  10.169(Ft/s)
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Warning: depth of flow exceeds top of curb
Distance that curb overflow reaches into property =    0.50(Ft.)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =   3.339(Ft.)
Flow velocity =  10.17(Ft/s)
Travel time =    0.45 min.     TC =   11.96  min.
 Adding area flow to street
RESIDENTIAL(5 - 7 dwl/acre)
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.500
Decimal fraction soil group D = 0.500
SCS curve number for soil(AMC 2)  = 72.00
Pervious ratio(Ap) = 0.5000     Max loss rate(Fm)=     0.251(In/Hr)
Rainfall intensity =      6.680(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.863
Subarea runoff =      6.695(CFS) for    1.530(Ac.)
Total runoff =     84.489(CFS)
Effective area this stream =       14.65(Ac.)
Total Study Area (Main Stream No. 1) =       18.77(Ac.)
Area averaged Fm value =    0.272(In/Hr)
Street flow at end of street =     84.489(CFS)
Half street flow at end of street =     42.244(CFS)
Depth of flow =   1.536(Ft.), Average velocity =  10.276(Ft/s)
Warning: depth of flow exceeds top of curb
Distance that curb overflow reaches into property =    0.52(Ft.)
Flow width (from curb towards crown)=   3.369(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      107.000 to Point/Station      108.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
PARK subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 1.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 56.00
Pervious ratio(Ap) = 0.8500     Max loss rate(Fm)=     0.624(In/Hr)
Time of concentration =    11.96 min.
Rainfall intensity =      6.680(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.861
Subarea runoff =      5.123(CFS) for    0.940(Ac.)
Total runoff =     89.612(CFS)
Effective area this stream =       15.59(Ac.)
Total Study Area (Main Stream No. 1) =       19.71(Ac.)
Area averaged Fm value =    0.293(In/Hr)
End of computations, Total Study Area =           19.71 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 0.517
Area averaged SCS curve number =  68.6
```

Rational Method for Tc Calulation

Appendix II

Education Material

The Updated Model Water Efficient Landscape Ordinance

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Landscapes are essential to the quality of life in California. They provide areas for recreation, enhance the environment, clean the air and water, prevent erosion, offer fire protection and replace ecosystems lost to development.

California's economic prosperity and environmental quality are dependant on an adequate supply of water for beneficial uses. In California, about half of the urban water used is for landscape irrigation. Ensuring **efficient landscapes** in new developments and reducing water waste in existing landscapes are the most cost-effective ways to stretch our limited water supplies and ensure that we continue to have sufficient water for California to prosper.

The Water Conservation in Landscaping Act of 2006 (Assembly Bill 1881, Laird) requires cities, counties, and charter cities and charter counties, to adopt landscape water conservation ordinances by January 1, 2010. Pursuant to this law, the Department of Water Resources (DWR) has prepared a Model Water Efficient Landscape Ordinance (Model Ordinance) for use by local agencies. The Model Ordinance was approved by the Office of Administrative Law on September 10, 2009. The Model Ordinance became effective on September 10.

All local agencies must adopt a water efficient landscape ordinance by **January 1, 2010**. The local agencies may adopt the state Model Ordinance, or craft an ordinance to fit local conditions. In addition, several local agencies may collaborate and craft a region-wide ordinance. In any case, the adopted ordinance must be as effective as the Model Ordinance in regard to water conservation.

For more information, please visit our web site at
http://www.water.ca.gov/wateruseefficiency/landscapeordinance/

DWR October 2009

Model Water Efficient Landscape Ordinance
CALIFORNIA DEPARTMENT OF WATER RESOURCES

Important points to consider...

Water purveyors have an important role.
The enabling statute was directed to local agencies that make land use decisions and approve land development. Active participation by water purveyors can make the implementation, enforcement and follow-up actions of an ordinance more effective.

Most new and rehabilitated landscapes are subject to a water efficient landscape ordinance. Public landscapes and private development projects including developer installed single family and multi-family residential landscapes with at least 2500 sq. ft. of landscape area are subject to the Model Ordinance .

Homeowner provided landscaping at single family and multi-family homes are subject to the Model Ordinance if the landscape area is at least 5000 sq. ft

Existing landscapes are also subject to the Model Ordinance.
Water waste is common in landscapes that are poorly designed or not well maintained. Water waste (from runoff, overspray, low head drainage, leaks and excessive amounts of applied irrigation water in landscapes is prohibited by Section 2, Article X of the California Constitution.

Any landscape installed prior to January 1, 2010, that is at least one acre in size may be subject to irrigation audits, irrigation surveys or water use analysis programs for evaluating irrigation system performance and adherence to the Maximum Applied Water Allowance as defined in the 1992 Model Ordinance with an Evapotranspiration Adjustment Factor (ETAF) of 0.8. Local agencies and water purveyors (designated by the local agency) may institute these or other programs to increase efficiency in existing landscapes.

All new landscapes will be assigned a water budget.
The water budget approach is a provision in the statute that ensures a landscape is allowed sufficient water. There are two water budgets in the Model Ordinance; the Maximum Applied Water Allowance (MAWA) and the Estimated Total Water Use (ETWU).

The MAWA, is the water budget used for compliance and is an annual water allowance based on landscape area, local evapotranspiration and ETAF of 0.7. The ETWU is an annual water use estimation for design purposes and is based on the water needs of the plants actually chosen for a given landscape. The ETWU may not exceed the MAWA.

Water efficient landscapes offer multiple benefits.
Water efficient landscapes will stretch our limited water supplies. Other benefits include reduced irrigation runoff, reduced pollution of waterways, less property damage, less green waste, increased drought resistance and a smaller carbon footprint.

The Department of Water Resources will offer technical assistance.
The Department plans to offer a series of workshops, publications and other assistance for successful adoption and implementation of the Model Ordinance or local water efficient landscape ordinances. Information regarding these resources may be found on the DWR website: **http://www.water.ca.gov/wateruseefficiency/landscapeordinance/**
Questions on the Model Ordinance may be sent by e-mail to DWR staff at: **mweo@water.ca.gov.**

R-3
AUTOMOBILE PARKING

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	
Bacteria	
Foaming Agents	
Metals	X
Hydrocarbons	X
Hazardous Materials	x
Pesticides and Herbicides	
Other	

Parked automobiles may contribute pollutants to the storm drain because poorly maintained vehicles may leak fluids containing hydrocarbons, metals, and other pollutants. In addition, heavily soiled automobiles may drop clods of dirt onto the parking surface, contributing to the sediment load when runoff is present. During rain events, or wash-down activities, the pollutants may be carried into the storm drain system. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before parking your car. Remember - The ocean starts at your front door.

Required Activities

- If required, vehicles have to be removed from the street during designated street sweeping/cleaning times.
- If the automobile is leaking, place a pan or similar collection device under the automobile, until such time as the leak may be repaired.
- Use dry cleaning methods to remove any materials deposited by vehicles (e.g. adsorbents for fluid leaks, sweeping for soil clod deposits).

Recommended Activities

- Park automobiles over permeable surfaces (e.g. gravel, or porous cement).
- Limit vehicle parking to covered areas.
- Perform routine maintenance to minimize fluid leaks, and maximize fuel efficiency.

For additional information contact:
County of Orange, OC **Watershed**
Main: (714) 955-0600/ 24hr Water Pollution Discharge Hotline 1-877-89-SPILL
or visit our website at: www.ocwatersheds.com

R-5
DISPOSAL OF PET WASTES

Pet wastes left in the environment may introduce solids, bacteria, and nutrients to the storm drain. The type and quantity of waste will dictate the proper disposal method. Small quantities of waste are best disposed with regular trash or flushed down a toilet. Large quantities of wastes from herbivore animals may be composted for subsequent use or disposal to landfill.

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	x
Bacteria	x
Foaming Agents	
Metals	
Hydrocarbons	
Hazardous Materials	
Pesticides and Herbicides	
Other	

Pick up after your pet! It's as easy as 1-2-3. 1) Bring a bag. 2) Clean it up. 3) Dispose of it properly (toilet or trash). The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before you dispose of any pet wastes. Remember - The ocean starts at your front door.

Required Activities

- All pet wastes must be picked up and properly disposed of. Pet waste should be disposed of in the regular trash, flushed down a toilet, or composted as type and quantities dictate.
- Properly dispose of unused flea control products (shampoo, sprays, or collars).
- Manure produced by livestock in uncovered areas should be removed at least daily for composting, or storage in water-tight container prior to disposal. Never hose down to stream or storm drain. Composting or storage areas should be configured and maintained so as not to allow contact with runoff. Compost may be donated to greenhouses, nurseries, and botanical parks. Topsoil companies and composting centers may also accept composted manure.
- Line waste pits or trenches with an impermeable layer, such as thick plastic sheeting.
- When possible, allow wash water to infiltrate into the ground, or collect in an area that is routed to the sanitary sewer.
- Confine livestock in fenced in areas except during exercise and grazing times. Restrict animal access to creeks and streams, preferably by fencing.

For additional information contact:
County of Orange, OC **Watershed**
Main: (714) 955-0600/ 24hr Water Pollution Discharge Hotline 1-877-89-SPILL
or visit our website at: www.ocwatersheds.com

- Install gutters that will divert roof runoff away from livestock areas.

Recommended Activities

- In order to properly dispose of pet waste, carry bags, pooper-scooper, or equivalent to safely pick up pet wastes while walking with pets.
- Bathe pets indoors and use less toxic shampoos. When possible, have pets professionally groomed.
- Properly inoculate your pet in order to maintain their health and reduce the possibility of pathogens in pet wastes.
- Maintain healthy and vigorous pastures with at least three inches of leafy material.
- Consider indoor feeding of livestock during heavy rainfall, to minimize manure exposed to potential runoff.
- Locate barns, corrals, and other high use areas on portions of property that either drain away from or are located distant form nearby creeks or storm drains.

For additional information contact:
County of Orange, OC **Watershed**
Main: (714) 955-0600/ 24hr Water Pollution Discharge Hotline 1-877-89-SPILL
or visit our website at: www.ocwatersheds.com

R-7
HOUSEHOLD HAZARDOUS WASTE

Household hazardous wastes (HHW) are defined as waste materials which are typically found in homes or similar sources, which exhibit characteristics such as: corrosivity, ignitability, reactivity, and/or toxicity, or are listed as hazardous materials by EPA.

The activities outlined in this fact sheet target the following pollutants:	
Sediment	
Nutrients	
Bacteria	
Foaming Agents	x
Metals	x
Hydrocarbons	x
Hazardous Materials	x
Pesticides and Herbicides	x
Other	x

List of most common HHW products:

- Drain openers
- Oven cleaners
- Wood and metal cleaners and polishes
- Automotive oil and fuel additives
- Grease and rust solvents
- Carburetor and fuel injection cleaners
- Starter fluids
- Batteries
- Paint Thinners
- Paint strippers and removers
- Adhesives
- Herbicides
- Pesticides
- Fungicides/wood preservatives

Many types of waste can be recycled, however options for each waste type are limited. Recycling is always preferable to disposal of unwanted materials. All gasoline, antifreeze, waste oil, and lead-acid batteries can be recycled. Latex and oil-based paint can be reused, as well as recycled. Materials that cannot be reused or recycled should be disposed of at a properly permitted landfill.

Think before disposing of any household hazardous waste. Remember - The ocean starts at your front door.

RECYCLE USED OIL

Required Activities

- Dispose of HHW at a local collection facility. Call (714) 834-6752 for the household hazardous waste center closest to your area.
- Household hazardous materials must be stored indoors or under cover, and in closed and labeled containers.
- If safe, contain, clean up, and properly dispose all household hazardous waste spills. If an unsafe condition exists, call 911 to activate the proper response team.

Recommended Activities

- Use non-hazardous or less-hazardous products.
- Participate in HHW reuse and recycling. Call (714) 834-6752 for the participating household hazardous waste centers.

The California Integrated Waste Management Board has a Recycling Hotline (800) 553-2962, that provides information and recycling locations for used oil.

For additional information contact:
County of Orange, OC **Watershed**
Main: (714) 955-0600/ 24hr Water Pollution Discharge Hotline 1-877-89-SPILL
or visit our website at: www.ocwatersheds.com

R-8
WATER CONSERVATION

Excessive irrigation and/or the overuse of water is often the most significant factor in transporting pollutants to the storm drain system. Pollutants from a wide variety of sources including automobile repair and maintenance, automobile washing, automobile parking, home and garden care activities and pet care may dissolve in the water and be transported to the storm drain. In addition, particles and materials coated with fertilizers and pesticides may be suspended in the flow and be transported to the storm drain.

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	x
Bacteria	x
Foaming Agents	x
Metals	x
Hydrocarbons	x
Hazardous Materials	x
Pesticides and Herbicides	x
Other	x

Hosing off outside areas to wash them down not only consumes large quantities of water, but also transports any pollutants, sediments, and waste to the storm drain system. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before using water. Remember - The ocean starts at your front door.

Required Activities

- Irrigation systems must be properly adjusted to reflect seasonal water needs.
- Do not hose off outside surfaces to clean, sweep with a broom instead.

Recommended Activities

- Fix any leaking faucets and eliminate unnecessary water sources.
- Use xeroscaping and drought tolerant landscaping to reduce the watering needs.
- Do not over watering lawns or gardens. Over watering wastes water and promotes diseases.
- Use a bucket to re-soak sponges/rags while washing automobiles and other items outdoors. Use hose only for rinsing.
- Wash automobiles at a commercial car wash employing water recycling.

For additional information contact:
County of Orange, OC **Watershed**
Main: (714) 955-0600/ 24hr Water Pollution Discharge Hotline 1-877-89-SPILL
or visit our website at: www.ocwatersheds.com

FP-2

LANDSCAPE MAINTENANCE

The model procedures described below focus on minimizing the discharge of pesticides and fertilizers, landscape waste, trash, debris, and other pollutants to the storm drain system and receiving waters. Landscape maintenance practices may involve one or more of the following activities:

1. **Mowing, Trimming/Weeding, and Planting**
2. **Irrigation**
3. **Fertilizer and Pesticide Management**
4. **Managing Landscape Waste**
5. **Erosion Control**

POLLUTION PREVENTION:

Pollution prevention measures have been considered and incorporated in the model procedures. Implementation of these measures may be more effective and reduce or eliminate the need to implement other more complicated or costly procedures. Possible pollution prevention measures for landscape maintenance include:

- Implement an integrated pest management (IPM) program. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools. Refer to Appendix D, Fertilizer and Pesticide Management Guidance for further details.
- Choose low water using flowers, trees, shrubs, and groundcover.
- Appropriate maintenance (i.e. properly timed fertilizing, weeding, pest control, and pruning) will preserve the landscapes water efficiency.
- Once per year, educate municipal staff on pollution prevention measures.

MODEL PROCEDURES:

1. Mowing, Trimming/Weeding, and Planting

Mowing, Trimming/Weeding

✓ Whenever possible, use mechanical methods of vegetation removal rather than applying herbicides. Use hand weeding where practical.

- ✓ When conducting mechanical or manual weed control, avoid loosening the soil, which could erode into streams or storm drains.
- ✓ Use coarse textured mulches or geotextiles to suppress weed growth and reduce the use of herbicides.
- ✓ Do not blow or rake leaves, etc. into the street or place yard waste in gutters or on dirt shoulders. Sweep up any leaves, litter or residue in gutters or on street.
- ✓ Collect lawn and garden clippings, pruning waste, tree trimmings, and weeds. Chip if necessary, and compost or dispose of at a landfill (see waste management section of this procedure sheet).
- ✓ Place temporarily stockpiled material away from watercourses, and berm or cover stockpiles to prevent material releases to storm drains.

Planting

- ✓ Where feasible, retain and/or plant selected native vegetation whose features are determined to be beneficial. Native vegetation usually requires less maintenance (e.g., irrigation, fertilizer) than planting ornamental vegetation.
- ✓ When planting or replanting consider using low water use groundcovers.

OPTIONAL:

- Careful soil mixing and layering techniques using a topsoil mix or composted organic material can be used as an effective measure to reduce herbicide use and watering.

2. Irrigation

- ✓ Utilize water delivery rates that do not exceed the infiltration rate of the soil.
- ✓ Use timers appropriately or a drip system to prevent runoff and then only irrigate as much as is needed.
- ✓ Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering, and repair leaks in the irrigation system as soon as they are observed.
- ✓ Where practical, use automatic timers to minimize runoff.
- ✓ Use popup sprinkler heads in areas with a lot of activity or where there is a chance the pipes may be broken. Consider the use of mechanisms that reduce water flow to sprinkler heads if broken.
- ✓ If re-claimed water is used for irrigation, ensure that there is no runoff from the landscaped area(s).
- ✓ If bailing of muddy water is required (e.g. when repairing a water line leak), do not put it in the storm drain; pour over landscaped areas.

3. Fertilizer and Pesticide Management

Usage

- ✓ Utilize a comprehensive management system that incorporates integrated pest management techniques.
- ✓ Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- ✓ Educate and train employees on use of pesticides and in pesticide application techniques to prevent pollution.
- ✓ Pesticide application must be under the supervision of a California qualified pesticide applicator.
- ✓ When applicable use the least toxic pesticides that will do the job. Avoid use of copper-based pesticides if possible.
- ✓ Do not mix or prepare pesticides or fertilizers for application near storm drains.
- ✓ Prepare the minimum amount of pesticide needed for the job and use the lowest rate that will effectively control the pest.
- ✓ Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.
- ✓ Calibrate fertilizer and pesticide application equipment to avoid excessive application.
- ✓ Periodically test soils for determining proper fertilizer use.
- ✓ Sweep pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- ✓ Inspect pesticide/fertilizer equipment and transportation vehicles daily.
- ✓ Refer to Appendix D for further guidance on Fertilizer and Pesticide management

OPTIONAL:

- Work fertilizers into the soil rather than dumping or broadcasting them onto the surface.
- Use beneficial insects where possible to control pests (green lacewings, ladybugs, praying mantis, ground beetles, parasitic nematodes, trichogramma wasps, seedhead weevils, and spiders prey on detrimental pest species).
- Use slow release fertilizers whenever possible to minimize leaching.

Scheduling

- ✓ Do not use pesticides if rain is expected within 24 hours.
- ✓ Apply pesticides only when wind speeds are low (less than 5 mph).

Disposal

- ✓ Purchase only the amount of pesticide that you can reasonably use in a given time period (month or year depending on the product).
- ✓ Triple rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- ✓ Dispose of empty pesticide containers according to the instructions on the container label.

4. Managing Landscape Waste

- ✓ Compost leaves, sticks, or other collected vegetation or dispose of at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.

Also see Waste Handling and Disposal procedure sheet

- ✓ Place temporarily stockpiled material away from watercourses and storm drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- ✓ Reduce the use of high nitrogen fertilizers that produce excess growth requiring more frequent mowing or trimming.
- ✓ Inspection of drainage facilities should be conducted to detect illegal dumping of clippings/cuttings in or near these facilities. Materials found should be picked up and properly disposed of.
- ✓ Landscape wastes in and around storm drain inlets should be avoided by either using bagging equipment or by manually picking up the material.

5. Erosion Control

- ✓ Maintain vegetative cover on medians and embankments to prevent soil erosion. Apply mulch or leave clippings to serve as additional cover for soil stabilization and to reduce the velocity of storm water runoff.

Also see Waste Handling and Disposal procedure sheet

- ✓ Minimize the use of disking as a means of vegetation management because the practice may result in erodable barren soil.
- ✓ Confine excavated materials to pervious surfaces away from storm drain inlets, sidewalks, pavement, and ditches. Material must be covered if rain is expected.

LIMITATIONS:

Alternative pest/weed controls may not be available, suitable, or effective in every case.

FP-6

WATER AND SEWER UTILITY OPERATION AND MAINTENANCE

Although the operation and maintenance of public utilities are not considered themselves a chronic source of stormwater pollution, some activities and accidents can result in the discharge of pollutants that can pose a threat to both human health and the quality of receiving waters if they enter the storm drain system. Activities associated with the operation and maintenance of water and sewer utilities to prevent and handle such incidents include the following:

1. **Water Line Maintenance**
2. **Sanitary Sewer Maintenance**
3. **Spill/Leak/Overflow Control, Response, and Containment**

Cities that do not provide maintenance of water and sewer utilities should coordinate with the contracting agency responsible for these activities and ensure that these model procedures are followed.

POLLUTION PREVENTION:

Pollution prevention measures have been considered and incorporated in the model procedures. Implementation of these measures may be more effective and reduce or eliminate the need to implement other more complicated or costly procedures. Possible pollution prevention measures for water and sewer utility operation and maintenance include:

- Inspect potential non-storm water discharge flow paths and clear/cleanup any debris or pollutants found (i.e. remove trash, leaves, sediment, and wipe up liquids, including oil spills).
- Once per year, educate municipal staff on pollution prevention measures.

MODEL PROCEDURES:

1. Water Line Maintenance

Procedures can be employed to reduce pollutants from discharges associated with water utility operation and maintenance activities. Planned discharges may include fire hydrant testing, flushing water supply mains after new construction, flushing lines due to complaints of taste and odor, dewatering mains for maintenance work. Unplanned discharges from treated, recycled water, raw water, and groundwater systems operation and maintenance activities can occur from water main breaks, sheared fire hydrants, equipment malfunction, and operator error.

Planned Discharges

✓ For planned discharges use one of the following options:

- Reuse water for dust suppression, irrigation, or construction compaction
- Discharge to the sanitary sewer system with approval
- Discharge to the storm drain system or to a creek using applicable pollution control measures listed below (this option is ONLY applicable to uncontaminated pumped ground water, water line flushing, fire hydrant testing and flushing, discharges from potable water sources other than water main breaks) and may require a permit from the Regional Water Quality Control Board.

✓ If water is discharged to a storm drain inlet (catch basin), control measures must be put in place to control potential pollutants (i.e. sediment, chlorine, etc.). Examples of some storm drain inlet protection options include:

- Silt fence – appropriate where the inlet drains a relatively flat area.
- Gravel and wire mesh sediment filter – Appropriate where concentrated flows are expected.
- Wooden weir and fabric – use at curb inlets where a compact installation is desired.

✓ Prior to discharge, inspect discharge flow path and clear/cleanup any debris or pollutants found (i.e. remove trash, leaves, sediment, and wipe up liquids, including oil spills).

✓ Select appropriate pollution control measure(s) considering the receiving system (i.e. curb inlet, drop inlet, culvert, creek, etc.) and ensure that the control device(s) fit properly.

✓ General design considerations for inlet protection devices include the following:

- The device should be constructed such that cleaning and disposal of trapped sediment is made easy, while minimizing interference with discharge activities.
- Devices should be constructed so that any standing water resulting from the discharge will not cause excessive inconvenience or flooding/damage to adjacent land or structures.

✓ The effectiveness of control devices must be monitored during the discharge period and any necessary repairs or modifications made as needed.

OPTIONAL:

- Sediment removal may be enhanced by placing filter fabric, gravel bags, etc. at storm drain inlets.

Unplanned Discharges

✓ Stop the discharge as quickly as possible by turning off water source.

✓ Inspect flow path of the discharged water:

- Control erosion along the flow path.
- Identify areas that may produce significant sediment or gullies, use sandbags to redirect the flow.
- Identify erodible areas which may need to be repaired or protected during subsequent repairs or corrective actions

✓ If repairs or corrective action will cause additional discharges of water, select the appropriate procedures for erosion control, chlorine residual, turbidity, and chemical additives. Prevent potential pollutants from entering the flow path and ensure that no additional discharged water enters storm drain inlets.

2. Sanitary Sewer Maintenance

Applicable to municipalities who own and operated a sewage collection system. Facilities that are covered under this program include sanitary sewer pipes and pump stations owned and operated by the Permittee. The owner of the sanitary sewer facilities is the entity responsible for carrying out this prevention and response program.

Sewer System Cleaning

- ✓ Sewer lines should be cleaned on a regular basis to remove grease, grit, and other debris that may lead to sewer backups.
- ✓ Establish routine maintenance program. Cleaning should be conducted at an established minimum frequency and more frequently for problem areas such as restaurants that are identified
- ✓ Cleaning activities may require removal of tree roots and other identified obstructions.

Preventative and Corrective Maintenance

- ✓ During routine maintenance and inspection note the condition of sanitary sewer structures and identify areas that need repair or maintenance. Items to note may include the following:
  - cracked/deteriorating pipes
  - leaking joints/seals at manhole
  - frequent line plugs
  - line generally flows at or near capacity
  - suspected infiltration or exfiltration
- ✓ Document suggestions and requests for repair and report the information to the appropriate manager or supervisor.
- ✓ Prioritize repairs based on the nature and severity of the problem. Immediate clearing of blockage or repair is required where an overflow is currently occurring or for urgent problems that may cause an imminent overflow (e.g. pump station failures, sewer line ruptures, sewer line blockages). These repairs may be temporary until scheduled or capital improvements can be completed.
- ✓ Review previous sewer maintenance records to help identify "hot spots" or areas with frequent maintenance problems and locations of potential system failure.

3. Spill/Leak/Overflow Control, Response, and Containment

Control

Also see Drainage System procedures sheet

- ✓ Refer to countywide *Illicit Discharge Detection and Elimination Program.* Components of this program include:
  - Investigation/inspection and follow-up
  - Elimination of illicit discharges and connections
  - Enforcement of ordinances
  - Respond to sewage spills

- Facilitate public reporting of illicit discharges and connections. A citizen's hotline for reporting observed overflow conditions should be established to supplement the field screening efforts being conducted by the Principal Permittee.

Response and Containment

- ✓ Establish lead department/agency responsible for spill response and containment. Provide coordination within departments.
- ✓ When a spill, leak, and/or overflow occurs, keep sewage from entering the storm drain system to the maximum extent practicable by covering or blocking storm drain inlets or by containing and diverting the sewage away from open channels and other storm drain facilities (using sandbags, inflatable dams, etc.).
- ✓ If a spill reaches the storm drain notify County of Orange Health Care Agency through Control One at (714) 628-7208.
- ✓ Remove the sewage using vacuum equipment or use other measures to divert it back to the sanitary sewer system.
- ✓ Record required information at the spill site.
- ✓ Perform field tests as necessary to determine the source of the spill.
- ✓ Develop additional notification procedures regarding spill reporting as needed.

LIMITATIONS:

Private property access rights needed to perform testing along storm drain right-of-ways. Requirements of municipal ordinance authority for suspected source verification testing necessary for guaranteed rights of entry.

REFERENCES:

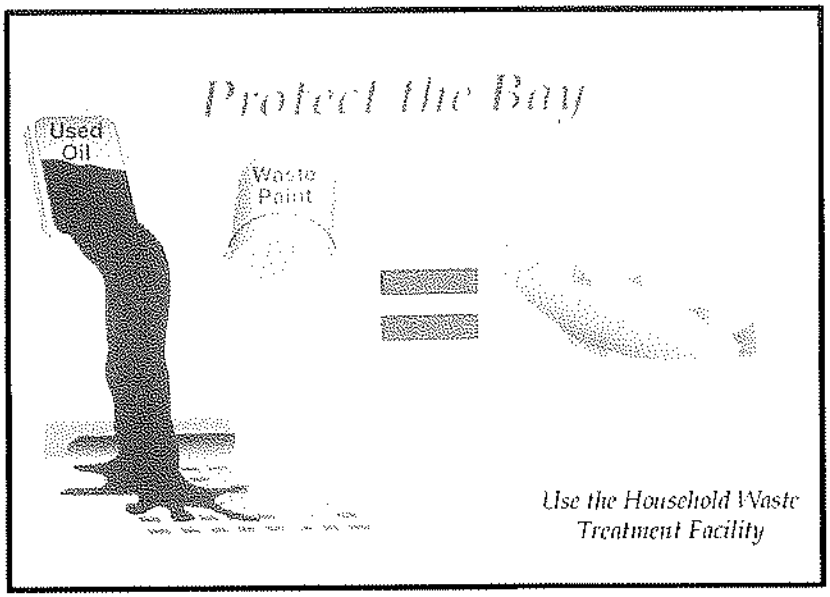
California Storm Water Best Management Practice Handbooks. Municipal Best Management Practice Handbook. Prepared by Camp Dresser & McKee, Larry Walker Associates, Uribe and Associates, Resources Planning Associates for Stormwater Quality Task Force. March 1993.

Los Angeles County Stormwater Quality. Public Agency Activities Model Program. On-line: http://ladpw.org/wmd/npdes/public_TC.cfm

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

Santa Clara Valley Urban Runoff Pollution Prevention Program. Water Utility Pollution Prevention Plan.

Non-Stormwater Discharges SC-10



Graphic by: Margie Winter

Objectives

- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	✓
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓
Oxygen Demanding	✓

Description

Non-stormwater discharges are those flows that do not consist entirely of stormwater. For municipalities non-stormwater discharges present themselves in two situations. One is from fixed facilities owned and/or operated by the municipality. The other situation is non-stormwater discharges that are discovered during the normal operation of a field program. Some non-stormwater discharges do not include pollutants and may be discharged to the storm drain. These include uncontaminated groundwater and natural springs. There are also some non-stormwater discharges that typically do not contain pollutants and may be discharged to the storm drain with conditions. These include car washing, and surface cleaning. However, there are certain non-stormwater discharges that pose environmental concern. These discharges may originate from illegal dumping or from internal floor drains, appliances, industrial processes, sinks, and toilets that are connected to the nearby storm drainage system. These discharges (which may include: process waste waters, cooling waters, wash waters, and sanitary wastewater) can carry substances (such as paint, oil, fuel and other automotive fluids, chemicals and other pollutants) into storm drains. The ultimate goal is to effectively eliminate non-stormwater discharges to the stormwater drainage system through implementation of measures to detect, correct, and enforce against illicit connections and illegal discharges.

Approach

The municipality must address non-stormwater discharges from its fixed facilities by assessing the types of non-stormwater discharges and implementing BMPs for the discharges determined to pose environmental concern. For field programs the field staff must be

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trained to now what to look for regarding non-stormwater discharges and the procedures to follow in investigating the detected discharges.

Suggested Protocols

Fixed Facility

General

- Post "No Dumping" signs with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Stencil storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- Landscaping and beautification efforts of hot spots might also discourage future dumping, as well as provide open space and increase property values.
- Lighting or barriers may also be needed to discourage future dumping.

Illicit Connections

- Locate discharges from the fixed facility drainage system to the municipal storm drain system through review of "as-built" piping schematics.
- Use techniques such as smoke testing, dye testing and television camera inspection (as noted below) to verify physical connections.
- Isolate problem areas and plug illicit discharge points.

Visual Inspection and Inventory

- Inventory and inspect each discharge point during dry weather.
- Keep in mind that drainage from a storm event can continue for several days following the end of a storm and groundwater may infiltrate the underground stormwater collection system. Also, non-stormwater discharges are often intermittent and may require periodic inspections.

Review Infield Piping

- Review the "as-built" piping schematic as a way to determine if there are any connections to the stormwater collection system.
- Inspect the path of floor drains in older buildings.

Smoke Testing

- Smoke testing of wastewater and stormwater collection systems is used to detect connections between the two systems.

- During dry weather the stormwater collection system is filled with smoke and then traced to sources. The appearance of smoke at the base of a toilet indicates that there may be a connection between the sanitary and the stormwater system.

Dye Testing

- A dye test can be performed by simply releasing a dye into either your sanitary or process wastewater system and examining the discharge points from the stormwater collection system for discoloration.

TV Inspection of Storm Sewer

- TV Cameras can be employed to visually identify illicit connections to the fixed facility storm drain system.

Illegal Dumping

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- Clean up spills on paved surfaces with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.
- Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- For larger spills, a private spill cleanup company or Hazmat team may be necessary.
- See fact sheet SC-11 Spill Prevention, Control, and Clean Up.

Field Program

General

- Develop clear protocols and lines of communication for effectively prohibiting non-stormwater discharges, especially ones that involve more than one jurisdiction and those that are not classified as hazardous, which are often not responded to as effectively as they need to be.
- Stencil storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- See SC-74 Stormwater Drainage System Maintenance for additional information.

Field Inspection

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- During routine field program maintenance field staff should look for evidence of illegal discharges or illicit connection:
  - Is there evidence of spills such as paints, discoloring, etc.
  - Are there any odors associated with the drainage system
  - Record locations of apparent illegal discharges/illicit connections and notify appropriate investigating agency.
- If trained, conduct field investigation of non-stormwater discharges to determine whether they pose a threat to water quality.

Recommended Complaint Investigation Equipment

- Field Screening Analysis
  - pH paper or meter
  - Commercial stormwater pollutant screening kit that can detect for reactive phosphorus, nitrate nitrogen, ammonium nitrogen, specific conductance, and turbidity
  - Sample jars
  - Sample collection pole
  - A tool to remove access hole covers
- Laboratory Analysis
  - Sample cooler
  - Ice
  - Sample jars and labels
  - Chain of custody forms.
- Documentation
  - Camera
  - Notebook
  - Pens
  - Notice of Violation forms

- Educational materials

Reporting

- A database is useful for defining and tracking the magnitude and location of the problem.
- Report prohibited non-stormwater discharges observed during the course of normal daily activities so they can be investigated, contained and cleaned up or eliminated.
- Document that non-stormwater discharges have been eliminated by recording tests performed, methods used, dates of testing, and any onsite drainage points observed.
- Maintain documentation of illicit connection and illegal dumping incidents, including significant conditionally exempt discharges that are not properly managed.

Enforcement

- Educate the responsible party if identified on the impacts of their actions, explain the stormwater requirements, and provide information regarding Best Management Practices (BMP), as appropriate. Initiate follow-up and/or enforcement procedures.
- If an illegal discharge is traced to a commercial, residential or industrial source, conduct the following activities or coordinate the following activities with the appropriate agency:
  - Contact the responsible party to discuss methods of eliminating the non-stormwater discharge, including disposal options, recycling, and possible discharge to the sanitary sewer (if within POTW limits).
  - Provide information regarding BMPs to the responsible party, where appropriate.
  - Begin enforcement procedures, if appropriate.
  - Continue inspection and follow-up activities until the illicit discharge activity has ceased.
- If an illegal discharge is traced to a commercial or industrial activity, coordinate information on the discharge with the jurisdiction's commercial and industrial facility inspection program.

Training

- Train technical staff to identify and document illegal dumping incidents.
- Well-trained employees can reduce human errors that lead to accidental releases or spills. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur. Employees should be familiar with the Spill Prevention Control and Countermeasure Plan.
- Train employees to identify non-stormwater discharges and report them to the appropriate departments.
- Train staff who have the authority to conduct surveillance and inspections, and write citations for those caught illegally dumping.

- Train municipal staff responsible for surveillance and inspection in the following:
  - OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).
  - OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and federal OSHA 29 CFR 1910.146).
  - Procedural training (field screening, sampling, smoke/dye testing, TV inspection).
- Educate the identified responsible party on the impacts of his or her actions.

Spill Response and Prevention

- See SC-11 Spill Prevention Control and Clean Up

Other Considerations

- The elimination of illegal dumping is dependent on the availability, convenience, and cost of alternative means of disposal. The cost of fees for dumping at a proper waste disposal facility are often more than the fine for an illegal dumping offense, thereby discouraging people from complying with the law. The absence of routine or affordable pickup service for trash and recyclables in some communities also encourages illegal dumping. A lack of understanding regarding applicable laws or the inadequacy of existing laws may also contribute to the problem.
- Municipal codes should include sections prohibiting the discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.
- Many facilities do not have accurate, up-to-date schematic drawings.
- Can be difficult to locate illicit connections especially if there is groundwater infiltration.

Requirements

Costs

- Eliminating illicit connections can be expensive especially if structural modifications are required such re-plumbing cross connections under an existing slab.
- Minor cost to train field crews regarding the identification of non-stormwater discharges. The primary cost is for a fully integrated program to identify and eliminate illicit connections and illegal dumping. However, by combining with other municipal programs (i.e. pretreatment program) cost may be lowered.
- Municipal cost for containment and disposal may be borne by the discharger.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

What constitutes a "non-stormwater" discharge?

- Non-stormwater discharges are discharges not made up entirely of stormwater and include water used directly in the manufacturing process (process wastewater), air conditioning condensate and coolant, non-contact cooling water, cooling equipment condensate, outdoor secondary containment water, vehicle and equipment wash water, landscape irrigation, sink and drinking fountain wastewater, sanitary wastes, or other wastewaters.

Permit Requirements

- Current municipal NPDES permits require municipalities to effectively prohibit non-stormwater discharges unless authorized by a separate NPDES permit or allowed in accordance with the current NPDES permit conditions. Typically the current permits allow certain non-stormwater discharges in the storm drain system as long as the discharges are not significant sources of pollutants. In this context the following non-stormwater discharges are typically allowed:
  - Diverted stream flows;
  - Rising found waters;
  - Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20));
  - Uncontaminated pumped ground water;
  - Foundation drains;
  - Springs;
  - Water from crawl space pumps;
  - Footing drains;
  - Air conditioning condensation;
  - Flows from riparian habitats and wetlands;
  - Water line and hydrant flushing ;
  - Landscape irrigation;
  - Planned and unplanned discharges from potable water sources;
  - Irrigation water;
  - Individual residential car washing; and
  - Lawn watering.

Municipal facilities subject to industrial general permit requirements must include a certification that the stormwater collection system has been tested or evaluated for the presence of non-stormwater discharges. The state's General Industrial Stormwater Permit requires that non-stormwater discharges be eliminated prior to implementation of the facility's SWPPP.

Illegal Dumping

- Establish a system for tracking incidents. The system should be designed to identify the following:
  - Illegal dumping hot spots
  - Types and quantities (in some cases) of wastes
  - Patterns in time of occurrence (time of day/night, month, or year)
  - Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)
  - Responsible parties

Outreach

One of the keys to success of reducing or eliminating illegal dumping is increasing the number of people on the street who are aware of the problem and who have the tools to at least identify the incident, if not correct it. There we a number of ways of accomplishing this:

- Train municipal staff from all departments (public works, utilities, street cleaning, parks and recreation, industrial waste inspection, hazardous waste inspection, sewer maintenance) to recognize and report the incidents.
- Deputize municipal staff who may come into contact with illegal dumping with the authority to write illegal dumping tickets for offenders caught in the act (see below).
- Educate the public. As many as 3 out of 4 people do not understand that in most communities the storm drain does not go to the wastewater treatment plant. Unfortunately, with the heavy emphasis in recent years on public education about solid waste management, including recycling and household hazardous waste, the sewer system (both storm and sanitary) has been the likely recipient of cross-media transfers of waste.
- Provide the public with a mechanism for reporting incidents such as a hot line and/or door hanger (see below).
- Help areas where incidents occur more frequently set up environmental watch programs (like crime watch programs).
- Train volunteers to notice and report the presence and suspected source of an observed pollutant to the appropriate public agency.

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  - Irrigation water;
  - Individual residential car washing; and
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Storm Drain Stenciling

- Stencil storm drain inlets with a message to prohibit illegal dumpings, especially in areas with waste handling facilities.
- Encourage public reporting of improper waste disposal by a HOTLINE number stenciled onto the storm drain inlet.
- See Supplemental Information section of this fact sheet for further detail on stenciling program approach.

Oil Recycling

- Contract collection and hauling of used oil to a private licensed used oil hauler/recycler.
- Comply with all applicable state and federal regulations regarding storage, handling, and transport of petroleum products.
- Create procedures for collection such as; collection locations and schedule, acceptable containers, and maximum amounts accepted.
- The California Integrated Waste Management Board has a Recycling Hotline, (800) 553-2962, that provides information and recycling locations for used oil.

Household Hazardous Waste

- Provide household hazardous waste (HHW) collection facilities. Several types of collection approaches are available including permanent, periodic, or mobile centers, curbside collection, or a combination of these systems.

Training

- Train municipal employees and contractors in proper and consistent methods for waste disposal.
- Train municipal employees to recognize and report illegal dumping.
- Train employees and subcontractors in proper hazardous waste management.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Federal Regulations (RCRA, SARA, CERCLA) and state regulations exist regarding the disposal of hazardous waste.
- Municipalities are required to have a used oil recycling and a HHW element within their integrate waste management plan.
- Significant liability issues are involved with the collection, handling, and disposal of HHW.

Examples

The City of Palo Alto has developed a public participation program for reporting dumping violations. When a concerned citizen or public employee encounters evidence of illegal dumping, a door hanger (similar in format to hotel "Do Not Disturb" signs) is placed on the front doors in the neighborhood. The door hanger notes that a violation has occurred in the neighborhood, informs the reader why illegal dumping is a problem, and notes that illegal dumping carries a significant financial penalty. Information is also provided on what citizens can do as well as contact numbers for more information or to report a violation.

The Port of Long Beach has a state of the art database incorporating storm drain infrastructure, potential pollutant sources, facility management practices, and a pollutant tracking system.

The State Department of Fish and Game has a hotline for reporting violations called CalTIP (1-800-952-5400). The phone number may be used to report any violation of a Fish and Game code (illegal dumping, poaching, etc.).

The California Department of Toxic Substances Control's Waste Alert Hotline, 1-800-69TOXIC, can be used to report hazardous waste violations.

References and Resources

http://www.stormwatercenter.net/

California's Nonpoint Source Program Plan http://www.co.clark.wa.us/pubworks/bmpman.pdf

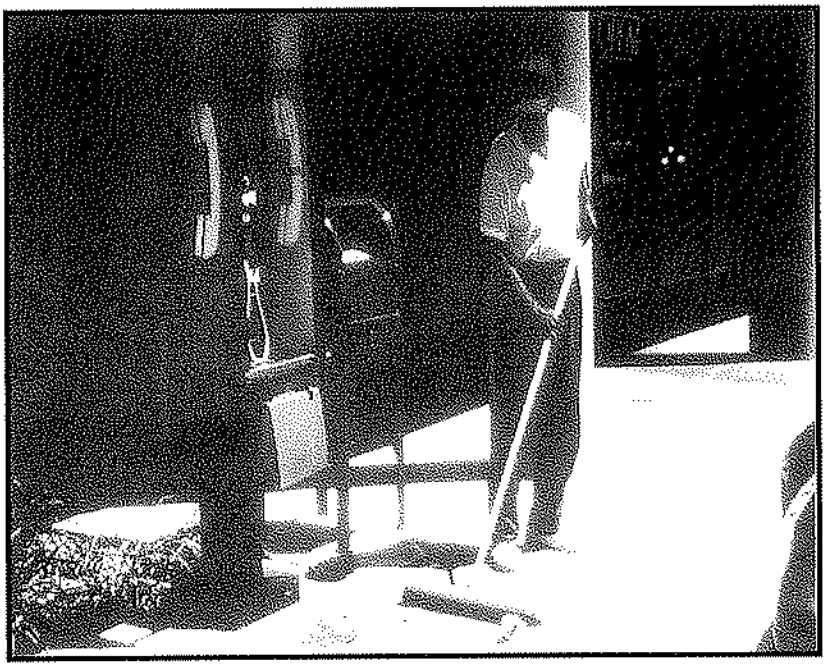
King County Stormwater Pollution Control Manual - http://dnr.metrokc.gov/wlr/dss/spcm.htm

Orange County Stormwater Program,
http://www.ocwatersheds.com/stormwater/swp_introduction.asp

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program
(http://www.projectcleanwater.org)

Santa Clara Valley Urban Runoff Pollution Prevention Program
http://www.scvurppp-w2k.com/pdf%20documents/PS_ICID.PDF

Plaza and Sidewalk Cleaning SC-71



Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Pollutants on sidewalks and other pedestrian traffic areas and plazas are typically due to littering and vehicle use. This fact sheet describes good housekeeping practices that can be incorporated into the municipality's existing cleaning and maintenance program.

Approach

Pollution Prevention

- Use dry cleaning methods whenever practical for surface cleaning activities.
- Use the least toxic materials available (e.g. water based paints, gels or sprays for graffiti removal).

Suggested Protocols

Surface Cleaning

- Regularly broom (dry) sweep sidewalk, plaza and parking lot areas to minimize cleaning with water.
- Dry cleanup first (sweep, collect, and dispose of debris and trash) when cleaning sidewalks or plazas, then wash with or without soap.
- Block the storm drain or contain runoff when cleaning with water. Discharge wash water to landscaping or collect water and pump to a tank or discharge to sanitary sewer if allowed. (Permission may be required from local sanitation district.)

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- Block the storm drain or contain runoff when washing parking areas, driveways or drive-throughs. Use absorbents to pick up oil; then dry sweep. Clean with or without soap. Collect water and pump to a tank or discharge to sanitary sewer if allowed. Street Repair and Maintenance.

Graffiti Removal

- Avoid graffiti abatement activities during rain events.
- Implement the procedures under Painting and Paint Removal in SC-70 Roads, Streets, and Highway Operation and Maintenance fact sheet when graffiti is removed by painting over.
- Direct runoff from sand blasting and high pressure washing (with no cleaning agents) into a dirt or landscaped area after treating with an appropriate filtering device.
- Plug nearby storm drain inlets and vacuum/pump wash water to the sanitary sewer if authorized to do so if a graffiti abatement method generates wash water containing a cleaning compound (such as high pressure washing with a cleaning compound). Ensure that a non-hazardous cleaning compound is used or dispose as hazardous waste, as appropriate.

Surface Removal and Repair

- Schedule surface removal activities for dry weather if possible.
- Avoid creating excess dust when breaking asphalt or concrete.
- Take measures to protect nearby storm drain inlets prior to breaking up asphalt or concrete (e.g. place hay bales or sand bags around inlets). Clean afterwards by sweeping up as much material as possible.
- Designate an area for clean up and proper disposal of excess materials.
- Remove and recycle as much of the broken pavement as possible to avoid contact with rainfall and stormwater runoff.
- When making saw cuts in pavement, use as little water as possible. Cover each storm drain inlet completely with filter fabric during the sawing operation and contain the slurry by placing straw bales, sandbags, or gravel dams around the inlets. After the liquid drains or evaporates, shovel or vacuum the slurry residue from the pavement or gutter and remove from site.
- Always dry sweep first to clean up tracked dirt. Use a street sweeper or vacuum truck. Do not dump vacuumed liquid in storm drains. Once dry sweeping is complete, the area may be hosed down if needed. Wash water should be directed to landscaping or collected and pumped to the sanitary sewer if allowed.

Concrete Installation and Repair

- Schedule asphalt and concrete activities for dry weather.

- Take measures to protect any nearby storm drain inlets and adjacent watercourses, prior to breaking up asphalt or concrete (e.g. place san bags around inlets or work areas).
- Limit the amount of fresh concrete or cement mortar mixed, mix only what is needed for the job.
- Store concrete materials under cover, away from drainage areas. Secure bags of cement after they are open. Be sure to keep wind-blown cement powder away from streets, gutters, storm drains, rainfall, and runoff.
- Return leftover materials to the transit mixer. Dispose of small amounts of hardened excess concrete, grout, and mortar in the trash.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile, or dispose in the trash.
- Protect applications of fresh concrete from rainfall and runoff until the material has dried.
- Do not allow excess concrete to be dumped onsite, except in designated areas.
- Wash concrete trucks off site or in designated areas on site designed to preclude discharge of wash water to drainage system.

Controlling Litter

- Post "No Littering" signs and enforce anti-litter laws.
- Provide litter receptacles in busy, high pedestrian traffic areas of the community, at recreational facilities, and at community events.
- Cover litter receptacles and clean out frequently to prevent leaking/spillage or overflow.
- Clean parking lots on a regular basis with a street sweeper.

Training

- Provide regular training to field employees and/or contractors regarding surface cleaning and proper operation of equipment.
- Train employee and contractors in proper techniques for spill containment and cleanup.
- Use a training log or similar method to document training.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Limitations related to sweeping activities at large parking facilities may include current sweeper technology to remove oil and grease.
- Surface cleaning activities that require discharges to the local sewering agency will require coordination with the agency.
- Arrangements for disposal of the swept material collected must be made, as well as accurate tracking of the areas swept and the frequency of sweeping.

Requirements

Costs

- The largest expenditures for sweeping and cleaning of sidewalks, plazas, and parking lots are in staffing and equipment. Sweeping of these areas should be incorporated into street sweeping programs to reduce costs.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

Community education, such as informing residents about their options for recycling and waste disposal, as well as the consequences of littering, can instill a sense of citizen responsibility and potentially reduce the amount of maintenance required by the municipality.

Additional BMPs that should be considered for parking lot areas include:

- Allow sheet runoff to flow into biofilters (vegetated strip and swale) and infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low concentrations.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.
- Structural BMPs such as storm drain inlet filters can be very effective in reducing the amount of pollutants discharged from parking facilities during periods of rain.

References and Resources

Bay Area Stormwater Management Agencies Association (BASMAA). 1996. Pollution From Surface Cleaning Folder http://www.basmaa.org

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July. 1998.

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Orange County Stormwater Program
http://www.ocwatersheds.com/stormwater/swp_introduction.asp

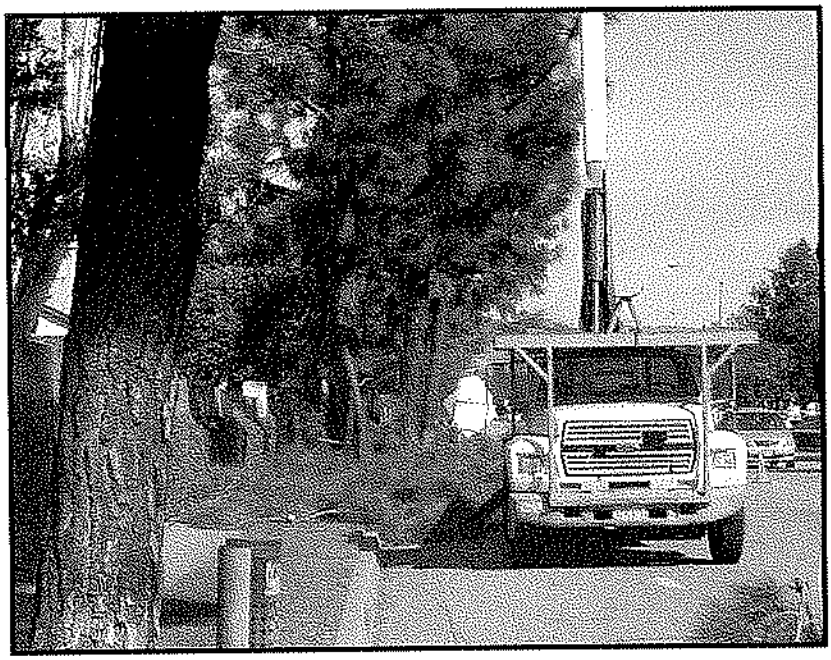
Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

Santa Clara Valley Urban Runoff Pollution Prevention Program. Maintenance Best Management Practices for the Construction Industry. Brochures: Landscaping, Gardening, and Pool; Roadwork and Paving; and Fresh Concrete and Mortar Application. June 2001.

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Plan. 2001. Municipal Activities Model Program Guidance. November.

Landscape Maintenance

SC-73



Objectives

- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	
Oxygen Demanding	☑

Description

Landscape maintenance activities include vegetation removal; herbicide and insecticide application; fertilizer application; watering; and other gardening and lawn care practices. Vegetation control typically involves a combination of chemical (herbicide) application and mechanical methods. All of these maintenance practices have the potential to contribute pollutants to the storm drain system. The major objectives of this BMP are to minimize the discharge of pesticides, herbicides and fertilizers to the storm drain system and receiving waters; prevent the disposal of landscape waste into the storm drain system by collecting and properly disposing of clippings and cuttings, and educating employees and the public.

Approach

Pollution Prevention

- Implement an integrated pest management (IPM) program. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools.
- Choose low water using flowers, trees, shrubs, and groundcover.
- Consider alternative landscaping techniques such as naturescaping and xeriscaping.
- Conduct appropriate maintenance (i.e. properly timed fertilizing, weeding, pest control, and pruning) to help preserve the landscapes water efficiency.

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- Consider grass cycling (grass cycling is the natural recycling of grass by leaving the clippings on the lawn when mowing. Grass clippings decompose quickly and release valuable nutrients back into the lawn).

Suggested Protocols

Mowing, Trimming, and Weeding

- Whenever possible use mechanical methods of vegetation removal (e.g mowing with tractor-type or push mowers, hand cutting with gas or electric powered weed trimmers) rather than applying herbicides. Use hand weeding where practical.
- Avoid loosening the soil when conducting mechanical or manual weed control, this could lead to erosion. Use mulch or other erosion control measures when soils are exposed.
- Performing mowing at optimal times. Mowing should not be performed if significant rain events are predicted.
- Mulching mowers may be recommended for certain flat areas. Other techniques may be employed to minimize mowing such as selective vegetative planting using low maintenance grasses and shrubs.
- Collect lawn and garden clippings, pruning waste, tree trimmings, and weeds. Chip if necessary, and compost or dispose of at a landfill (see waste management section of this fact sheet).
- Place temporarily stockpiled material away from watercourses, and berm or cover stockpiles to prevent material releases to storm drains.

Planting

- Determine existing native vegetation features (location, species, size, function, importance) and consider the feasibility of protecting them. Consider elements such as their effect on drainage and erosion, hardiness, maintenance requirements, and possible conflicts between preserving vegetation and the resulting maintenance needs.
- Retain and/or plant selected native vegetation whose features are determined to be beneficial, where feasible. Native vegetation usually requires less maintenance (e.g., irrigation, fertilizer) than planting new vegetation.
- Consider using low water use groundcovers when planting or replanting.

Waste Management

- Compost leaves, sticks, or other collected vegetation or dispose of at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Place temporarily stockpiled material away from watercourses and storm drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Reduce the use of high nitrogen fertilizers that produce excess growth requiring more frequent mowing or trimming.

- Avoid landscape wastes in and around storm drain inlets by either using bagging equipment or by manually picking up the material.

Irrigation

- Where practical, use automatic timers to minimize runoff.
- Use popup sprinkler heads in areas with a lot of activity or where there is a chance the pipes may be broken. Consider the use of mechanisms that reduce water flow to sprinkler heads if broken.
- Ensure that there is no runoff from the landscaped area(s) if re-claimed water is used for irrigation.
- If bailing of muddy water is required (e.g. when repairing a water line leak), do not put it in the storm drain; pour over landscaped areas.
- Irrigate slowly or pulse irrigate to prevent runoff and then only irrigate as much as is needed.
- Apply water at rates that do not exceed the infiltration rate of the soil.

Fertilizer and Pesticide Management

- Utilize a comprehensive management system that incorporates integrated pest management (IPM) techniques. There are many methods and types of IPM, including the following:
  - Mulching can be used to prevent weeds where turf is absent, fencing installed to keep rodents out, and netting used to keep birds and insects away from leaves and fruit.
  - Visible insects can be removed by hand (with gloves or tweezers) and placed in soapy water or vegetable oil. Alternatively, insects can be sprayed off the plant with water or in some cases vacuumed off of larger plants.
  - Store-bought traps, such as species-specific, pheromone-based traps or colored sticky cards, can be used.
  - Slugs can be trapped in small cups filled with beer that are set in the ground so the slugs can get in easily.
  - In cases where microscopic parasites, such as bacteria and fungi, are causing damage to plants, the affected plant material can be removed and disposed of (pruning equipment should be disinfected with bleach to prevent spreading the disease organism).
  - Small mammals and birds can be excluded using fences, netting, tree trunk guards.
  - Beneficial organisms, such as bats, birds, green lacewings, ladybugs, praying mantis, ground beetles, parasitic nematodes, trichogramma wasps, seed head weevils, and spiders that prey on detrimental pest species can be promoted.
- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.

- Use pesticides only if there is an actual pest problem (not on a regular preventative schedule).
- Do not use pesticides if rain is expected. Apply pesticides only when wind speeds are low (less than 5 mph).
- Do not mix or prepare pesticides for application near storm drains.
- Prepare the minimum amount of pesticide needed for the job and use the lowest rate that will effectively control the pest.
- Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Calibrate fertilizer and pesticide application equipment to avoid excessive application.
- Periodically test soils for determining proper fertilizer use.
- Sweep pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Purchase only the amount of pesticide that you can reasonably use in a given time period (month or year depending on the product).
- Triple rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Dispose of empty pesticide containers according to the instructions on the container label.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering, and repair leaks in the irrigation system as soon as they are observed.
- Inspect pesticide/fertilizer equipment and transportation vehicles daily.

Training

- Educate and train employees on use of pesticides and in pesticide application techniques to prevent pollution. Pesticide application must be under the supervision of a California qualified pesticide applicator.
- Train/encourage municipal maintenance crews to use IPM techniques for managing public green areas.
- Annually train employees within departments responsible for pesticide application on the appropriate portions of the agency's IPM Policy, SOPs, and BMPs, and the latest IPM techniques.

- Employees who are not authorized and trained to apply pesticides should be periodically (at least annually) informed that they cannot use over-the-counter pesticides in or around the workplace.
- Use a training log or similar method to document training.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Have spill cleanup materials readily available and in a know in location
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- The Federal Pesticide, Fungicide, and Rodenticide Act and California Title 3, Division 6, Pesticides and Pest Control Operations place strict controls over pesticide application and handling and specify training, annual refresher, and testing requirements. The regulations generally cover: a list of approved pesticides and selected uses, updated regularly; general application information; equipment use and maintenance procedures; and record keeping. The California Department of Pesticide Regulations and the County Agricultural Commission coordinate and maintain the licensing and certification programs. All public agency employees who apply pesticides and herbicides in "agricultural use" areas such as parks, golf courses, rights-of-way and recreation areas should be properly certified in accordance with state regulations. Contracts for landscape maintenance should include similar requirements.
- All employees who handle pesticides should be familiar with the most recent material safety data sheet (MSDS) files.
- Municipalities do not have the authority to regulate the use of pesticides by school districts, however the California Healthy Schools Act of 2000 (AB 2260) has imposed requirements on California school districts regarding pesticide use in schools. Posting of notification prior to the application of pesticides is now required, and IPM is stated as the preferred approach to pest management in schools.

Requirements

Costs

Additional training of municipal employees will be required to address IPM techniques and BMPs. IPM methods will likely increase labor cost for pest control which may be offset by lower chemical costs.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

Waste Management

Composting is one of the better disposal alternatives if locally available. Most municipalities either have or are planning yard waste composting facilities as a means of reducing the amount of waste going to the landfill. Lawn clippings from municipal maintenance programs as well as private sources would probably be compatible with most composting facilities

Contractors and Other Pesticide Users

Municipal agencies should develop and implement a process to ensure that any contractor employed to conduct pest control and pesticide application on municipal property engages in pest control methods consistent with the IPM Policy adopted by the agency. Specifically, municipalities should require contractors to follow the agency's IPM policy, SOPs, and BMPs; provide evidence to the agency of having received training on current IPM techniques when feasible; provide documentation of pesticide use on agency property to the agency in a timely manner.

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Drainage System Maintenance SC-74

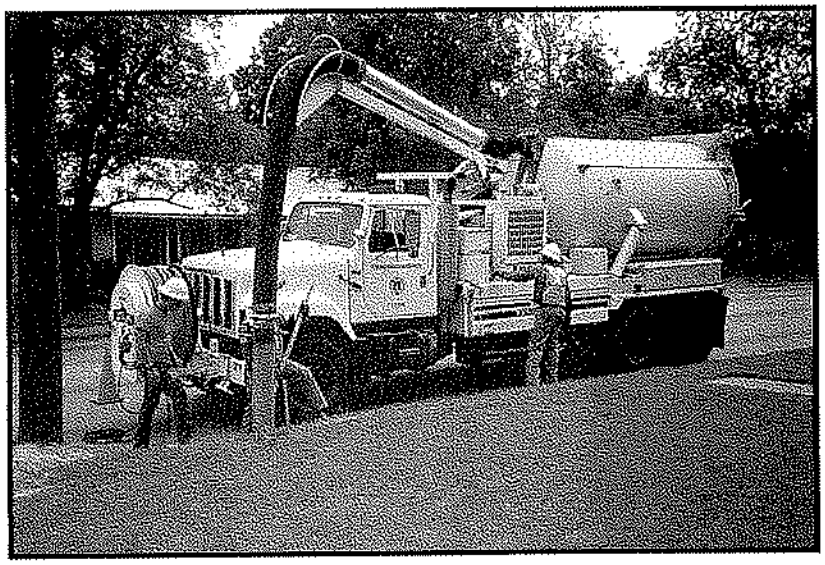

Photo Credit: Geoff Brosseau

Objectives

- Contain
- Educate
- Reduce/Minimize

Description

As a consequence of its function, the stormwater conveyance system collects and transports urban runoff that may contain certain pollutants. Maintaining catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis will remove pollutants, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Approach

Suggested Protocols

Catch Basins/Inlet Structures

- Municipal staff should regularly inspect facilities to ensure the following:
  - Immediate repair of any deterioration threatening structural integrity.
  - Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.
  - Stenciling of catch basins and inlets (see SC-75 Waste Handling and Disposal).
- Clean catch basins, storm drain inlets, and other conveyance structures in high pollutant load areas just before the wet season to remove sediments and debris accumulated during the summer.

- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Clean and repair as needed.
- Keep accurate logs of the number of catch basins cleaned.
- Record the amount of waste collected.
- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
- Dewater the wastes with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed of. Do not dewater near a storm drain or stream.
- Except for small communities with relatively few catch basins that may be cleaned manually, most municipalities will require mechanical cleaners such as eductors, vacuums, or bucket loaders.

Storm Drain Conveyance System

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Collect flushed effluent and pump to the sanitary sewer for treatment.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge from cleaning a storm drain pump station or other facility to reach the storm drain system.
- Conduct quarterly routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.
- Sample collected sediments to determine if landfill disposal is possible, or illegal discharges in the watershed are occurring.

Open Channel

- Consider modification of storm channel characteristics to improve channel hydraulics, to increase pollutant removals, and to enhance channel/creek aesthetic and habitat value.
- Conduct channel modification/improvement in accordance with existing laws. Any person, government agency, or public utility proposing an activity that will change the natural (emphasis added) state of any river, stream, or lake in California, must enter into a steam or Lake Alteration Agreement with the Department of Fish and Game. The developer-applicant should also contact local governments (city, county, special districts), other state agencies

(SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Federal Corps of Engineers and USFWS

Illicit Connections and Discharges

- During routine maintenance of conveyance system and drainage structures field staff should look for evidence of illegal discharges or illicit connections:
  - Is there evidence of spills such as paints, discoloring, etc.
  - Are there any odors associated with the drainage system
  - Record locations of apparent illegal discharges/illicit connections
  - Track flows back to potential dischargers and conduct aboveground inspections. This can be done through visual inspection of up gradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
  - Once the origin of flow is established, require illicit discharger to eliminate the discharge.
- Stencil storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

Illegal Dumping

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - Illegal dumping hot spots
  - Types and quantities (in some cases) of wastes
  - Patterns in time of occurrence (time of day/night, month, or year)
  - Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)
  - Responsible parties
- Post "No Dumping" signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

- The State Department of Fish and Game has a hotline for reporting violations called Cal TIP (1-800-952-5400). The phone number may be used to report any violation of a Fish and Game code (illegal dumping, poaching, etc.).
- The California Department of Toxic Substances Control's Waste Alert Hotline, 1-800-69TOXIC, can be used to report hazardous waste violations.

Training

- Train crews in proper maintenance activities, including record keeping and disposal.
- Only properly trained individuals are allowed to handle hazardous materials/wastes.
- Train municipal employees from all departments (public works, utilities, street cleaning, parks and recreation, industrial waste inspection, hazardous waste inspection, sewer maintenance) to recognize and report illegal dumping.
- Train municipal employees and educate businesses, contractors, and the general public in proper and consistent methods for disposal.
- Train municipal staff regarding non-stormwater discharges (See SC-10 Non-Stormwater Discharges).

Spill Response and Prevention

- Refer to SC-11, Prevention, Control & Cleanup
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Cleanup activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.
- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, liquid/sediment disposal, and disposal of flushed effluent to sanitary sewer may be prohibited in some areas.
- Regulations may include adoption of substantial penalties for illegal dumping and disposal.
- Municipal codes should include sections prohibiting the discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.
- Private property access rights may be needed to track illegal discharges up gradient.

- Requirements of municipal ordinance authority for suspected source verification testing for illicit connections necessary for guaranteed rights of entry.

Requirements

Costs

- An aggressive catch basin cleaning program could require a significant capital and O&M budget. A careful study of cleaning effectiveness should be undertaken before increased cleaning is implemented. Catch basin cleaning costs are less expensive if vacuum street sweepers are available; cleaning catch basins manually can cost approximately twice as much as cleaning the basins with a vacuum attached to a sweeper.

- Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary. Encouraging reporting of illicit discharges by employees can offset costs by saving expense on inspectors and directing resources more efficiently. Some programs have used funds available from "environmental fees" or special assessment districts to fund their illicit connection elimination programs.

Maintenance

- Two-person teams may be required to clean catch basins with vactor trucks.

- Identifying illicit discharges requires teams of at least two people (volunteers can be used), plus administrative personnel, depending on the complexity of the storm sewer system.

- Arrangements must be made for proper disposal of collected wastes.

- Requires technical staff to detect and investigate illegal dumping violations, and to coordinate public education.

Supplemental Information

Further Detail of the BMP

Storm Drain flushing

Sanitary sewer flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in sanitary sewer systems. The same principles that make sanitary sewer flushing effective can be used to flush storm drains. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as to an open channel, to another point where flushing will be initiated, or over to the sanitary sewer and on to the treatment facilities, thus preventing re-suspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. The deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to

cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce the impacts of stormwater pollution, a second inflatable device, placed well downstream, may be used to re-collect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to re-collect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75 percent for organics and 55-65 percent for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used or that fire hydrant line flushing coincide with storm drain flushing.

Flow Management

Flow management has been one of the principal motivations for designing urban stream corridors in the past. Such needs may or may not be compatible with the stormwater quality goals in the stream corridor.

Downstream flood peaks can be suppressed by reducing through flow velocity. This can be accomplished by reducing gradient with grade control structures or increasing roughness with boulders, dense vegetation, or complex banks forms. Reducing velocity correspondingly increases flood height, so all such measures have a natural association with floodplain open space. Flood elevations laterally adjacent to the stream can be lowered by increasing through flow velocity.

However, increasing velocity increases flooding downstream and inherently conflicts with channel stability and human safety. Where topography permits, another way to lower flood elevation is to lower the level of the floodway with drop structures into a large but subtly excavated bowl where flood flows we allowed to spread out.

Stream Corridor Planning

Urban streams receive and convey stormwater flows from developed or developing watersheds. Planning of stream corridors thus interacts with urban stormwater management programs. If local programs are intended to control or protect downstream environments by managing flows delivered to the channels, then it is logical that such programs should be supplemented by management of the materials, forms, and uses of the downstream riparian corridor. Any proposal for steam alteration or management should be investigated for its potential flow and stability effects on upstream, downstream, and laterally adjacent areas. The timing and rate of flow from various tributaries can combine in complex ways to alter flood hazards. Each section of channel is unique, influenced by its own distribution of roughness elements, management activities, and stream responses.

Flexibility to adapt to stream features and behaviors as they evolve must be included in stream reclamation planning. The amenity and ecology of streams may be enhanced through the landscape design options of 1) corridor reservation, 2) bank treatment, 3) geomorphic restoration, and 4) grade control.

Corridor reservation - Reserving stream corridors and valleys to accommodate natural stream meandering, aggradation, degradation, and over bank flows allows streams to find their own form and generate less ongoing erosion. In California, open stream corridors in recent urban developments have produced recreational open space, irrigation of streamside plantings, and the aesthetic amenity of flowing water.

Bank treatment - The use of armoring, vegetative cover, and flow deflection may be used to influence a channel's form, stability, and biotic habitat. To prevent bank erosion, armoring can be done with rigid construction materials, such as concrete, masonry, wood planks and logs, riprap, and gabions. Concrete linings have been criticized because of their lack of provision of biotic habitat. In contrast, riprap and gabions make relatively porous and flexible linings. Boulders, placed in the bed reduce velocity and erosive power.

Riparian vegetation can stabilize the banks of streams that are at or near a condition of equilibrium. Binding networks of roots increase bank shear strength. During flood flows, resilient vegetation is forced into erosion-inhibiting mats. The roughness of vegetation leads to lower velocity, further reducing erosive effects. Structural flow deflection can protect banks from erosion or alter fish habitat. By concentrating flow, a deflector causes a pool to be scoured in the bed.

Geomorphic restoration – Restoration refers to alteration of disturbed streams so their form and behavior emulate those of undisturbed streams. Natural meanders are retained, with grading to gentle slopes on the inside of curves to allow point bars and riffle-pool sequences to develop. Trees are retained to provide scenic quality, biotic productivity, and roots for bank stabilization, supplemented by plantings where necessary.

A restorative approach can be successful where the stream is already approaching equilibrium. However, if upstream urbanization continues new flow regimes will be generated that could disrupt the equilibrium of the treated system.

Grade Control - A grade control structure is a level shelf of a permanent material, such as stone, masonry, or concrete, over which stream water flows. A grade control structure is called a sill, weir, or drop structure, depending on the relation of its invert elevation to upstream and downstream channels.

A sill is installed at the preexisting channel bed elevation to prevent upstream migration of nick points. It establishes a firm base level below which the upstream channel can not erode.

A weir or check dam is installed with invert above the preexisting bed elevation. A weir raises the local base level of the stream and causes aggradation upstream. The gradient, velocity, and erosive potential of the stream channel are reduced. A drop structure lowers the downstream invert below its preexisting elevation, reducing downstream gradient and velocity. Weirs and drop structure control erosion by dissipating energy and reducing slope velocity.

When carefully applied, grade control structures can be highly versatile in establishing human and environmental benefits in stabilized channels. To be successful, application of grade control structures should be guided by analysis of the stream system both upstream and downstream from the area to he reclaimed.

Examples

The California Department of Water Resources began the Urban Stream Restoration Program in 1985. The program provides grant funds to municipalities and community groups to implement stream restoration projects. The projects reduce damages from streambank aid watershed instability arid floods while restoring streams' aesthetic, recreational, and fish and wildlife values.

In Buena Vista Park, upper floodway slopes are gentle and grassed to achieve continuity of usable park land across the channel of small boulders at the base of the slopes.

The San Diego River is a large, vegetative lined channel, which was planted in a variety of species to support riparian wildlife while stabilizing the steep banks of the floodway.

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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.

Vehicle Washing Areas SD-33

Photo Credit: Geoff Brosseau

Design Objectives

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

Description

Vehicle washing, equipment washing, and steam cleaning may contribute high concentrations of metals, oil and grease, solvents, phosphates, and suspended solids to wash waters that drain to stormwater conveyance systems.

Approach

Project plans should include appropriately designed area(s) for washing-steam cleaning of vehicles and equipment. Depending on the size and other parameters of the wastewater facility, wash water may be conveyed to a sewer, an infiltration system, recycling system or other alternative. Pretreatment may be required for conveyance to a sanitary sewer.

Suitable Applications

Appropriate applications include commercial developments, restaurants, retail gasoline outlets, automotive repair shops and others.

Design Considerations

Design requirements for vehicle maintenance are governed by Building and Fire Codes, and by current local agency ordinances, and zoning requirements. Design criteria described in this fact sheet are meant to enhance and be consistent with these code requirements.

Designing New Installations

Areas for washing/steam cleaning should incorporate one of the following features:

- Be self-contained and/or covered with a roof or overhang
- Be equipped with a clarifier or other pretreatment facility
- Have a proper connection to a sanitary sewer

- Include other features which are comparable and equally effective

CAR WASH AREAS - Some jurisdictions' stormwater management plans include vehicle-cleaning area source control design requirements for community car wash racks in complexes with a large number of dwelling units. In these cases, wash water from the areas may be directed to the sanitary sewer, to an engineered infiltration system, or to an equally effective alternative. Pre-treatment may also be required.

Depending on the jurisdiction, developers may be directed to divert surface water runoff away from the exposed area around the wash pad (parking lot, storage areas), and wash pad itself to alternatives other than the sanitary sewer. Roofing may be required for exposed wash pads.

It is generally advisable to cover areas used for regular washing of vehicles, trucks, or equipment, surround them with a perimeter berm, and clearly mark them as a designated washing area. Sumps or drain lines can be installed to collect wash water, which may be treated for reuse or recycling, or for discharge to the sanitary sewer. Jurisdictions may require some form of pretreatment, such as a trap, for these areas.

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.

Additional Information

Maintenance Considerations

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Other Resources

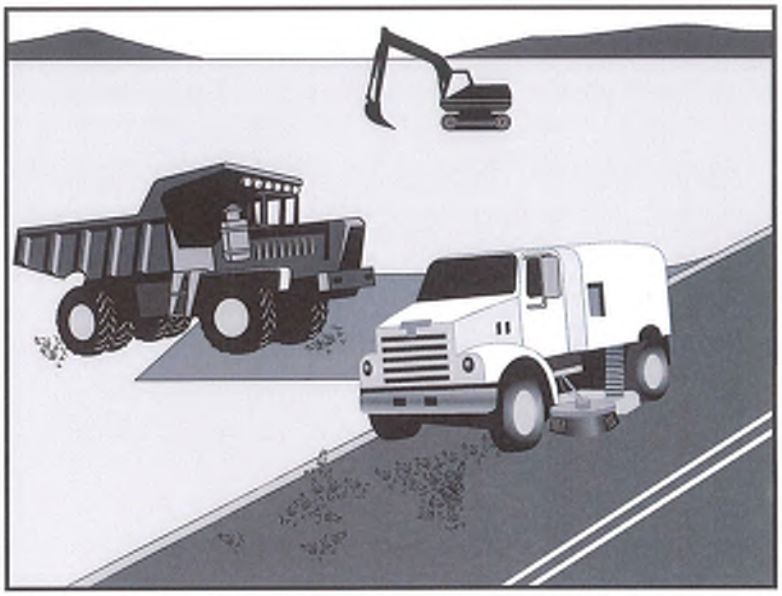
A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

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.

Street Sweeping and Vacuuming SE-7



Categories		
EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.
- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.

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- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Costs

Rental rates for self-propelled sweepers vary depending on hopper size and duration of rental. Expect rental rates from $58/hour (3 yd^3 hopper) to $88/hour (9 yd^3 hopper), plus operator costs. Hourly production rates vary with the amount of area to be swept and amount of sediment. Match the hopper size to the area and expect sediment load to minimize time spent dumping.

Inspection and Maintenance

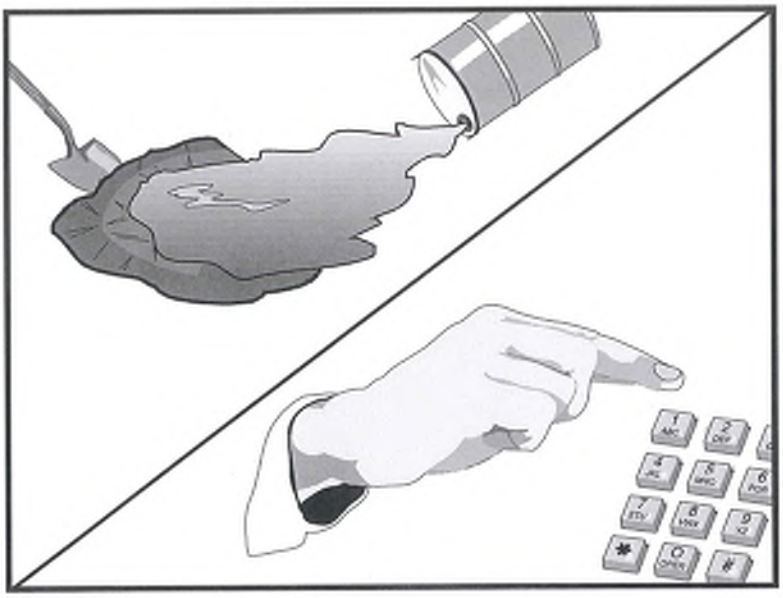
- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.

Spill Prevention and Control WM-4



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

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

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to drainage systems or watercourses from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, WM-1, Materials Delivery and Storage, and WM-2, Material Use, also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

This BMP is suitable for all construction projects. Spill control procedures are implemented anytime chemicals or hazardous substances are stored on the construction site, including the following materials:

- Soil stabilizers/binders
- Dust palliatives
- Herbicides
- Growth inhibitors
- Fertilizers
- Deicing/anti-icing chemicals

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- Fuels
- Lubricants
- Other petroleum distillates

Limitations

- In some cases it may be necessary to use a private spill cleanup company.
- This BMP applies to spills caused by the contractor and subcontractors.
- Procedures and practices presented in this BMP are general. Contractor should identify appropriate practices for the specific materials used or stored onsite

Implementation

The following steps will help reduce the stormwater impacts of leaks and spills:

Education

- Be aware that different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- Have contractor's superintendent or representative oversee and enforce proper spill prevention and control measures.

General Measures

- To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110,117, and 302, and sanitary and septic wastes should be contained and cleaned up immediately.
- Store hazardous materials and wastes in covered containers and protect from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals to oversee and enforce control measures.
- Spills should be covered and protected from stormwater runon during rainfall to the extent that it doesn't compromise clean up activities.
- Do not bury or wash spills with water.

- Store and dispose of used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose in conformance with the provisions in applicable BMPs.
- Do not allow water used for cleaning and decontamination to enter storm drains or watercourses. Collect and dispose of contaminated water in accordance with WM-10, Liquid Waste Management.
- Contain water overflow or minor water spillage and do not allow it to discharge into drainage facilities or watercourses.
- Place proper storage, cleanup, and spill reporting instructions for hazardous materials stored or used on the project site in an open, conspicuous, and accessible location.
- Keep waste storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

Cleanup

- Clean up leaks and spills immediately.
- Use a rag for small spills on paved surfaces, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this section for specific information.

Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Absorbent materials should be promptly removed and disposed of properly.
- Follow the practice below for a minor spill:
  - Contain the spread of the spill.
  - Recover spilled materials.
  - Clean the contaminated area and properly dispose of contaminated materials.

Semi-Significant Spills

- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.

- Spills should be cleaned up immediately:
  - Contain spread of the spill.
  - Notify the project foreman immediately.
  - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
  - If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.
  - If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Significant/Hazardous Spills

- For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps should be taken:
  - Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.
  - Notify the Governor's Office of Emergency Services Warning Center, (916) 845-8911.
  - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor should notify the National Response Center at (800) 424-8802.
  - Notification should first be made by telephone and followed up with a written report.
  - The services of a spills contractor or a Haz-Mat team should be obtained immediately. Construction personnel should not attempt to clean up until the appropriate and qualified staffs have arrived at the job site.
  - Other agencies which may need to be consulted include, but are not limited to, the Fire Department, the Public Works Department, the Coast Guard, the Highway Patrol, the City/County Police Department, Department of Toxic Substances, California Division of Oil and Gas, Cal/OSHA, etc.

Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hours).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur onsite, use a designated area and a secondary containment, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Regularly inspect onsite vehicles and equipment for leaks and repair immediately
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around
- Oil filters disposed of in trashcans or dumpsters can leak oil and pollute stormwater. Place the oil filter in a funnel over a waste oil-recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask the oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur onsite, use designate areas, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Discourage "topping off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/ leaks.

Costs

Prevention of leaks and spills is inexpensive. Treatment and/ or disposal of contaminated soil or water can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Keep ample supplies of spill control and cleanup materials onsite, near storage, unloading, and maintenance areas.
- Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals onsite.

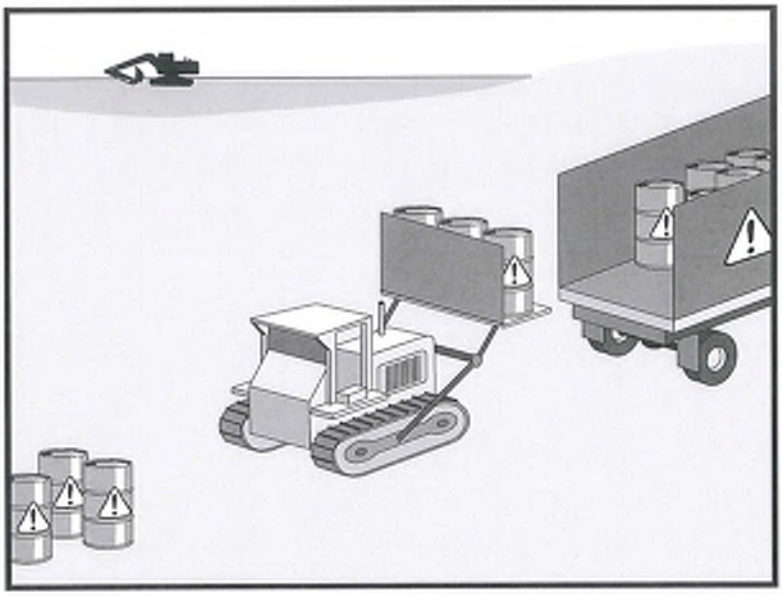
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Hazardous Waste Management WM-6



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

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

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products
- Asphalt Products
- Concrete Curing Compounds
- Pesticides
- Palliatives
- Acids
- Septic Wastes
- Paints
- Stains
- Solvents
- Wood Preservatives
- Roofing Tar
- Any materials deemed a hazardous waste in California, Title 22 Division 4.5, or listed in 40 CFR Parts 110, 117, 261, or 302

In addition, sites with existing structures may contain wastes, which must be disposed of in accordance with federal, state, and local regulations. These wastes include:

- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints
- Asbestos
- PCBs (particularly in older transformers)

Limitations

- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
- Nothing in this BMP relieves the contractor from responsibility for compliance with federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes.
- This BMP does not cover aerially deposited lead (ADL) soils. For ADL soils refer to WM-7, Contaminated Soil Management.

Implementation

The following steps will help reduce stormwater pollution from hazardous wastes:

Material Use

- Wastes should be stored in sealed containers constructed of a suitable material and should be labeled as required by Title 22 CCR, Division 4.5 and 49 CFR Parts 172, 173, 178, and 179.
- All hazardous waste should be stored, transported, and disposed as required in Title 22 CCR, Division 4.5 and 49 CFR 261-263.
- Waste containers should be stored in temporary containment facilities that should comply with the following requirements:
  - Temporary containment facility should provide for a spill containment volume equal to 1.5 times the volume of all containers able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater.
  - Temporary containment facility should be impervious to the materials stored there for a minimum contact time of 72 hours.
  - Temporary containment facilities should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be placed into drums after each rainfall. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids should be sent to an approved disposal site.
  - Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.

- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.

- Throughout the rainy season, temporary containment facilities should be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs.

- Drums should not be overfilled and wastes should not be mixed.

- Unless watertight, containers of dry waste should be stored on pallets.

- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application. Allow time for infiltration and avoid excess material being carried offsite by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with federal and state regulations.

- Paint brushes and equipment for water and oil based paints should be cleaned within a contained area and should not be allowed to contaminate site soils, watercourses, or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused should be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths should be disposed of as solid waste.

- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and reuse thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.

- The following actions should be taken with respect to temporary contaminant:

  - Ensure that adequate hazardous waste storage volume is available.

  - Ensure that hazardous waste collection containers are conveniently located.

  - Designate hazardous waste storage areas onsite away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.

  - Minimize production or generation of hazardous materials and hazardous waste on the job site.

  - Use containment berms in fueling and maintenance areas and where the potential for spills is high.

  - Segregate potentially hazardous waste from non-hazardous construction site debris.

  - Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.

- Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Do not mix wastes.
- Use all of the product before disposing of the container.
- Do not remove the original product label; it contains important safety and disposal information.

Waste Recycling Disposal

- Select designated hazardous waste collection areas onsite.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, making recycling impossible and complicating disposal.
- Recycle any useful materials such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g., excess oil-based paint and sludge) is collected, removed, and disposed of only at authorized disposal areas.

Disposal Procedures

- Waste should be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
- A Department of Health Services certified laboratory should sample waste to determine the appropriate disposal facility.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
- Attention is directed to "Hazardous Material", "Contaminated Material", and "Aerially Deposited Lead" of the contract documents regarding the handling and disposal of hazardous materials.

Education

- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors on potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings).
- The contractor's superintendent or representative should oversee and enforce proper hazardous waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events..
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Hazardous waste should be regularly collected.
- A foreman or construction supervisor should monitor onsite hazardous waste storage and disposal procedures.
- Waste storage areas should be kept clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

- Hazardous spills should be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.
- The National Response Center, at (800) 424-8802, should be notified of spills of federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302. Also notify the Governors Office of Emergency Services Warning Center at (916) 845-8911.
- A copy of the hazardous waste manifests should be provided.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Appendix III

Soils Percolation Test

Converse Consultants
Geotechnical Engineering
Environmental & Groundwater Science
Inspection & Testing Services

UPDATED GEOTECHNICAL INVESTIGATION & WATER INFILTRATION TEST REPORT

APPROXIMATELY 20.60-ACRE RESIDENTIAL DEVELOPMENT

SOUTHEAST CORNER OF HOPLAND STREET AND CAHUENGA ROAD
CITY OF VICTORVILLE, SAN BERNARDINO COUNTY, CALIFORNIA

CONVERSE PROJECT NO. 19-81-173-01

Prepared For:

LANSING COMPANIES
12671 High Bluff Drive, Suite 150
San Diego, CA 92130

Presented By:

CONVERSE CONSULTANTS
2021 Rancho Drive, Suite 1
Redlands, CA 92373
909-796-0544

July 16, 2019

Converse Consultants
Geotechnical Engineering, Environmental & Groundwater Science, Inspection & Testing Services

July 16, 2019

Mr. Casey Malone
Project Manager
Lansing Companies
12671 High Bluff Drive, Suite 150
San Diego, CA 92130

Subject: **UPDATED GEOTECHNICAL INVESTIGATION AND WATER INFILTRATION TEST REPORT**
Approximately 20.60-Acre Residential Development
Southeast Corner of Hopland Street and Cahuenga Road
City of Victorville, San Bernardino County, California
Converse Project No. 19-81-173-01

Dear Mr. Malone:

Converse Consultants (Converse) has prepared this updated geotechnical investigation and water infiltration test report to present the findings, conclusions and recommendations for the approximately 20.60-Acre Residential Development project located on the southeast corner of Hopland Street and Cahuenga Road in the city of Victorville, San Bernardino County, California. This report is prepared in accordance with our proposal dated May 14, 2019 and your General Consultant Agreement dated May 16, 2019.

Converse Consultants prepared a geotechnical investigation report (05-81-351-01) for the subject site dated January 27, 2006 for Victory Ridge Estate Homes, LLC (Converse, 2006). A portion of the site was developed. This report includes design and construction recommendations for development of the remaining site.

Based upon our field investigation, laboratory data, and analyses, the proposed project is considered suitable from a geotechnical standpoint, provided the recommendations presented in this report are incorporated into the design and construction of the project.

We appreciate the opportunity to be of continued service to Lansing Companies. If you should have any questions, please contact the undersigned at 909-796-0544.

CONVERSE CONSULTANTS

Hashmi S. E. Quazi, PhD, PE, GE
Regional Manager/Principal Engineer

Dist.: 3/Addressee

PROFESSIONAL CERTIFICATION

This report has been prepared by the following professionals whose seals and signatures appear herein.

The findings, recommendations, specifications and professional opinions contained in this report were prepared in accordance with the generally accepted professional engineering and engineering geologic principle and practice in this area of Southern California. We make no other warranty, either expressed or implied.

Zahangir Alam, PhD, EIT
Senior Staff Engineer

James Burnham, PG
Project Geologist

Hashmi S. E. Quazi, PhD, PE, GE
Principal Engineer

EXECUTIVE SUMMARY

The following is a summary of our geotechnical investigation, conclusions and recommendations as presented in this report. Please refer to the pertinent section of the attached report for complete conclusions and recommendations. In the event of a conflict between this summary and the report, or an omission in the summary, the report shall prevail.

- The proposed 20.60-acre residential development site is located on the southeast corner of Hopland Street and Cahuenga Road in the City of Victorville, San Bernardino County, California. The site is irregularly shaped and is roughly bounded on the east by residential developments, Carmelia Drive, and vacant land; on the west by Cahuenga Road; on the north by residential developments and Hopland Street; and on the south by Tawney Ridge Lane. The site is presently vacant. The topography of the site is irregular, but generally trends downwards from approximately 2,910 feet above mean sea level (AMSL) along the eastern-most boundary to approximately 2,875 feet AMSL along the western-most boundary. The landscape is relatively flat and clear of major vegetation.

- It was planned to build 129 single-family, one- and two-story homes supported by conventional continuous and/or isolated footing foundations with slab-on-grade. It is our understanding that the development included driveways, in-tract streets with curbs and gutters, sidewalks, landscaped areas, and under- and above-ground utilities. We understand approximately 10-acre of the original 30-acre has been developed with 59 single-family homes, above and below ground utilities and interior streets. We are not aware when the site was graded and who provided observation and testing during grading and post-grading. The remaining 20.60-acre site will now be developed for 70 single-family homes supported by conventional continuous and/or isolated footing foundations with slab-on-grade. The project also includes streets, driveways, curb and gutter, sidewalks, landscape areas and above and underground utilities. A detention basin approximately between 6.5 to 8 feet deep is planned at the northeast corner of the site.

- Our scope of work included project set-up, subsurface exploration, percolation testing, laboratory testing, engineering analysis, and preparation of this report.

- For the previous investigation performed by Converse, a total of seven exploratory borings (BH-1 to BH-7) were drilled on December 7, 2005 across the project site, to depths of 16.5 to 51.5 feet below ground surface (bgs).
- Additionally, two exploratory borings (BH-8 and BH-9) were drilled on June 3, 2019 to investigate subsurface conditions at the project site. The borings were drilled to depths of 15.8 and 16.4 feet below existing ground surface (bgs). Two exploratory percolation test holes (PT-01 and PT-02) were drilled on June 3, 2019 to perform

percolation testing. Both percolation test borings were drilled to approximately 8.0 feet below the existing ground surface (bgs). The percolation test holes were re-drilled to 10 feet bgs on July 12, 2019. Logs of borings from the previous and present investigation are included in Appendix A, *Field Exploration*.

- The subsurface soil at the site consists primarily mixture of silt, sand, and gravel. Gravel up to 2 inches in largest dimension was encountered in most of the borings.

- Groundwater was not encountered during our current (2019) or previous (2006) field investigation to the maximum explored depths of 16.4 and 51.5 feet bgs, respectively. Current groundwater is expected to be deeper than 16.4 feet bgs. It should be noted that the groundwater level could vary depending upon the seasonal precipitation and possible groundwater pumping activity in the vicinity.

- The project site is not located within a currently mapped State of California Earthquake Fault Zone for surface fault rupture.

- Due to the absence of shallow groundwater, the project site is not considered susceptible to liquefaction.

- The risk to the site from lateral spreading, landsliding, seiches, tsunamis, and earthquake-induced flooding are considered to be low.

- The expansion index (EI) of soil samples from the upper 10 feet varied from 0 to 43, corresponding to very low to low expansion potential. The collapse potentials of the upper 10 feet soils were between 0.25 to 3.03 (including consolidation test) percent, indicating slight to moderate collapse potential.

- The sulfate contents of the sampled soils correspond to American Concrete Institute (ACI) exposure category S0 for these sulfate concentrations. No concrete type restrictions are specified for exposure category S0. A minimum compressive strength of 2,500 psi is recommended. The chloride contents of the sampled soils correspond to American Concrete Institute (ACI) exposure category C1 (concrete is exposed to moisture, but not to external sources of chlorides). For exposure category C1, ACI provides concrete compressive strength of at least 2,500 psi and a maximum chloride content of 0.3 percent.

- The measured value of the minimum electrical resistivity of the sample when saturated were 876 and 4,046 ohm-cm for the site. This indicates that the soils tested are mildly corrosive to severely corrosive to ferrous metals in contact with the soil. Converse does not practice in the area of corrosion consulting. A qualified corrosion consultant should provide appropriate corrosion mitigation measures for any ferrous metals in contact with the site soils.

- Prior to the start of construction, all existing underground utilities and appurtenances, if present, should be located at the project site. Such utilities should either be protected in-place or removed and replaced during construction as required by the project specifications. All excavations should be conducted in such a manner as not to cause loss of bearing and/or lateral support of existing utilities and structure (if any).

- Based on our subsurface exploration, we anticipate that the site soils will be excavatable with conventional heavy-duty earthmoving equipment. Difficult excavation may be encountered in areas of high concentration of granular materials.

- Excavated onsite earth materials cleared of deleterious matter can be moisture conditioned and re-used as compacted fill.

- About five feet of alluvial soils should be removed and replaced with compacted fill, prior to placing additional compacted fill.

- For building pads, deeper excavation may be required below finish grade in cut areas. If less than five feet is removed from original ground (og), excavation should continue to provide a minimum of two feet of compacted fill below bottom of footings. If more than five feet is removed, the bottom surface should be evaluated for suitability by the geotechnical consultant. All over-excavations should extend at least five feet or equal to the depth of over-excavation, whichever is greater, outside the building footprint.

- The cut portion of transition lots (and if necessary, the fill portion) should be excavated to a depth to provide a minimum of two feet of compacted fill beneath the entire pads.

- As a minimum, the upper three feet of surficial soils from all areas receiving asphalt concrete or Portland concrete paving, including driveways, sidewalks, street areas, curbs and gutters and other flatwork should be excavated, removed if necessary, and/or replaced as compacted fill. Such over-excavation should extend at least two feet beyond the pavement area edges.

- As a minimum, the upper three feet of surficial soils within two feet of either side of retaining/perimeter walls less than six feet in height, should be excavated, removed if necessary, and/or processed and replaced as compacted fill. The depth of the structural fill under retaining/perimeter wall footings should be at least two feet or equal to footing width, whichever is greater.

- Fill soils should be placed on scarified and recompacted excavation bottoms, moisture conditioned, and compacted to at least 90 percent of the laboratory maximum dry density. At least the upper 12 inches of fill beneath pavement intended to support

vehicle loads should be compacted to at least 95 percent of the laboratory maximum dry density.

- Residential one- or two-story wood-frame, lightly loaded structures may be supported on conventional continuous (strip) and/or isolated (spread) footings. Interior and exterior footings should be placed at least 12 inches and 18 inches, respectively, below lowest adjacent soil grade. Width of the continuous and isolated footings for one-story buildings should be at least 12 inches and 18 inches, respectively. Width of the continuous and isolated footings for two-story buildings should be at least 18 inches and 24 inches, respectively. Footings placed at a depth of 12 inches and 18 inches below lowest adjacent grade may be designed based on an allowable net bearing capacity of 2,000 pounds per square foot (psf).

- The total settlement of shallow footings from static structural loads and short-term settlement of properly compacted fill is anticipated to be one inch or less. The differential settlement resulting from static loads is anticipated to be 0.5 inches or less over a horizontal distance of 40 feet.

- Based on the observed high blow counts below 5 feet bgs in all borings and over-excavation recommendations, we anticipate the site will likely have negligible seismic settlement. For the design purpose, seismic settlement may be taken as 1 inch or less and the differential settlement may be taken as half of the total seismic settlement.

- The recommended infiltration rate is 0.17 inches/hour at 8 feet bgs or 1.01 inches per hour at 10 feet bgs at the location of the infiltration basin.

- Lateral earth pressures and pipe design parameters are presented in the text of this report.

- Pavement design recommendations are presented in the text of this report.

- Recommendations for temporary sloped excavations are provided in the text of this report.

Based on our investigation, it is our professional opinion that the site is suitable for the construction of the proposed building provided the recommendations presented in this geotechnical investigation report are implemented in the planning, design and construction of the project.

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APPENDICES

1.0 INTRODUCTION

This updated report contains the findings of the geotechnical investigation and percolation tests performed by Converse for the proposed residential development within a 20.60-acre site located on the southeast corner of Hopland Street and Cahuenga Road in the city of Victorville, San Bernardino County, California. The project location is shown in Figure No. 1, *Approximate Project Location Map.*

Converse Consultants investigated the site on December 7, 2005 by drilling seven exploratory borings ranging in depths from 16.5 to 51.5 feet below existing ground surface (bgs). A geotechnical investigation report was prepared for Victory Ridge Estate Homes, LLC (Converse, 2006).

The purpose of this investigation was to evaluate the current nature and engineering properties of the subsurface soils and groundwater conditions, and to provide updated geotechnical recommendations for the proposed residential development.

This report is written for the project described herein and is intended for use solely by Lansing Companies and their design team. It should not be used as a bidding document but may be made available to the potential contractors for information on factual data only. For bidding purposes, the contractors should be responsible for making their own interpretation of the data contained in this report.

2.0 PROJECT BACKGROUND AND DESCRIPTION

The original approximately 30-acre site is located at the southeast corner of Hopland Street and Cahuenga Road in the City of Victorville, San Bernardino County, California.

It was planned to build 129 single-family, one- and two-story homes supported by conventional continuous and/or isolated footing foundations with slab-on-grade. It is our understanding that the development included driveways, in-tract streets with curbs and gutters, sidewalks, landscaped areas, and under- and above-ground utilities.

We understand approximately 10-acre of the original 30-acre has been developed with 59 single-family homes, above and below ground utilities and interior streets. We are not aware when the site was graded and who provided observation and testing during grading and post-grading.

The remaining 20.60-acre site will now be developed for 70 single-family homes supported by conventional continuous and/or isolated footing foundations with slab-on-grade. The project also includes streets, driveways, curb and gutter, sidewalks, landscape areas and above and underground utilities. A detention basin approximately between 6.5 to 8 feet deep is planned at the northeast corner of the site.

Approximate Project Location Map

Project: Approximately 20.60-Acre Residential Development
Location: City of Victorville, San Bernardino County, California

Project No
19-81-173-01

For: Lansing Companies

Converse Consultants

FIGURE NO.
1

Rough grading plans have not been prepared or reviewed at the time of this report. Based on our experience with similar projects, site development may include slopes and earth retaining walls (perimeter walls) less than six feet in height. These walls will be founded on conventional continuous footings.

3.0 SITE DESCRIPTION

The proposed 20.60-acre residential development site is irregularly shaped and is roughly bounded on the east by residential developments, Carmelia Drive, and vacant land; on the west by Cahuenga Road; on the north by residential developments and Hopland Street; and on the south by Tawney Ridge Lane. The site is presently vacant.

The topography of the site is irregular, but generally trends downwards from approximately 2,910 feet above mean sea level (AMSL) along the eastern-most boundary to approximately 2,875 feet AMSL along the western-most boundary. The landscape is relatively flat and clear of major vegetation. Few large boulders are randomly dispersed throughout the site and a large depression and gently sloping mound of soil is located roughly in the center of the site in the vicinity of boring BH-9. Short piles of undocumented fill soil are also present throughout the western portion of the site. The present site conditions are shown in Photograph 1 below.

Photograph No. 1, Present site conditions near center-west boundary, facing northwest.

4.0 SCOPE OF WORK

The scope of this investigation included project set-up, subsurface exploration, laboratory testing, engineering analysis, and preparation of this report, as described in the following sections.

4.1 Document Review

We reviewed geologic maps, aerial photographs, groundwater data, and other information pertaining to the project site to assist in the evaluation of geologic hazards that may be present. We used pertinent information (the documents cited in Section 15, *Reference*s) to understand the subsurface conditions and plan the investigation for this project.

4.2 Project Set-up

The project set-up consisted of the following tasks.

- Conducted a field reconnaissance and marked the boring locations such that the drill rig access to all locations was available.
- Notified Underground Service Alert (USA) at least 48 hours prior to drilling to clear the boring location of any conflict with existing underground utilities.
- Engaged a California-licensed driller to drill exploratory borings.

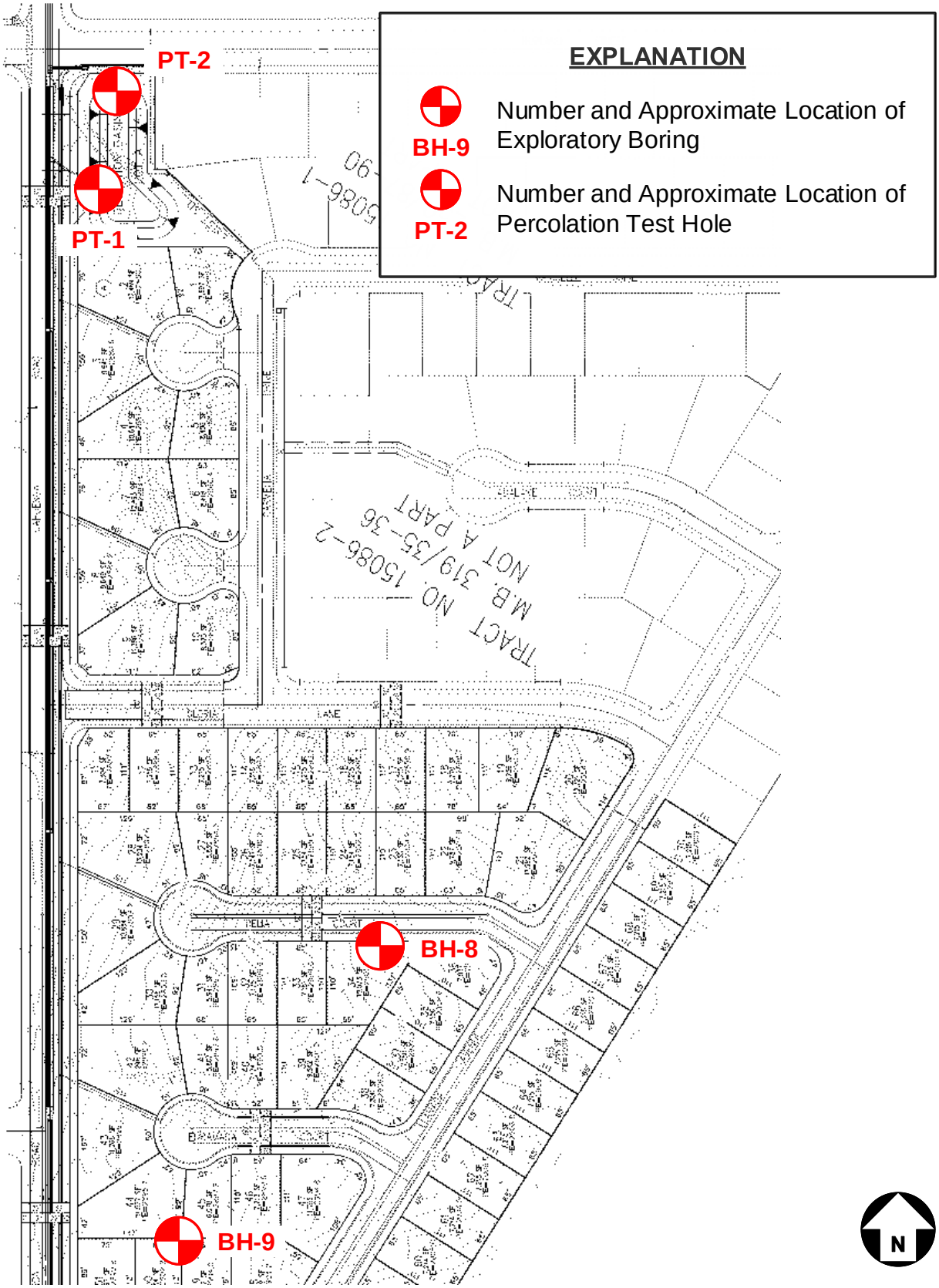
4.3 Subsurface Exploration

For the previous investigation performed by Converse, a total of seven exploratory borings (BH-1 to BH-7) were drilled on December 7, 2005 across the project site, to depths of 16.5 to 51.5 feet below ground surface (bgs).

Additionally, two exploratory borings (BH-8 and BH-9) were drilled on June 3, 2019 to investigate subsurface conditions at the project site. The borings were drilled to depths of 15.8 and 16.4 feet below existing ground surface (bgs).

Two exploratory percolation test holes (PT-01 and PT-02) were drilled on June 3, 2019 to perform percolation testing. Both percolation test borings were drilled to approximately 8.0 feet below the existing ground surface (bgs).

Approximate boring and percolation testing locations are indicated in Figure No. 2a, *Approximate Boring and Percolation Test Locations Map*. Previous (2006) approximate boring locations are also attached after Figure No. 2a. For a description of the field exploration and sampling program, see Appendix A, *Field Exploration*.



Approximate Boring and Percolation Test Locations Map

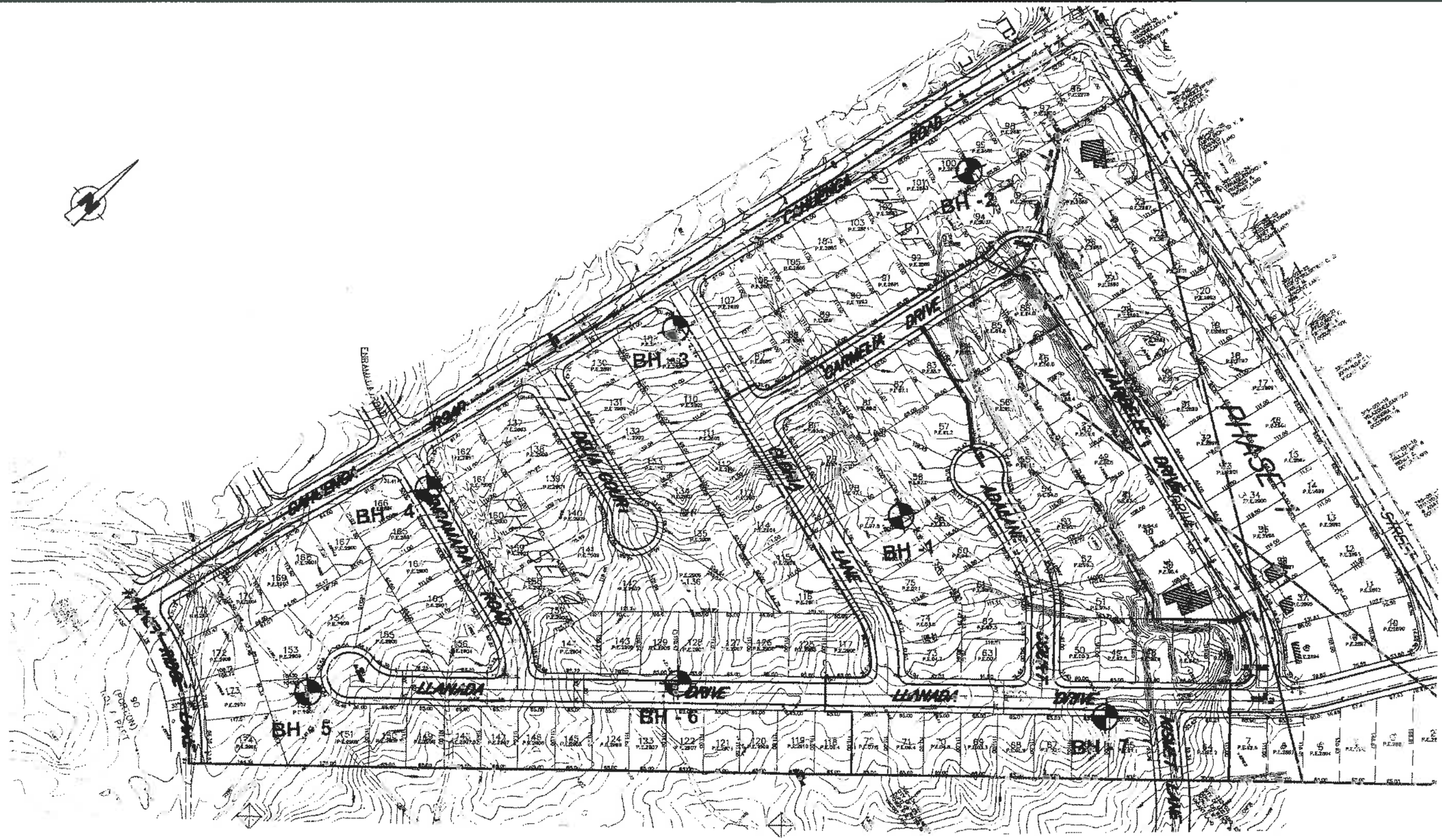
Project: Approximately 20.60-Acre Residential Development
Location: City of Victorville, San Bernardino County, California

For: Lansing Companies

Project No.
19-81-173-01

Converse Consultants

Figure No.
2a



APPROXIMATE BORING LOCATION MAP

APRROXIMATELY 30 – ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

EXPLANATION

BH - 1 Number and Approximate Boring Location

Converse Consultants

Scale	NTS
Prepared By	KQ
Checked By	BAS
Approved By	RJR
Project No.	05-81-351-01
Figure No.	2

4.4 Laboratory Testing

Representative soil samples of the project site were tested in the laboratory to aid in the soils classification and to evaluate the relevant engineering properties of the site soils. These tests included the following.

- *In*-situ moisture contents and dry densities (ASTM D2216 and ASTM D7263)
- Expansion index (ASTM D4829)
- R-value (California Test Method 301)
- Soil corrosivity (California Tests 643, 422, and 417)
- Collapse Potential (ASTM Standard D4546)
- Grain size distribution (ASTM D6913)
- Maximum dry density and optimum-moisture content (ASTM D1557)
- Direct shear (ASTM D3080)

For *in-situ* moisture and dry density data, see the Logs of Borings in Appendix A, *Field Exploration*. For a description of the laboratory test methods and test results, see Appendix B, *Laboratory Testing Program.*

4.5 Analysis and Report Preparation

Data obtained from the field exploration and laboratory testing program was compiled and evaluated. Geotechnical analyses of the compiled data were performed, and this report was prepared to present our findings, conclusions and recommendations for the proposed project.

5.0 SITE CONDITIONS

A general description of the subsurface conditions and various materials encountered at the site during our field exploration is contained in this section.

5.1 Subsurface Profile

Based on the exploratory borings, test pits, and laboratory test results, the subsurface soil at the site consists primarily mixture of silt, sand, and gravel. Gravel up to 2 inches in largest dimension was encountered in most of the borings.

For a detailed description of the subsurface materials encountered in the exploratory borings, see Drawings No. A-2 through A-8 (2006) and A-9 through A-12 (2019), Logs of Borings, in Appendix A, Field Exploration.

5.2 Groundwater

Groundwater was not encountered during our current (2019) or previous (2006) field investigation to the maximum explored depths of 16.4 and 51.5 feet bgs, respectively. The GeoTracker database (SWRCB, 2019) was reviewed for groundwater data from sites within an approximately 1.0-mile radius of both the proposed development. Data in the following table was found on the National Water Information System (USGS, 2019a).

Table No. 1, Summary of USGS Groundwater Depth Data

Alignment No.	Location	Groundwater Depth Range (ft. bgs)	Date Range
343239117194801	West side of Torrance Ln. cross of Village Dr.	137.1-161.9	1992-2014
343149117205301	Approximately 600ft. West of El Evado Rd. between Mojave Dr. and Fontaine Way	143.1	1917
343145117204701	Approximately 15ft. East of El Evado Rd. between Mojave Dr. and Dumosa Drive	211-214	2006-2010
343146117194401	Approximately 15ft. East of El Evado Rd. between Mojave Dr. and Dumosa Drive	198.1-221	2004-2014

Based on available data, the historical high groundwater level reported at wells within approximately one mile of the site was approximately 137.1 feet bgs. Current groundwater is expected to be deeper than 16.4 feet bgs. It should be noted that the groundwater level could vary depending upon the seasonal precipitation and possible groundwater pumping activity in the vicinity.

5.3 Excavatability

The subsurface materials at the site are expected to be excavatable by conventional heavy-duty earth moving equipment. Difficult excavation may be encountered in areas of high concentration of granular materials.

The phrase “conventional heavy-duty excavation equipment” is intended to include commonly used equipment such as excavators, scrapers, and trenching machines. It does not include hydraulic hammers (“breakers”), jackhammers, blasting, or other specialized equipment and techniques used to excavate hard earth materials. Selection of an appropriate excavation equipment models should be done by an experienced earthwork contractor.

5.4 Subsurface Variations

Based on results of the subsurface exploration and our experience, some variations in the continuity and nature of subsurface conditions within the project site should be anticipated. Because of the uncertainties involved in the nature and depositional characteristics of the earth material, care should be exercised in interpolating or extrapolating subsurface conditions between or beyond the boring locations.

6.0 ENGINEERING GEOLOGY

The regional and local geology within the proposed project area are discussed below.

6.1 Regional Geology

The project site is located in the Mojave Desert Geomorphic Province of Southern California. The Mojave Desert is a broad interior region of isolated mountain ranges separated by wide desert plains. The area is roughly triangular shaped and bounded by the Garlock Fault on the north, the San Andreas Fault on the southwest, and the Colorado River on the east. The drainages are primarily closed and terminate in playas within the valley floors.

The province is a seismically active region primarily characterized by a series of northwest-southeast-trending strike-slip faults and east-west trending secondary faults. The most prominent of the nearby fault zones include the Helendale, Lenwood, Landers, and San Andreas Fault Zones, all of which have been known to be active during Quaternary time.

Extension of the region has resulted in exposure of basement rocks dating to the Precambrian age, deposition of young Holocene-aged sedimentary basins, and eruptions of volcanic units.

6.2 Site Geology

Loose to well-consolidated sand, silt, and pebble-cobble gravel. (Hernandez et al., 2008).

6.3 Flooding

Review of National Flood Insurance Rate Maps indicates that the project site is within a Flood Hazard Zone "X". The Zone “X” is designated as “Areas determined to be outside the 500-year floodplain (FEMA, 2008).

7.0 FAULTING AND SEISMICITY

The approximate distance and seismic characteristics of nearby faults as well as seismic design coefficients are presented in the following subsections.

7.1 Faulting

The proposed site is situated in a seismically active region. As is the case for most areas of Southern California, ground-shaking resulting from earthquakes associated with nearby and more distant faults may occur at the project site. During the life of the project, seismic activity associated with active faults can be expected to generate moderate to strong ground shaking at the site. Review of recent seismological and geophysical publications indicates that the seismic hazard for the project is high.

The project site is not located within a currently mapped State of California Earthquake Fault Zone for surface fault rupture. Table No. 2, *Summary of Regional Faults,* summarizes selected data of known faults capable of seismic activity within 50 kilometers of the site. The data presented below was calculated using the National Seismic Hazard Maps Database (USGS, 2008) and other published geologic data.

Table No. 2, Summary of Regional Faults

Fault Name and Section	Closest Distance (km)	Slip Sense	Length (km)	Slip Rate (mm/year)	Maximum Magnitude
North Frontal (West)	19.35	reverse	50	1	7.20
Helendale-So Lockhart	20.01	strike slip	114	0.6	7.40
Cleghorn	27.36	strike slip	25	3	6.80
S. San Andreas	31.19	strike slip	548	n/a	8.18
San Jacinto	34.44	strike slip	241	n/a	7.88
Cucamonga	41.09	thrust	28	5	6.70
Lenwood-Lockhart-Old Woman Springs	42.71	strike slip	145	0.9	7.50

(Source: https://earthquake.usgs.gov/cfusion/hazfaults_2008_search/)

7.2 CBC Seismic Design Parameters

Seismic parameters based on the 2016 California Building Code (CBSC, 2016) are provided in the following table were determined using the Seismic Design Maps application (OSHPD, 2019) and are presented in the following table.

Table No. 3, CBC Seismic Design Parameters

Seismic Parameters	
Site Coordinates	34.5409 N, 117.3393 W
Site Class	D
Risk Category	III
Mapped Short period (0.2-sec) Spectral Response Acceleration, S_s	1.424g
Mapped 1-second Spectral Response Acceleration, S_1	0.563g
Site Coefficient (from Table 1613.5.3(1)), F_a	1.0
Site Coefficient (from Table 1613.5.3(2)), F_v	1.5
MCE 0.2-sec period Spectral Response Acceleration, S_{MS}	1.424g
MCE 1-second period Spectral Response Acceleration, SM_1	0.845g
Design Spectral Response Acceleration for short period S_{DS}	0.950g
Design Spectral Response Acceleration for 1-second period, S_{D1}	0.563g
Maximum Peak Ground Acceleration, PGA_M	0.500g

7.3 Secondary Effects of Seismic Activity

In addition to ground shaking, effects of seismic activity on a project site may include surface fault rupture, soil liquefaction, landslides, lateral spreading, seismic settlement, tsunamis, seiches and earthquake-induced flooding. Results of a site-specific evaluation of each of the above secondary effects are explained below:

Surface Fault Rupture: The project site is not located within a currently designated State of California Earthquake Fault Zone. Based on review of existing geologic information, no major surface fault crosses through or extends toward the site. The potential for surface rupture resulting from the movement of a presently unrecognized fault beneath the site is not known with certainty but is considered very low.

Liquefaction: Liquefaction is defined as the phenomenon in a soil mass, because of the development of excess pore pressures, soil mass suffers a substantial reduction in its shear strength. During earthquakes, excess pore pressures in saturated soil deposits may develop as a result of induced cyclic shear stresses, resulting in liquefaction. Soil liquefaction occurs in submerged granular soils during or after strong ground shaking. There are several requirements for liquefaction to occur. They are as follows:

- Soils must be submerged
- Soils must be primarily granular
- Soils must be contractive, that is, loose to medium-dense

- Ground motion must be intense
- Duration of shaking must be sufficient for the soils to lose shear resistance

Groundwater was not encountered during our current (2019) or previous (2006) field investigation to a maximum depth of 16.4 and 51.5 feet bgs, respectively. Due to the absence of shallow groundwater, the project site is not considered susceptible to liquefaction (USGS, 2010a).

***Seismic Settlement**:* Dynamic dry settlement may occur in loose, granular, unsaturated soils during a large seismic event. Based on the observed high blow counts below 5 feet bgs in all borings and over-excavation recommendations, we anticipate the site will have negligible seismic settlement.

Landslides: Seismically induced landslides and other slope failures are common occurrences during or after earthquakes in areas of significant relief. The project site is not adjacent to any steep slopes. In the absence of significant ground slopes, the potential for seismically induced landslides to affect the proposed site is considered to be low.

Lateral Spreading: Seismically induced lateral spreading involves primarily lateral movement of earth materials due to ground shaking. It differs from the slope failure in that complete ground failure involving large movement does not occur due to the relatively smaller gradient of the initial ground surface. Lateral spreading is demonstrated by near-vertical cracks with predominantly horizontal movement of the soil mass involved. Due to the absence of shallow groundwater and lack of liquefaction potential, the risk for lateral spreading to affect the site is considered low.

Tsunamis: Tsunamis are tidal waves generated in large bodies of water by fault displacement or major ground movement. Based on the location of the site, tsunamis do not pose a hazard to this site.

Seiches: Seiches are large waves generated in enclosed bodies of water in response to ground shaking. Review of the area adjacent to the site indicates that there are no significant up-gradient lakes or reservoirs with the potential of flooding the site.

Earthquake-Induced Flooding: This is flooding caused by failure of dams or other water-retaining structures as a result of earthquakes. Review of the area adjacent to the site indicates the site is not located in any potential inundation path of any reservoir. The potential for flooding of the site due to dam failure is considered very low (USGS, 2010b).

8.0 LABORATORY TESTING

Laboratory testing was performed to determine the physical and chemical characteristics and engineering properties of the subsurface soils. Tests results are included in Appendix A, *Field Exploration* and Appendix B, *Laboratory Testing Program*. Discussions of the various test results performed for the current investigation (2019) are presented below. The test results from previous investigation (Converse, 2006) are included in Appendix B, *Laboratory Testing Program.*

8.1 Physical Testing

Physical test results are presented as follows.

- *In-situ* Moisture and Dry Density – *In-situ* dry density and moisture content of the site soils were determined in accordance to ASTM Standard D2216 and D7263. Dry densities of the upper 10 feet soils ranged from 109 to 128 pounds per cubic foot (pcf) with moisture contents of 3 to 15 percent. Results are presented in the logs of borings in Appendix A, *Field Exploration.*
- Expansion Index – Two representative samples from the upper ten feet of the site soils was tested to evaluate Expansion Potential in accordance with ASTM Standard D4829. The values of the measured EI are 2 and 3, indicating very low expansion potential.
- R-value – One R-value test was performed on a representative bulk soil sample in accordance with California Test 301. The R-value of the sample tested was 66.
- Collapse – To evaluate the moisture sensitivity (collapse potential) of the encountered soils, three representative ring samples were loaded up to approximately 2 kips per square foot (ksf) in accordance with ASTM Standard D4546, allowed to stabilize under load, and then submerged. The collapse ranged from 0.40 to 2.1 percent, which corresponds to slight to moderate collapse potential.
- Grain Size Analysis – Two representative samples were tested to determine the relative grain size distribution in accordance with the ASTM Standard D6913. The test results are graphically presented in Drawing No. B-1, *Grain Size Distribution Results.*
- Maximum Dry Density and Optimum Moisture Content – Typical moisture-density relationship test was performed on a representative soil sample in accordance with ASTM Standard D1557. The result is presented in Drawing No. B-2, *Moisture-Density Relationship Results*, in Appendix B, *Laboratory Testing Program*. The laboratory maximum dry density and optimum moisture content of the sample tested was 133.0 pcf and 6.5 percent, respectively.
- Direct Shear – Two direct shear tests were performed on representative samples under soaked moisture condition in accordance with ASTM Standard D3080. The

results are presented in Drawings No. B-3 and B-4, *Direct Shear Test Results* in Appendix B, *Laboratory Testing Program*.

8.2 Chemical Testing - Corrosivity Evaluation

One soil sample was tested to determine minimum electrical resistivity, pH, and chemical content, including soluble sulfate and chloride concentrations. The purpose of these tests was to determine the corrosion potential of site soils when placed in contact with common construction materials. These tests were performed by AP Engineering and Testing, Inc. (Pomona, CA) in accordance with California Test Methods 643, 422, and 417. The test results are summarized in the following table and are presented in Appendix B, *Laboratory Testing Program.*

- The pH measurement of the tested sample was 9.3.
- The sulfate contents of the tested sample were 0.0051 percent by weight.
- The chloride concentrations of the tested sample were 42 ppm.
- The minimum electrical resistivity when saturated was 4,046 ohm-cm.

9.0 PERCOLATION TESTING

Two percolation tests (PT-01 and PT-02) were conducted on June 10, 2019 to evaluate water infiltration rate of the site. The infiltration rate at the depth tested in PT-02 was deemed insufficient for the project. The borings were re-drilled to a more coarse-grained soil layer two feet deeper. Two additional percolation tests were conducted on July 12, 2019. The measured percolation test data and calculations for conversion to infiltration rate, porosity correction, and factor of safety are shown on Plates No. 1 through 4, *Estimated Infiltration Rate from Percolation Test Data* and graphically represented on Plates No. 5 and 8, *Infiltration Rate Versus Time* in Appendix C, *Water Infiltration Testing*. The estimated infiltration rate at the test hole is presented in the following table.

Table No. 4, Estimated Infiltration Rates

Percolation Test	Depth (feet)	Soil Type	Infiltration Rate (inches/hour)
PT-01	8	Silty Sand (SM)	1.30
PT-02	8	Sandy Silt (ML)	0.17
PT-01 (2)	10	Silty Sand (SM)	1.27
PT-02 (2)	10	Silty Sand (SM)	1.01

Based on the calculated infiltration rate during the final respective intervals in each test, we recommend an infiltration rate of 0.17 inches per hour at a depth of 8 feet bgs and 1.01 inches per hour at a depth of 10 feet bgs in the area of the infiltration basin.

10.0 EARTHWORK AND SITE GRADING RECOMMENDATIONS

Earthwork recommendations for the project are presented in the following sections.

10.1 General

This section contains our general recommendations regarding earthwork and site grading for the proposed development. These recommendations are based on our experience with similar projects in the area and the results of our field exploration, laboratory testing, and data evaluation as presented in the preceding sections. These recommendations may need to be modified based on observation of the actual field conditions during grading. While a grading plan is not yet available, it is our present understanding that the import of soil will be required to achieve proposed design grades. All borrow soils should be tested and evaluated by the geotechnical consultant prior to importing to the site.

Prior to the start of construction, all existing underground utilities and appurtenances, if present, should be located at the project site. Such utilities should either be protected in-place or removed and replaced during construction as required by the project specifications. All excavations should be conducted in such a manner as not to cause loss of bearing and/or lateral support of existing utilities and structure (if any).

All debris, surface vegetation, deleterious material, surficial soils containing roots and perishable materials and demolished materials should be stripped and removed from the site.

The final bottom surfaces of all excavations should be observed to locate zones of overly saturated and/or loose unsuitable material of any origin and should be approved by the project geotechnical consultant prior to placing any fill and/or structures. Based on observations, removal of localized areas deeper than those documented may be required during grading. Some variations in the depth and lateral extent of over-excavation recommended in this report should be anticipated.

10.2 Subgrade Preparation-Fill Areas

About five feet of alluvial soils should be removed and replaced with compacted fill, prior to placing additional compacted fill. The actual depth of removal should be based on observations made during grading. The specific over-excavation recommendations are provided in later sections of this report.

10.3 Over-excavation/Removal within Building Pads

In cut areas, deeper excavation may be required below finish grade. If less than five feet is removed from original ground (og), excavation should continue to provide a minimum of two feet of compacted fill below bottom of footings. If more than five feet is removed, the bottom surface should be evaluated for suitability by the geotechnical consultant. All over-excavations should extend at least five feet or equal to the depth of over-excavation, whichever is greater, outside the building footprint. If future construction is permitted beyond the lateral over-excavation, over-excavation should extend 5 feet beyond the new limits.

If isolated pockets of very soft, loose, eroded, or pumping soil are encountered, the unstable soil should be excavated as needed to expose undisturbed, firm, and unyielding soils.

The contractor should determine the best manner to conduct the excavations, such that there are no losses of bearing and/or lateral support to the existing structures or utilities (if any).

10.4 Transition Lots

The cut portion of transition lots (and if necessary, the fill portion) should be excavated to a depth to provide a minimum of two feet of compacted fill beneath the entire pad.

10.5 Over-excavation/Removal for Pavement Areas

As a minimum, the upper three feet of surficial soils from all areas receiving asphalt concrete or Portland concrete paving, including driveways, sidewalks, street areas, curbs and gutters and other flatwork should be excavated, removed if necessary, and/or replaced as compacted fill. Such over-excavation should extend at least two feet beyond the pavement area edges.

10.6 Over-excavation/Removal for Retaining/Perimeter Walls

As a minimum, the upper three feet of surficial soils within two feet of either side of retaining/perimeter walls less than six feet in height, should be excavated, removed if necessary, and/or processed and replaced as compacted fill. The depth of the structural fill under retaining/perimeter wall footings should be at least two feet or equal to footing width, whichever is greater.

10.7 Engineered Fill

No fill or aggregate base should be placed until excavations and/or natural ground preparation have been observed by the geotechnical consultant. The native soils encountered within the project site are generally considered suitable for re-use as compacted fill. Excavated soils should be processed, including removal of roots and debris, removal of oversized particles, mixing, and moisture conditioning, before placing as compacted fill. On-site soils used as fill should meet the following criteria.

- No particles larger than 3 inches in largest dimension.
- Rocks larger than one inch should not be placed within the upper 12 inches of subgrade soils.
- Free of all organic matter, debris, or other deleterious material.
- Expansion index of 20 or less.
- Sand Equivalent greater than 15 (greater than 30 for pipe bedding).
- Contain less than 40 percent fines (passing #200 sieve).

Based on field investigation and laboratory testing results, on-site soils may be suitable as fill materials.

Imported materials, if required, should meet the above criteria prior to being used as compacted fill. Any imported fills should be tested and approved by geotechnical representative prior to delivery to the site.

10.8 Compacted Fill Placement

All surfaces to receive structural fills should be scarified to a depth of 12 inches. The soil should be moisture conditioned to within ±3 percent of optimum moisture content for coarse soils and 0 to 2 percent above optimum moisture content for fine soils. The scarified soils should be recompacted to at least 90 percent of the laboratory maximum dry density.

Fill soils should be mixed thoroughly, and moisture conditioned to within ±3 percent of optimum moisture content for coarse soils and 0 to 2 percent above optimum moisture content for fine soils. Fill soils should be evenly spread in horizontal lifts not exceeding 8 inches in uncompacted thickness.

All fill placed at the site should be compacted to at least 90 percent of the laboratory maximum dry densities as determined by ASTM Standard D1557 test method, unless a higher compaction is specified herein. At least the upper 12 inches of subgrade soils below footings, slabs and pavement finish grade should be compacted to at least 95 percent of the laboratory maximum dry density.

Fill materials should not be placed, spread or compacted during unfavorable weather conditions. When site grading is interrupted by heavy rain, filling operations should not resume until the geotechnical consultant approves the moisture and density conditions of the previously placed fill.

At the time of our field investigation, *in-situ* moisture content of the upper six and one-half feet of native soils ranged from 1 to 13 percent. The optimum moisture contents were between 6.5 and 8.0 percent. Therefore, moisture conditioning may be necessary prior to the material being placed as compacted fill. The amount of processing required for proper moisture conditioning at the site will depend on the variations in the *in-situ* moisture conditions, the equipment, and the processing method.

10.9 Backfill Recommendations Behind Subterranean Wall

Compaction of backfill adjacent to structural walls can produce excessive lateral pressures. Improper types and locations of compaction equipment and/or compaction techniques may damage the walls. The use of heavy compaction equipment should not be permitted within a horizontal distance of 5 feet from the wall. Backfill behind any structural walls within the recommended 5-foot zone should be compacted using lightweight construction equipment such as handheld compactors to avoid overstressing the walls. The compaction of wall backfill should be conducted procedure described in section 10.8 *Compaction fill placement*

10.10 Shrinkage and Subsidence

The volume of excavated and recompacted soils will decrease as a result of grading. The shrinkage would depend on, among other factors, the depth of cut and/or fill, and the grading method and equipment utilized. For preliminary estimation, shrinkage factors for various units of earth material at the site may be taken as presented below.

- The shrinkage factor (defined as a percentage of soil volume reduction when moisture conditioned and compacted to the average of 92 percent relative compaction) for the upper 5 feet of soils is estimated to range from 6 to 12 percent. An average value of 9 percent may be used for preliminary earthwork planning.
- Subsidence (defined as the settlement of native materials from the equipment load applied during grading) would depend on the construction methods including type of equipment utilized. Ground subsidence may be negligible as the site is previously graded.

Although these values are only approximate, they represent our best estimates of the factors to be used to calculate lost volume that may occur during grading. If more accurate shrinkage and subsidence factors are needed, it is recommended that field-testing using the actual equipment and grading techniques be conducted.

10.11 Site Drainage

Adequate positive drainage should be provided away from the site and excavation areas to prevent ponding and to reduce percolation of water into the foundation soils. Surface drainage should be directed to suitable non-erosive devices.

10.12 Utility Trench Backfill

The following sections present earthwork recommendations for utility trench backfill, including subgrade preparation and trench zone backfill.

Open cuts adjacent to existing roadways or structures are not recommended within a 1:1 (horizontal:vertical) plane extending down and away from the roadway or structure perimeter (if any).

Soils from the trench excavation should not be stockpiled more than 6 feet in height or within a horizontal distance from the trench edge equal to the depth of the trench. Soils should not be stockpiled behind the shoring, if any, within a horizontal distance equal to the depth of the trench, unless the shoring has been designed for such loads.

10.12.1 Pipeline Subgrade Preparation

The final subgrade surface should be level, firm, uniform, and free of loose materials and properly graded to provide uniform bearing and support to the entire section of the pipe placed on bedding material. Protruding oversize particles larger than 2 inches in dimension, if any, should be removed from the trench bottom and replaced with compacted on-site materials.

Any loose, soft and/or unsuitable materials encountered at the pipe subgrade should be removed and replaced with an adequate bedding material. During the digging of depressions for proper sealing of the pipe joints, the pipe should rest on a prepared bottom for as near its full length as is practicable.

10.12.2 Pipe Bedding

Bedding is defined as the material supporting and surrounding the pipe to 1 foot above the pipe. Recommendations for pipe bedding are provided below.

To provide uniform and firm support for the pipe, compacted granular materials such as clean sand, gravel or ¾-inch crushed aggregate, or crushed rock may be used as pipe bedding material. Typically, soils with sand equivalent value of 30 or more are used as pipe bedding material. The pipe designer should determine if the soils are suitable as pipe bedding material.

The type and thickness of the granular bedding placed underneath and around the pipe, if any, should be selected by the pipe designer. The load on the rigid pipes and deflection of flexible pipes and, hence, the pipe design, depends on the type and the amount of bedding placed underneath and around the pipe.

Bedding materials should be vibrated in-place to achieve compaction. Care should be taken to densify the bedding material below the springline of the pipe. Prior to placing the pipe bedding material, the pipe subgrade should be uniform and properly graded to provide uniform bearing and support to the entire section of the pipe placed on bedding material. During the digging of depressions for proper sealing of the pipe joints, the pipe should rest on a prepared bottom for as near its full length as is practicable.

Migration of fines from the surrounding native and/or fill soils must be considered in selecting the gradation of any imported bedding material. We recommend that the pipe bedding material should satisfy the following criteria to protect migration of fine materials.

i. $\frac{D15(F)}{D85(B)} \leq 5$

ii. $\frac{D50(F)}{D50(B)} < 25$

iii. Bedding Materials must have less than 5 percent minus 75 µm (No. 200) sieve to avoid internal movement of fines.

Where,
F = Bedding Material
B = Surrounding Native and/or Fill Soils
*D*15(F) = Particle size through which 15% of bedding material will pass
*D*85(B) = Particle size through which 85% of surrounding soil will pass
*D*50(F) = Particle size through which 50% of bedding material will pass
*D*50(B) = Particle size through which 50% of surrounding soil will pass

If the above criteria do not satisfy, commercially available geofabric used for filtration purposes (such as Mirafi 140N or equivalent) may be wrapped around the bedding material encasing the pipe to separate the bedding material from the surrounding native or fill soils.

10.12.3 Trench Zone Backfill

The trench zone is defined as the portion of the trench above the pipe bedding extending up to the final grade level of the trench surface. Excavated on-site soils free of oversize particles and deleterious matter may be used to backfill the trench zone. Trench backfill recommendations are presented below.

- Trench backfill should be compacted by mechanical methods, such as sheepsfoot, vibrating or pneumatic rollers or mechanical tampers to achieve the density specified herein.
- The contractor should select the equipment and processes to be used to achieve the specified density without damage to adjacent ground, structures, utilities and completed work.
- The field density of the compacted soil should be measured by the ASTM D1556 (Sand Cone) or ASTM D6938 (Nuclear Gauge) or equivalent.
- It should be the responsibility of the contractor to maintain safe working conditions during all phases of construction.
- Observations and field tests should be performed by the project soils consultant to confirm that the required degree of compaction has been obtained. Where compaction is less than that specified, additional compactive effort should be made with adjustment of the moisture content as necessary, until the specified compaction is obtained.

11.0 DESIGN RECOMMENDATIONS

The various design recommendations provided in this section are based on the assumption that the above earthwork and grading recommendations will be implemented in the project design and construction.

11.1 Shallow Foundation Design Parameters

Residential one- or two-story wood-frame, lightly loaded structures may be supported on conventional continuous (strip) and/or isolated (spread) footings.

Interior and exterior footings should be placed at least 12 inches and 18 inches, respectively, below lowest adjacent soil grade.

Width of the continuous and isolated footings for one-story buildings should be at least 12 inches and 18 inches, respectively. Width of the continuous and isolated footings for two-story buildings should be at least 18 inches and 24 inches, respectively.

Footings placed at a depth of 12 inches and 18 inches below lowest adjacent grade may be designed based on an allowable net bearing capacity of 2,000 pounds per square foot (psf).

The actual footing dimensions and reinforcement should be based on structural design. The allowable bearing capacity can be increased by 500 pounds per square foot (psf) with each foot of additional embedment and 100 psf with each foot of additional width up to a maximum of 3,000 psf.

The net allowable bearing values indicated above are for the dead loads and frequently applied live loads and are obtained by applying a factor of safety of 3.0 to the net ultimate bearing capacity. If normal code requirements are applied for design, the above vertical bearing value may be increased by 33 percent for short duration loadings, which will include loadings induced by wind or seismic forces.

11.2 Lateral Earth Pressures and Resistance to Lateral Loads

In the following subsections, the lateral earth pressures and resistance to lateral loads are estimated by using on-site native soils strength parameters obtained from laboratory testing.

11.2.1 Active Earth Pressures

The active earth pressure behind any buried wall or foundation depends primarily on the allowable wall movement, type of backfill materials, backfill slopes, wall or foundation inclination, surcharges, and any hydrostatic pressures. The lateral earth pressures are presented in the following table.

Table No. 5, Active and At-Rest Earth Pressures

Loading Conditions	Lateral Earth Pressure (psf/ft of depth)
Active earth conditions (wall is free to deflect at least 0.001 radian)	40
At-rest (wall is restrained)	60

These pressures assume a level ground surface behind the walls for a distance greater than the walls height and no surcharge and no hydrostatic pressure. If water pressure is allowed to build up behind the walls, the active pressures should be reduced by 50 percent and added to a full hydrostatic pressure to compute the design pressures against the walls.

11.2.2 Passive Earth Pressure

Resistance to lateral loads can be assumed to be provided by a combination of friction acting at the base of foundations and by passive earth pressure. A coefficient of friction of 0.35 between formed concrete and soil may be used with the dead load forces. An allowable passive earth pressure of 250 psf per foot of depth may be used for the sides of the footing poured against recompacted native soils. A factor of safety of 1.5 was applied in calculating passive earth pressure. The maximum value of the passive earth pressure should be limited to 2,000 psf.

Vertical and lateral bearing values indicated above are for the total dead loads and frequently applied live loads. If normal code requirements are applied for design, the above vertical bearing and lateral resistance values may be increased by 33 percent for short duration loading, which will include the effect of wind or seismic forces.

Due to the low overburden stress of the soil at shallow depth, the upper 1 foot of passive resistance should be neglected unless the soil is confined by pavement or slab.

11.3 Slabs-on-Grade

Slabs-on-grade should be supported on properly compacted fill. Compacted fill used to support slabs-on-grade should be placed and compacted in accordance with Section 10.8 *Compacted Fill Placement*.

Slabs-on-grade should have a minimum thickness of 4 inches for support of nominal live loads. Structural design elements of slabs-on-grade, including but not limited to thickness, reinforcement, joint spacing of more heavily-loaded slabs will be dependent upon the anticipated loading conditions and the modulus of subgrade reaction (200 kcf) of the supporting materials and should be designed by a structural engineer.

If moisture-sensitive flooring or environments are planned, slabs-on-grade should be protected by 10-mil-thick polyethylene vapor barriers. The sub-grade surface should be free of all exposed rocks or other sharp objects prior to placement of the barrier. The barrier should be overlain by 2 inches of sand, to minimize punctures and to aid in the concrete curing. At discretion of the structure engineer, the sand layer may be eliminated.

Slabs should be designed and constructed as promulgated by the American Concrete Institute (ACI) and the Portland Cement Association (PCA). Care should be taken during concrete placement to avoid slab curling. Prior to the slab pour, all utility trenches should be properly backfilled and compacted.

Subgrade for slabs-on-grade should be firm and uniform. All loose or disturbed soils including under-slab utility trench backfill should be recompacted.

In hot weather, the contractor should take appropriate curing precautions after placement of concrete to minimize cracking or curling of the slabs. The potential for slab cracking may be lessened by the addition of fiber mesh to the concrete and/or control of the water/cement ratio (maximum 0.45).

Concrete should be cured by protecting it against loss of moisture and rapid temperature change for at least 7 days after placement. Moist curing, waterproof paper, white polyethylene sheeting, white liquid membrane compound, or a combination thereof may be used after finishing operations have been completed. The edges of concrete slabs exposed after removal of forms should be immediately protected to provide continuous curing.

11.4 Settlement

The total settlement of shallow footings from static structural loads and short-term settlement of properly compacted fill is anticipated to be 1 inch or less. The differential settlement resulting from static loads is anticipated to be 0.5 inches or less over a horizontal distance of 40 feet.

Based on the observed high blow counts below 5 feet bgs in all borings and over-excavation recommendations, we anticipate the site may have negligible seismic settlement. For the design purpose, seismic settlement may be taken as 1 inch or less and the differential settlement may be taken as half of the total seismic settlement.

Generally, the static and dynamic settlement does not occur at the same time. For design purposes, the structural engineer should decide whether static and dynamic settlement will be combined or not.

11.5 Pipe Design Parameters

Structural design of pipelines requires proper evaluation of all possible loads acting on pipes. The stresses and strains induced on buried pipes depend on many factors, including the type of soil, density, bearing pressure, angle of internal friction, coefficient of passive earth pressure, and coefficient of friction at the interface between the backfill and native soils. The recommended values of the various soil parameters for the pipe design are provided in Table No. 6, *Soil Parameters for Pipe Design*.

Where pipelines are connecting to rigid structures near, or at its lower levels, and then are subjected to significant loads as the backfill is placed to finish grade, we recommend that provisions be incorporated in the design to provide support of these pipelines where they exit the structure. Consideration can be given to flexible connections, concrete slurry support beneath the pipes where they exit the structures, overlaying and supporting the pipes with a few inches of compressible material, (i.e. Styrofoam, or other materials), or other techniques. Automatic shutoffs should be installed to limit the potential leakage in the event of damage in a seismic event.

Table No. 6, Soil Parameters for Pipe Design

Soil Parameters	Parameters
Unit weight of compacted backfill (assuming 92% average relative compaction), γ	130 pcf
Angle of internal friction of soils, ϕ	30
Soil cohesion, c	50 pcf
Coefficient of friction between concrete and native soils, fs	0.30
Coefficient of friction between pipe and native soils, fs	0.25 for RCP/PVC/HDPE pipe
Bearing pressure against Alluvial Soils	2,000 psf
Coefficient of passive earth pressure, Kp	3.0
Coefficient of active earth pressure, Ka	0.33
Modulus of Soil Reaction, E'	1,500 psi

11.6 Bearing Pressure for Anchor and Thrust Blocks

An allowable net bearing pressure presented in Table No. 5, *Soil Parameters for Pipe Design* may be used for anchor and thrust block design against alluvial soils. Such thrust blocks should be at least 18 inches wide.

If normal code requirements are applied for design, the above recommended bearing capacity and passive resistances may be increased by 33 percent for short duration loading such as seismic or wind loading.

11.7 Soil Corrosivity

Two representative soil samples (one is 2006 and another in 2019) were evaluated for corrosivity with respect to common construction materials such as concrete and steel. The test results are presented in Appendix B, *Laboratory Testing Program* and design recommendations pertaining to soil corrosivity are presented below.

The sulfate contents of the sampled soils correspond to American Concrete Institute (ACI) exposure category S0 for these sulfate concentrations (ACI 318-14, Table 19.3.1.1). No concrete type restrictions are specified for exposure category S0 (ACI 318-14, Table 19.3.2.1). A minimum compressive strength of 2,500 psi is recommended.

We anticipate that concrete structures such as footings, slabs, and flatwork will be exposed to moisture from precipitation and irrigation. Based on the site location and the results of chloride testing of the site soils, we do not anticipate that concrete structures

will be exposed to external sources of chlorides, such as deicing chemicals, salt, brackish water, or seawater. ACI specifies exposure category C1 where concrete is exposed to moisture, but not to external sources of chlorides (ACI 318-14, Table 19.3.1.1). ACI provides concrete design recommendations in ACI 318-14, Table 19.3.2.1, including a compressive strength of at least 2,500 psi and a maximum chloride content of 0.3 percent.

The measured value of the minimum electrical resistivity of the sample when saturated were 876 and 4,046 ohm-cm for the site. This indicates that the soils tested are mildly corrosive to severely corrosive to ferrous metals in contact with the soil (Romanoff, 1957).

Converse does not practice in the area of corrosion consulting. A qualified corrosion consultant should provide appropriate corrosion mitigation measures for any ferrous metals in contact with the site soils.

11.8 Pavement Recommendations

Two soil samples (one in 2006 and another in 2019) were tested to determine the R-value of the subgrade soils. Based on laboratory testing, R-values were 16 and 46. For pavement design, we have utilized an R-value of 16 and design Traffic Indices (TIs) ranging from 5 to 10.

Based on the above information, asphalt concrete and aggregate base thickness results are presented using the Caltrans Highway Design Manual (Caltrans, 2017), Chapter 630 with a safety factor of 0.2 for asphalt concrete/aggregate base section and 0.1 for full depth asphalt concrete section. Preliminary asphalt concrete pavement sections are presented in the following table below.

Table No. 7, Recommended Preliminary Pavement Sections

	Traffic Index (TI)	Pavement Section		
		Option 1		Option 2
		Asphalt Concrete (inches)	Aggregate Base (inches)	Full AC Section (inches)
Design R-value 16	5	4.0	5.5	7.0
	6	4.0	9.5	9.0
	7	5.0	11.0	11.0
	8	6.0	13.0	13.5
	9	7.0	14.0	15.5
	10	8.0	15.0	17.5

At or near the completion of grading, subsurface samples should be tested to evaluate the actual subgrade R-value for final pavement design.

Prior to placement of aggregate base, at least the upper 12 inches of subgrade soils should be scarified, moisture-conditioned if necessary, and recompacted to at least 95 percent of the laboratory maximum dry density as defined by ASTM Standard D1557 test method.

Base materials should conform with Section 200-2.2,"*Crushed Aggregate Base*," of the current Standard Specifications for Public Works Construction (SSPWC; Public Works Standards, 2018) and should be placed in accordance with Section 301-2 of the SSPWC.

Asphaltic concrete materials should conform to Section 203 of the SSPWC and should be placed in accordance with Section 302-5 of the SSPWC.

11.9 Concrete Flatwork

Except as modified herein, concrete walks, driveways, access ramps, curb and gutters should be constructed in accordance with Section 303-5, *Concrete Curbs, Walks, Gutters, Cross-Gutters, Alley Intersections, Access Ramps, and Driveways*, of the Standard Specifications for Public Works Construction (Public Works Standards, 2018).

The subgrade soils under the above structures should consist of compacted fill placed as described in this report. Prior to placement of concrete, the upper 12 inches of subgrade soils should be moisture conditioned to between within 3 percent of optimum moisture content for coarse-grained soils and 0 and 2 percent above optimum for fine-grained soils.

The thickness of driveways for passenger vehicles should be at least 4 inches, or as required by the civil or structural engineer. Transverse control joints for driveways should be spaced not more than 10 feet apart. Driveways wider than 12 feet should be provided with longitudinal control joints.

Concrete walks subjected to pedestrian and bicycle loading should be at least 4 inches thick, or as required by the civil or structural engineer. Transverse joints should be spaced 15 feet or less and should be cut to a depth of one-fourth the slab thickness.

Positive drainage should be provided away from all driveways and sidewalks to prevent seepage of surface and/or subsurface water into the concrete base and/or subgrade.

12.0 CONSTRUCTION RECOMMENDATIONS

Temporary sloped excavation recommendations are presented in the following sections.

12.1 General

Prior to the start of construction, all existing underground utilities (if any) should be located at the project site. Such utilities should either be protected in-place or removed and replaced during construction as required by the project specifications.

Vertical braced excavations can be considered for the foundations. Sloped excavations may not be feasible in locations adjacent to existing utilities, pavement or structure (if any). Recommendations pertaining to temporary excavations are presented in this section.

Excavations near existing structures may require vertical side wall excavation. Where the side of the excavation is a vertical cut, it should be adequately supported by temporary shoring to protect workers and any adjacent structures.

All applicable requirements of the California Construction and General Industry Safety Orders, the Occupational Safety and Health Act, and the Construction Safety Act should be met. The soils exposed in cuts should be observed during excavation by the geotechnical consultant and the competent person designated by the contractor. If potentially unstable soil conditions are encountered, modifications of slope ratios for temporary cuts may be required.

12.2 Temporary Sloped Excavations

Temporary open-cut trenches may be constructed with side slopes as recommended in the following table. Temporary cuts encountering soft and wet fine-grained soils; dry loose, cohesionless soils or loose fill from trench backfill may have to be constructed at a flatter gradient than presented below.

Table No. 8, Slope Ratios for Temporary Excavations

Soil Type	OSHA Soil Type	Depth of Cut (feet)	Recommended Maximum Slope (Horizontal:Vertical)[1]
Silty Sand (SM), Sand with Silt (SP-SM), Clayey Sand (SC), Sandy Silt (ML) and Sand (SP)	C	0-10	1.5:1

[1] Slope ratio assumed to be uniform from top to toe of slope.

For steeper temporary construction slopes or deeper excavations, or unstable soil encountered during the excavation, shoring or trench shields should be provided by the contractor to protect the workers in the excavation. Design recommendations for temporary shoring are provided in the following section.
Surfaces exposed in slope excavations should be kept moist but not saturated to retard raveling and sloughing during construction. Adequate provisions should be made to

protect the slopes from erosion during periods of rainfall. Surcharge loads, including construction materials, should not be placed within 5 feet of the unsupported slope edge. Stockpiled soils with a height higher than 6 feet will require greater distance from trench edges.

13.0 GEOTECHNICAL SERVICES DURING CONSTRUCTION

The project geotechnical consultant should review plans and specifications as the project design progresses. Such review is necessary to identify design elements, assumptions, or new conditions which require revisions or additions to our geotechnical recommendations.

The project geotechnical consultant should be present to observe conditions during construction. Geotechnical observation and testing should be performed as needed to verify compliance with project specifications. Additional geotechnical recommendations may be required based on subsurface conditions encountered during construction.

14.0 CLOSURE

This report is prepared for the project described herein and is intended for use solely by Lansing Companies and their authorized agents, to assist in the design and construction of the proposed project. Our findings and recommendations were obtained in accordance with generally accepted professional principles practiced in geotechnical engineering. We make no other warranty, either expressed or implied.

Converse Consultants is not responsible or liable for any claims or damages associated with interpretation of available information provided to others. Site exploration identifies actual soil conditions only at those points where samples are taken, when they are taken. Data derived through sampling and laboratory testing is extrapolated by Converse employees who render an opinion about the overall soil conditions. Actual conditions in areas not sampled may differ. In the event that changes to the project occur, or additional, relevant information about the project is brought to our attention, the recommendations contained in this report may not be valid unless these changes and additional relevant information are reviewed and the recommendations of this report are modified or verified in writing. In addition, the recommendations can only be finalized by observing actual subsurface conditions revealed during construction. Converse cannot be held responsible for misinterpretation or changes to our recommendations made by others during construction.

As the project evolves, continued consultation and construction monitoring by a qualified geotechnical consultant should be considered an extension of geotechnical investigation services performed to date. The geotechnical consultant should review plans and specifications to verify that the recommendations presented herein have been

appropriately interpreted, and that the design assumptions used in this report are valid. Where significant design changes occur, Converse may be required to augment or modify the recommendations presented herein. Subsurface conditions may differ in some locations from those encountered in the explorations, and may require additional analyses and, possibly, modified recommendations.

Design recommendations given in this report are based on the assumption that the recommendations contained in this report are implemented. Additional consultation may be prudent to interpret Converse's findings for contractors, or to possibly refine these recommendations based upon the review of the actual site conditions encountered during construction. If the scope of the project changes, if project completion is to be delayed, or if the report is to be used for another purpose, this office should be consulted.

15.0 REFERENCES

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Appendix A

Field Exploration

APPENDIX A

FIELD EXPLORATION

Our field investigation included a site reconnaissance and a subsurface exploration program consisting of drilling soil borings. During the site reconnaissance, the surface conditions were noted, and the locations of the borings were selected. The borings were located using existing topography and boundary features and should be considered accurate only to the degree implied by the method used.

For the previous investigation performed by Converse, a total of seven exploratory borings (BH-1 to BH-7) were drilled on December 7, 2005 across the project site, to depths of 16.5 to 51.5 feet below ground surface (bgs).

Additionally, two exploratory borings (BH-8 and BH-9) were drilled on June 3, 2019 to investigate subsurface conditions at the project site. The borings were drilled to depths of 15.8 and 16.4 feet below existing ground surface (bgs).

Two exploratory percolation test holes (PT-01 and PT-02) were drilled on June 3, 2019 to perform percolation testing. Both percolation test borings were drilled to approximately 8.0 feet below the existing ground surface (bgs).

The borings were advanced using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers for soils sampling. Encountered materials were continuously logged by a Converse geologist and classified in the field by visual classification in accordance with the Unified Soil Classification System. Where appropriate, the field descriptions and classifications have been modified to reflect laboratory test results.

Relatively undisturbed samples were obtained using California Modified Samplers (2.4 inches inside diameter and 3.0 inches outside diameter) lined with thin sample rings. The steel ring sampler was driven into the bottom of the borehole with successive drops of a 140-pound driving weight falling 30 inches. Blow counts at each sample interval are presented on the boring logs. Samples were retained in brass rings (2.4 inches inside diameter and 1.0 inch in height) and carefully sealed in waterproof plastic containers for shipment to the Converse laboratory. Bulk samples of typical soil types were also obtained.

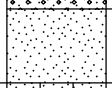
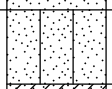
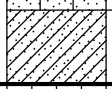
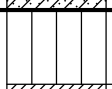
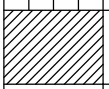
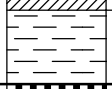
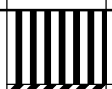
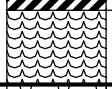
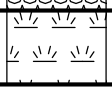
Standard Penetration Testing (SPT) was also performed in accordance with the ASTM Standard D1586 test method in boring BH-4 (2006) at depths of 20, 25, 30, 35, 40, 45 and 50 feet bgs using a standard (1.4 inches inside diameter and 2.0 inches outside diameter) split-barrel sampler. The mechanically driven hammer for the SPT sampler was 140 pounds, falling 30 inches for each blow. The recorded blow counts for every 6 inches for a total of 1.5 feet of sampler penetration are shown on the Logs of Borings.

The exact depths at which material changes occur cannot always be established accurately. Unless a more precise depth can be established by other means, changes in material conditions that occur between drive samples are indicated on the logs at the top of the next drive sample.

Following the completion of logging and sampling, the borings were backfilled with soil cuttings and tamped. If construction is delayed, the surface may settle over time. Therefore, we recommend the owner monitor the boring locations and backfill any depressions that might occur or provide protection around the boring locations to prevent trip and fall injuries from occurring near the area of any potential settlement.

For a key to soil symbols and terminology used in the boring logs, refer to Drawing No. A-1, *Unified Soil Classification and Key to Boring Log Symbols*. For logs of borings, see Drawings No. A-2 through A-8 (2006) and A-9 through A-12 (2019), Logs of Borings.

SOIL CLASSIFICATION CHART

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

BORING LOG SYMBOLS

SAMPLE TYPE

STANDARD PENETRATION TEST
Split barrel sampler in accordance with ASTM D-1586-84 Standard Test Method

DRIVE SAMPLE 2.42" I.D. sampler (CMS).

DRIVE SAMPLE No recovery

BULK SAMPLE

GROUNDWATER WHILE DRILLING

GROUNDWATER AFTER DRILLING

LABORATORY TESTING ABBREVIATIONS			
TEST TYPE (Results shown in Appendix B)		STRENGTH	
		Pocket Penetrometer	p
		Direct Shear	ds
		Direct Shear (single point)	ds*
		Unconfined Compression	uc
CLASSIFICATION		Triaxial Compression	tx
Plasticity	pi	Vane Shear	vs
Grain Size Analysis	ma	Consolidation	c
Passing No. 200 Sieve	wa	Collapse Test	col
Sand Equivalent	se	Resistance (R) Value	r
Expansion Index	ei	Chemical Analysis	ca
Compaction Curve	max	Electrical Resistivity	er
Hydrometer	h	Permeability	perm
Disturb	Dist.	Soil Cement	sc

Apparant Density	Very Loose	Loose	Medium	Dense	Very Dense
SPT (N)	< 4	4 - 11	11 - 30	31 - 50	> 50
CA Sampler	< 5	5 - 12	13 - 35	36 - 60	> 60
Relative Density (%)	< 20	20 - 40	40 - 60	60 - 80	> 80

Consistency	Very Soft	Soft	Medium	Stiff	Very Stiff	Hard
SPT (N)	< 2	2-4	5-8	9-15	16-30	> 30
CA Sampler	< 3	3-6	7-12	13-25	26-50	> 50

UNIFIED SOIL CLASSIFICATION AND KEY TO BORING LOG SYMBOLS

Converse Consultants

Approximately 20.60-Acre Residential Development
Southeast Corner of Hopland Street and Cahuenga Road
City of Victorville, San Bernardino County, California
For: Lansing Companies

Project No. **19-81-173-01**

Drawing No. **A-1**

Project ID: 19-81-173-01.GPJ; Template: KEY

Log of Boring No. BH - 1

Dates Drilled: 12/7/2005 Logged by: FA Checked By: RJR

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2899 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
		ALLUVIUM (Qal)						ma
		SAND WITH SILT (SP-SM): medium- to coarse-grained, some gravel, brown.	■		8/11/15	3	111	col
5			■		13/25/50 (6")	4	107	ds
		- orange brown	■		25/50 (6")	2	108	
10			■		25/50 (4")	4	106	
15			■		25/50 (5.5")	4	95	
20			■		30/50 (5")	5	96	
		End of Boring at 21.5 feet. Groundwater not encountered during drilling. Boring backfilled with soil cuttings on 12/7/05.						

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. A - 2

Log of Boring No. BH - 2

Dates Drilled: 12/7/2005 Logged by: FA Checked By: RJR

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2879 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
		ALLUVIUM (Qal) **SILTY SAND (SM):** fine- to medium-grained, brown.						er, ca
					9/15/20	5	107	
5					7/15/21	8	113	col
					13/17/27	9	114	
10		- some gravel			25/50 (3")	7	104	
15		**SAND (SP):** fine- to coarse-grained, orange brown.			25/50 (5")	1	102	
		End of Boring at 16.5 feet. Groundwater not encountered during drilling. Boring backfilled with soil cuttings on 12/7/05.						

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. A - 3

Log of Boring No. BH - 3

Dates Drilled: 12/7/2005 Logged by: FA Checked By: RJR

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2886 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
		ALLUVIUM (Qal) **SILTY SAND (SM):** fine- to medium-grained, brown.	■		3/5/9	4	102	ei
5		**SANDY SILT (ML):** fine-grained sand with clay, brown.	■		7/10/17	13	103	
		GRAVELLY SAND (SP): medium- to coarse-grained, light brown.	■		41/50 (6")	2	123	col
10		**SAND (SP):** fine-grained with gravel, pink brown.	■		22/50 (2")	4	107	
15		**SILTY SAND (SM):** fine- to medium-grained, brown.	■		16/50 (5")	5	107	
		End of Boring at 16.5 feet. Groundwater not encountered during drilling. Boring backfilled with soil cuttings on 12/7/05.						

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. A - 4

Log of Boring No. BH - 4

Dates Drilled: 12/7/2005 Logged by: FA Checked By: RJR

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2892 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
		ALLUVIUM (Qal) **SILTY SAND (SM):** fine- to medium-grained, dark brown.						max, ds
			■		5/8/14	4	113	
5			■		15/17/27	6	120	c
		SAND WITH SILT (SP-SM): fine- to coarse-grained, some gravel, brown.	■		15/32/50 (5")	4	107	
10		**GRAVELLY SAND (SP):** medium- to coarse-grained, light gray.	■		30/50 (2")	2	113	
15		**SILTY SAND (SM):** fine-grained, light brown.	■		30/50 (3")	6	98	
20			⊠		41/50 (3")			
25		- fine- to medium-grained	⊠		50 (3")			
30		- medium- to coarse-grained, brown	⊠		50 (3")			

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. A - 5a

Log of Boring No. BH - 4

Dates Drilled: 12/7/2005 Logged by: FA Checked By: RJR

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2892 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
		SILTY SAND (SM): fine-grained, light brown.	X		50 (2")			
40		- dark brown	X		50 (6")			
45		- brown	X		50 (5")			
50			X		55 (6")			
		End of Boring at 51.5 feet. Groundwater not encountered during drilling. Boring backfilled with soil cuttings on 12/7/05.						

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. A - 5b

Log of Boring No. BH - 5

Dates Drilled: 12/8/2005 Logged by: FA Checked By: RJR

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2901 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
		ALLUVIUM (Qal) **CLAYEY SAND (SC):** fine- to coarse-grained, brown.	■	▨	27/50 (5")	13	122	r, ei
5		**SILTY SAND (SM):** fine- to medium-grained, brown.	■		50 (4")	7	102	col
			■		50 (6")	4	97	
10		**SANDY SILT (ML):** fine-grained sand with clay, light brown.	■		37/50 (2")	8	92	
15		**SILTY SAND (SM):** medium- to coarse-grained, brown.	■		50 (4")	5	98	
		End of Boring at 16.5 feet. Groundwater not encountered during drilling. Boring backfilled with soil cuttings on 12/8/05.						

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. A - 6

Log of Boring No. BH - 6

Dates Drilled: 12/7/2005 Logged by: FA Checked By: RJR

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2916 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
		ALLUVIUM (Qal) **SILTY SAND (SM):** fine- to coarse-grained, brown.						ma
			■		6/15/25	3	111	
5		**GRAVELLY SAND (SP):** fine- to coarse-grained, orange brown.	■		25/36/37	2	112	
			■		18/37/50 (6")	2	125	
10		**SAND (SP):** medium- to coarse-grained, brown.	■		18/30/43	2	109	
15		**SANDY SILT (ML):** fine- to medium-grained sand, orange brown.	■		27/50 (3")	15	106	
		End of Boring at 16.5 feet. Groundwater not encountered during drilling. Boring backfilled with soil cuttings on 12/8/05.						

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. A - 7

Log of Boring No. BH - 7

Dates Drilled: 12/7/2005 Logged by: FA Checked By: RJR

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2905 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES: DRIVE	SAMPLES: BULK	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
		ALLUVIUM (Qal) **SAND WITH SILT (SP-SM):** fine- to coarse-grained, some gravel, brown.	■		5/8/23	2	116	
5			■	▨	17/37/50 (3")	1		dist.
			■	▨	37/50 (3")	3	110	col
10		**SANDY SILT (ML):** fine-grained sand with caliche, brown.	■		40/50 (3")	12	107	
15		- fine- to medium-grained	■		23/50 (5")	10	103	
		End of Boring at 16.5 feet. Groundwater not encountered during drilling. Boring backfilled with soil cuttings on 12/8/05.						

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. A - 8

Log of Boring No. BH-8

Dates Drilled: 6/3/2019 Logged by: Catherine Nelson Checked By: James Burnham

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2901 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES: DRIVE	SAMPLES: BULK	BLOWS	MOISTURE	DRY UNIT WT. (pcf)	OTHER
		ALLUVIUM **SAND WITH SILT (SP-SM):** fine to coarse-grained, few gravel up to 2" in largest dimension, light brown.	■		12/20/28	3	109	
5		**SANDY SILT (ML):** fine to medium-grained sand, scattered gravel up to 1.5" in largest dimension, brown.	■	▨	12/47/50-4"	11	110	ds
			■	▨	17/50-4"	15	115	ei col
10		**SILTY SAND (SM):** fine to coarse-grained, brown.	■		25/50-4"	8	113	
15		- scattered gravel up to 1" in largest dimension	■		17/48/50-4"	7	124	
		End of boring at 16.4 feet bgs. No groundwater encountered. Borehole backfilled with soil cuttings and tamped on 06/10/2019.						

Converse Consultants

Approximately 20.60-Acre Residential Development
Southeast Corner of Hopland Street and Cahuenga Road
City of Victorville, San Bernardino County, California
For: Lansing Companies

Project No. 19-81-173-01

Drawing No. A-9

Log of Boring No. BH-9

Dates Drilled: 6/3/2019 Logged by: Catherine Nelson Checked By: James Burnham

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 2901 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES: DRIVE	SAMPLES: BULK	BLOWS	MOISTURE	DRY UNIT WT. (pcf)	OTHER
		This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.						
		ALLUVIUM **SILTY SAND (SM):** fine to coarse-grained, brown.						r, ca, er ma, max
			■		7/10/14	4	113	col
5		**SAND WITH SILT (SP-SM):** fine to coarse-grained, brown.	■		7/15/26	3	119	ds
			■		35/50-5"	5	128	col
10		**SANDY SILT (ML):** fine-grained sand, brown.	■		22/48/50-3"	13	103	
15		**SILTY SAND (SM):** fine to coarse-grained, brown.	■		32/50-3"	7	95	
		End of boring at 15.8 feet bgs. No groundwater encountered. Borehole backfilled with soil cuttings and tamped on 06/10/2019.						

Converse Consultants

Approximately 20.60-Acre Residential Development
Southeast Corner of Hopland Street and Cahuenga Road
City of Victorville, San Bernardino County, California
For: Lansing Companies

Project No. 19-81-173-01

Drawing No. A-10

Log of Boring No. PT-01

Dates Drilled: 6/3/2019 Logged by: Catherine Nelson Checked By: James Burnham

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: N/A

Ground Surface Elevation (ft): 2877 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES: DRIVE	SAMPLES: BULK	BLOWS	MOISTURE	DRY UNIT WT. (pcf)	OTHER
5		**ALLUVIUM:** **SILTY SAND (SM):** fine to coarse-grained, scattered gravel up to 2" in largest dimension, brown.						ma
		End of boring at 8.0 feet bgs. No groundwater encountered. Borehole utilized for percolation testing on 06/10/2019. Backfilled with pea-gravel and soil cuttings on 06/10/2019.						

Converse Consultants

Approximately 20.60-Acre Residential Development
Southeast Corner of Hopland Street and Cahuenga Road
City of Victorville, San Bernardino County, California
For: Lansing Companies

Project No. 19-81-173-01

Drawing No. A-11

Log of Boring No. PT-02

Dates Drilled: 6/3/2019 Logged by: Catherine Nelson Checked By: James Burnham

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: N/A

Ground Surface Elevation (ft): 2876 Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES: DRIVE	SAMPLES: BULK	BLOWS	MOISTURE	DRY UNIT WT. (pcf)	OTHER
5		**ALLUVIUM:** **SILTY SAND (SM):** fine to coarse-grained, scattered gravel up to 2" in largest dimension, brown.						ei
		End of boring at 8.0 feet bgs. No groundwater encountered. Borehole utilized for percolation testing on 06/10/2019. Backfilled with pea-gravel and soil cuttings on 06/10/2019.						

Converse Consultants

Approximately 20.60-Acre Residential Development
Southeast Corner of Hopland Street and Cahuenga Road
City of Victorville, San Bernardino County, California
For: Lansing Companies

Project No. 19-81-173-01

Drawing No. A-12

Appendix B

Laboratory Testing Program

APPENDIX B

LABORATORY TESTING PROGRAM

Tests were conducted in our laboratory on representative soil samples for the purpose of classification and evaluation of their physical properties and engineering characteristics. The amount and selection of tests were based on the geotechnical parameters required for this project. Test results are presented herein and on the Logs of Borings, in Appendix A, *Field Exploration*. The following is a summary of the various laboratory tests conducted for this project. The test results from previous investigation (Converse, 2006) are also included.

Moisture Content and Dry Density

In-situ dry density and moisture content tests were performed on relatively undisturbed ring samples, in accordance to ASTM Standard D2216 and D7263 to aid soils classification and to provide qualitative information on strength and compressibility characteristics of the site soils. For test results, see the Logs of Borings in Appendix A, Field Exploration.

Expansion Index

Four representative bulk samples were tested to evaluate the expansion potential of materials encountered at the site in accordance with ASTM D4829 Standard. The test results are presented in the following table.

Table No. B-1, Expansion Index Test Results

Boring No./Report	Depth (feet)	Soil Description	Expansion Index	Expansion Potential
BH-8/2019	5-10	Sandy Silt (ML)	3	Very Low
PT-02/2019	5-8	Silty Sand (SM)	2	Very Low
BH-3/2006	0-5	Silty Sand (SM)	0	Very Low
BH-5/2006	0-5	Clayey Sand (SC)	43	Low

R-value

Two representative bulk soil samples were tested for resistance value (R-value) in accordance with California Test Method CT301. The test provides a relative measure of

soil strength for use in pavement design. The test results are shown in the following table.

Table No. B-2, R-Value Test Results

Boring No./Report	Depth (feet)	Soil Classification	Measured R-value
BH-9/2019	0-5	Silty Sand (SM)	46
BH-5/2006	0-5	Clayey Sand (SC)	16

Soil Corrosivity

One representative soil sample (2019) was tested by AP Engineering and Testing, Inc. (Pomona, CA and One representative soil sample (2006) was tested by Anaheim Laboratory (Santa Ana, CA) in accordance with California Tests 663, 622, and 617, to determine minimum electrical resistivity, pH, and chemical content, including soluble sulfate and chloride concentrations. The purpose of these tests was to determine the corrosion potential of site soils when placed in contact with common construction materials such as concrete and steel. Test results are presented on the following table.

Table No. B-3, Summary of Corrosivity Test Results

Boring No./Report	Depth (feet)	pH	Soluble Sulfates (CA 617) (percent by weight)	Soluble Chlorides (CA 622) (ppm)	Min. Resistivity (CA 663) (Ohm-cm)
BH-9/2019	0-5	9.3	0.0051	42	4,046
BH-5/2006	0-5	8.8	0.0040	22	876

Collapse

To evaluate the moisture sensitivity (collapse/swell potential) of the encountered soils, eight collapse tests were performed in accordance with the ASTM Standard D4546 laboratory procedure. The sample was loaded to approximately 2 kips per square foot (ksf), allowed to stabilize under load, and then submerged. The test results including collapse test are presented in the following table.

Table No. B-4, Collapse Test Results

Boring No./Report	Depth (feet)	Soil Classification	Percent Swell (+) Percent Collapse (-)	Collapse Potential
BH-8/2019	7.5-9.0	Sandy Silt (ML)	-0.4	Slight
BH-9/2019	2.5-4.0	Silty Sand (SM)	-2.1	Moderate
BH-9/2019	7.5-9.0	Sand with Silt (SP-SM)	-0.6	Slight
BH-1/2006	2.0-3.5	Sand with Silt (SP-SM)	-0.8	Slight
BH-2/2006	5.0-6.5	Silty Sand (SM)	-0.4	Slight
BH-3/2006	7.0-8.5	Gravelly Sand (SP-P)	-0.35	Slight
*BH-4/2006	5.-6.5	Silty Sand (SM)	-0.25	Slight
BH-5/2006	5.0-6.5	Silty Sand (SM)	-3.03	Moderate
BH-7/2006	7.0-8.5	Sand with Silt (SP-SM)	-1.1	Slight

(*Result from consolidation test)

Grain-Size Analyses

To assist in classification of soils, mechanical grain-size analyses were performed on four select samples in accordance with the ASTM Standard D6913 test method. Grain-size curves are shown in Drawing No. B-1, *Grain Size Distribution Results* and results are presented in the following table.

Table No. B-5, Grain Size Distribution Test Results

Boring No./ Report	Depth (ft)	Soil Classification	% Gravel	% Sand	%Silt	%Clay
BH-9/2019	0-5	Silty Sand (SM)	0.0	83.0	17.0	
PT-01/2019	5-8	Silty Sand (SM)	1.0	79.0	20.0	
BH-1/2006	0-5	Sand with Silt (SP-SM)	13.8	76.6	9.6	
BH-6/2006	0-5	Silty Sand (SM)	6.9	73.5	19.6	

Maximum Dry Density and Optimum Moisture Content

Laboratory maximum dry density and optimum moisture content relationship tests were performed on two representative bulk soil samples. The test was conducted in accordance with ASTM Standard D1557 method. The test results are presented on Drawing No. B-2, *Moisture-Density Relationship Results,* and summarized in the following table.

Table No. B-6, Laboratory Maximum Density Test Results

Boring No./ Report	Depth (feet)	Soil Description	Maximum Dry Density (pcf)	Optimum Moisture (%)
BH-9/2019	0-5	Silty Sand, Brown	133.0	6.5
BH-4/2006	0-5	Silty Sand, Dark Brown	134.5	8.0

Direct Shear

Three direct shear tests were performed on representative undisturbed samples and one on sample remolded to 90% of the laboratory maximum dry density under soaked moisture condition in accordance with ASTM Standard D3080. For each test, three samples contained in brass sampler rings were placed, one at a time, directly into the test apparatus and subjected to a range of normal loads appropriate for the anticipated conditions. The samples were then sheared at a constant strain rate of 0.01 and 0.02 inch/minute, depending on the sample. Shear deformation was recorded until a maximum of about 0.25-inch shear displacement was achieved. Ultimate strength was selected from the shear-stress deformation data and plotted to determine the shear strength parameters. For test data, including sample density and moisture content, see Drawings No. B-3 and B-4*, Direct Shear Test Results,* and the following table.

Table No. B-7, Direct Shear Test Results

Boring No./Report	Depth (feet)	Soil Description	Ultimate Strength Parameters	
			Friction Angle (degrees)	Cohesion (psf)
BH-8/2019	5.0-6.5	Sandy Silt (ML)	28	200
BH-9/2019	5.0-6.5	Sand with Silt (SP-SM)	30	120
BH-1/2006	5.0-6.5	Sand with Silt (SP-SM)	41	400
*BH-4/2006	5.0-6.5	Silty Sand (SM)	40	350

(*Sample remolded to 90% of the laboratory maximum dry density)

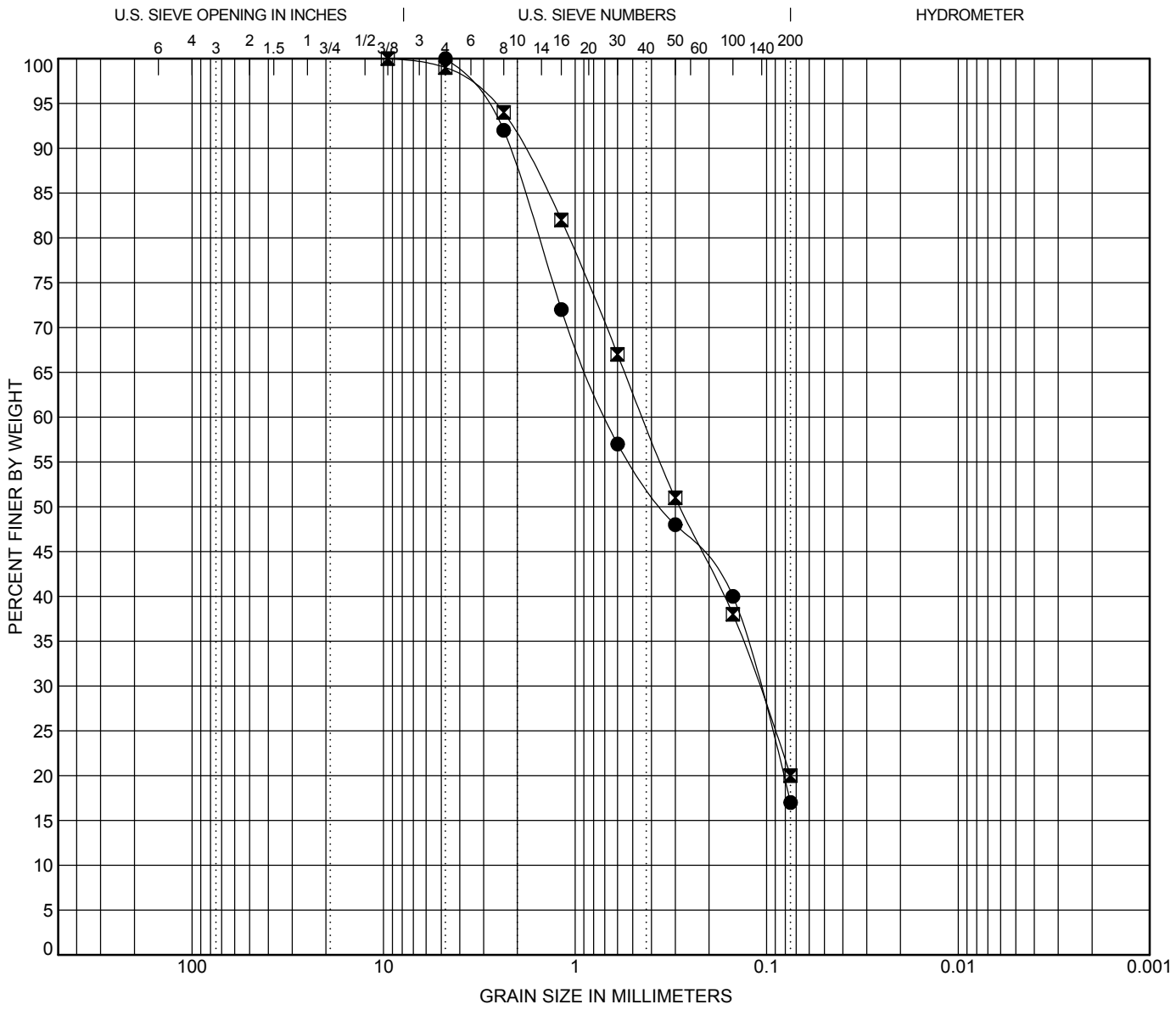
Consolidation

Consolidation test (2006) was performed on one selected sample in accordance with the ASTM Standard D2435 test method. Data obtained from this test performed on a relatively undisturbed soil sample was used to evaluate the settlement characteristics of the foundation soils under load. Preparation for this test involved trimming the sample and placing the one-inch high brass ring into the test apparatus, which contained porous stones, both top and bottom, to accommodate drainage during testing. Normal axial loads were applied to one end of the sample through the porous stones, and the resulting deflections were recorded at various time periods. The load was increased after the sample reached a reasonable state of equilibrium. Normal loads were applied

at a constant load-increment ratio, successive loads being generally twice the preceding load. The sample was tested at field and submerged conditions. The test result is presented in Drawing No. B-5, *Consolidation Test Results*.

Sample Storage

Soil samples currently stored in our laboratory will be discarded thirty days after the date of the final report, unless this office receives a specific request to retain the samples for a longer period.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	**BH-9**	**0-5**	**SILTY SAND (SM)**					
⊠	**PT-01**	**5-8**	**SILTY SAND (SM)**					

	Boring No.	Depth (ft)	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-9**	**0-5**	**4.75**	**0.687**	**0.111**		**0.0**	**83.0**	**17.0**	
⊠	**PT-01**	**5-8**	**9.5**	**0.443**	**0.11**		**1.0**	**79.0**	**20.0**	

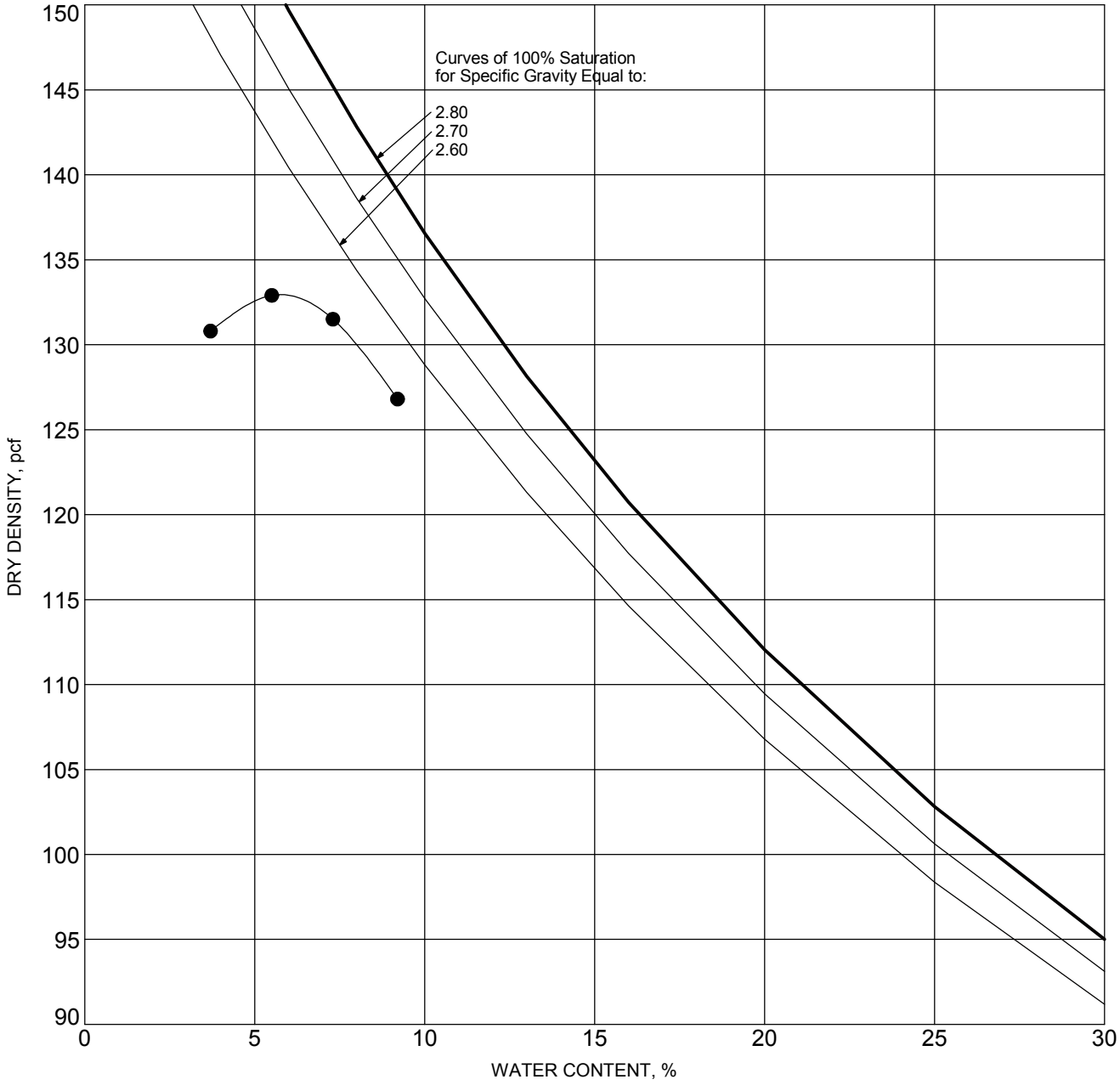
GRAIN SIZE DISTRIBUTION RESULTS

Converse Consultants

Approximately 20.60-Acre Residential Development
Southeast Corner of Hopland Street and Cahuenga Road
City of Victorville, San Bernardino County, California
For: Lansing Companies

Project No. **19-81-173-01**

Drawing No. **B-1**



SYMBOL	BORING NO.	DEPTH (ft)	DESCRIPTION	ASTM TEST METHOD	OPTIMUM WATER, %	MAXIMUM DRY DENSITY, pcf
●	**BH-9**	**0-5**	**SILTY SAND (SM), BROWN**	**D1557 -A**	**6.5**	**133.0**

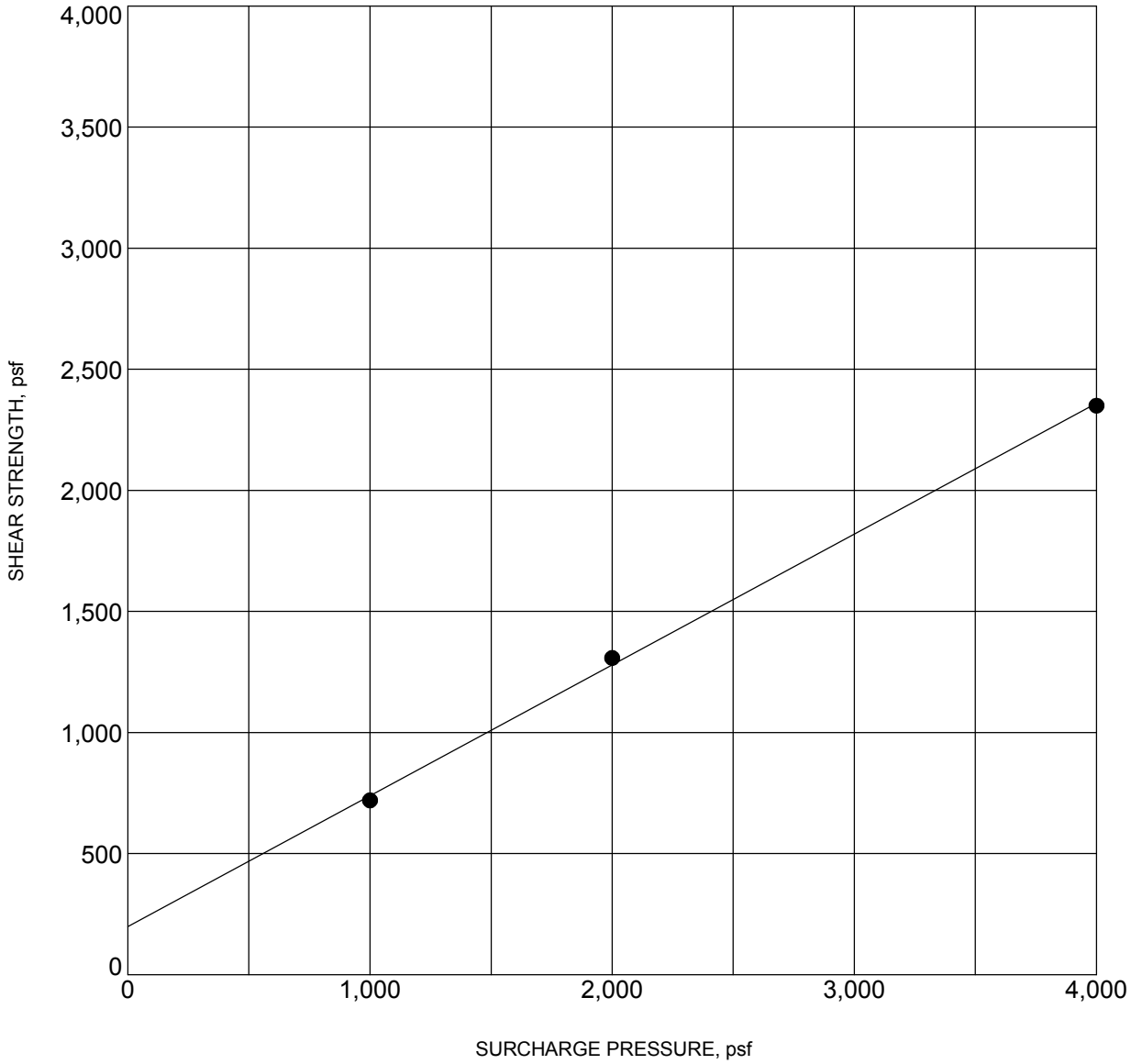
MOISTURE-DENSITY RELATIONSHIP RESULTS

Converse Consultants

Approximately 20.60-Acre Residential Development
Southeast Corner of Hopland Street and Cahuenga Road
City of Victorville, San Bernardino County, California
For: Lansing Companies

Project No. **19-81-173-01**

Drawing No. **B-2**



BORING NO.	:	**BH-8**	DEPTH (ft)	:	**5.0-6.5**
DESCRIPTION	:	**SANDY SILT (ML)**			
COHESION (psf)	:	**200**	FRICTION ANGLE (degrees):		**28**
MOISTURE CONTENT (%)	:	**11**	DRY DENSITY (pcf)	:	**113.0**

NOTE: Ultimate Strength.

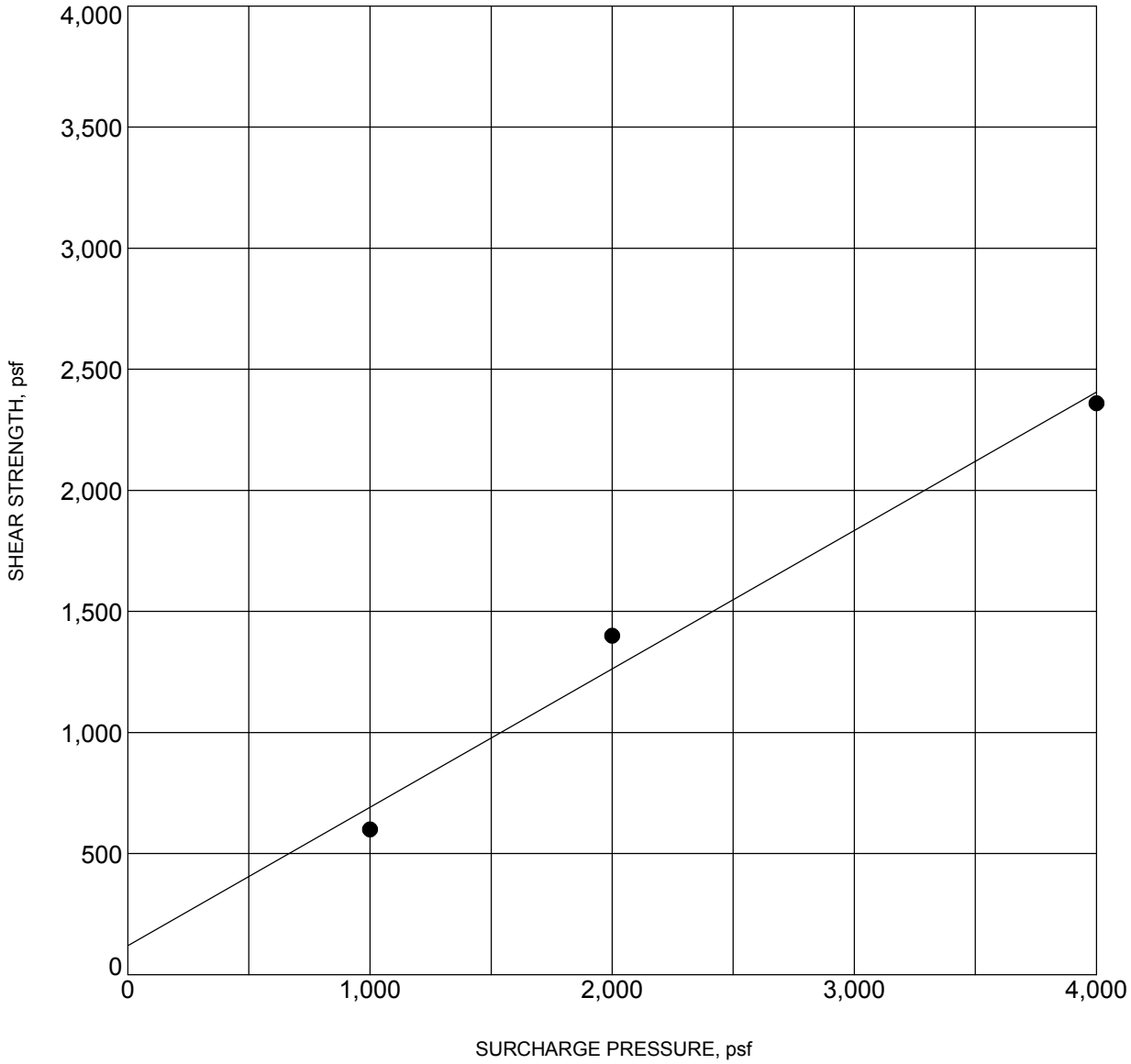
DIRECT SHEAR TEST RESULTS

Converse Consultants

Approximately 20.60-Acre Residential Development
Southeast Corner of Hopland Street and Cahuenga Road
City of Victorville, San Bernardino County, California
For: Lansing Companies

Project No. **19-81-173-01**

Drawing No. **B-3**



BORING NO.	:	**BH-9**	DEPTH (ft)	:	**5.0-6.5**
DESCRIPTION	:	**SAND WITH SILT (SP-SM)**			
COHESION (psf)	:	**120**	FRICTION ANGLE (degrees):		**30**
MOISTURE CONTENT (%)	:	**3.0**	DRY DENSITY (pcf)	:	**119.0**

NOTE: Ultimate Strength.

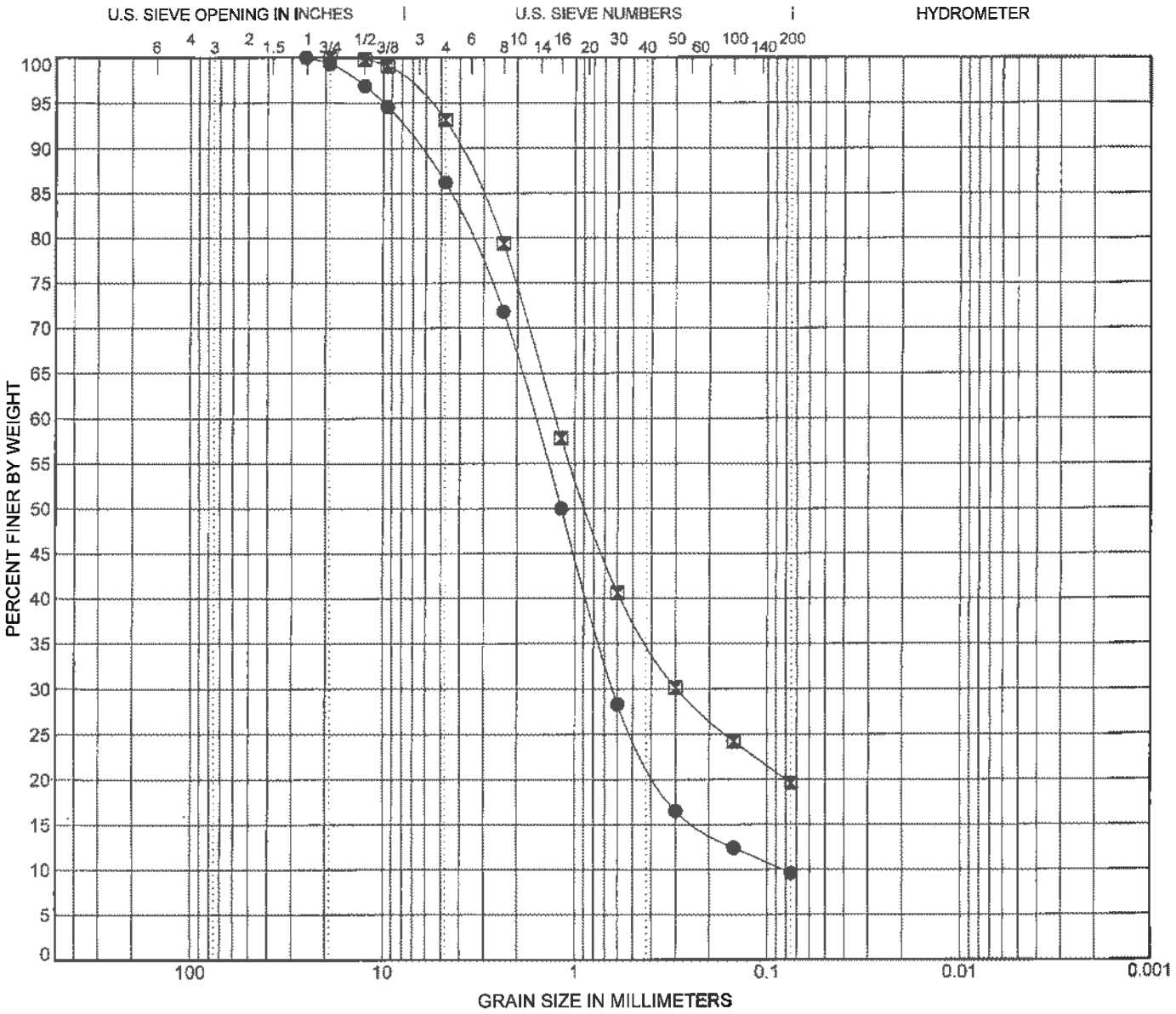
DIRECT SHEAR TEST RESULTS

Converse Consultants

Approximately 20.60-Acre Residential Development
Southeast Corner of Hopland Street and Cahuenga Road
City of Victorville, San Bernardino County, California
For: Lansing Companies

Project No. **19-81-173-01**

Drawing No. **B-4**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	BH - 1	0 - 5'	SAND WITH SILT (SP-SM)				2.98	19.60
⊠	BH - 6	0 - 5'	SILTY SAND (SM)					

	Boring No.	Depth (ft)	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH - 1	0 - 5'	25.4	1.622	0.633	0.083	13.8	76.6	9.6	
⊠	BH - 6	0 - 5'	19	1.266	0.296		6.9	73.5	19.6	

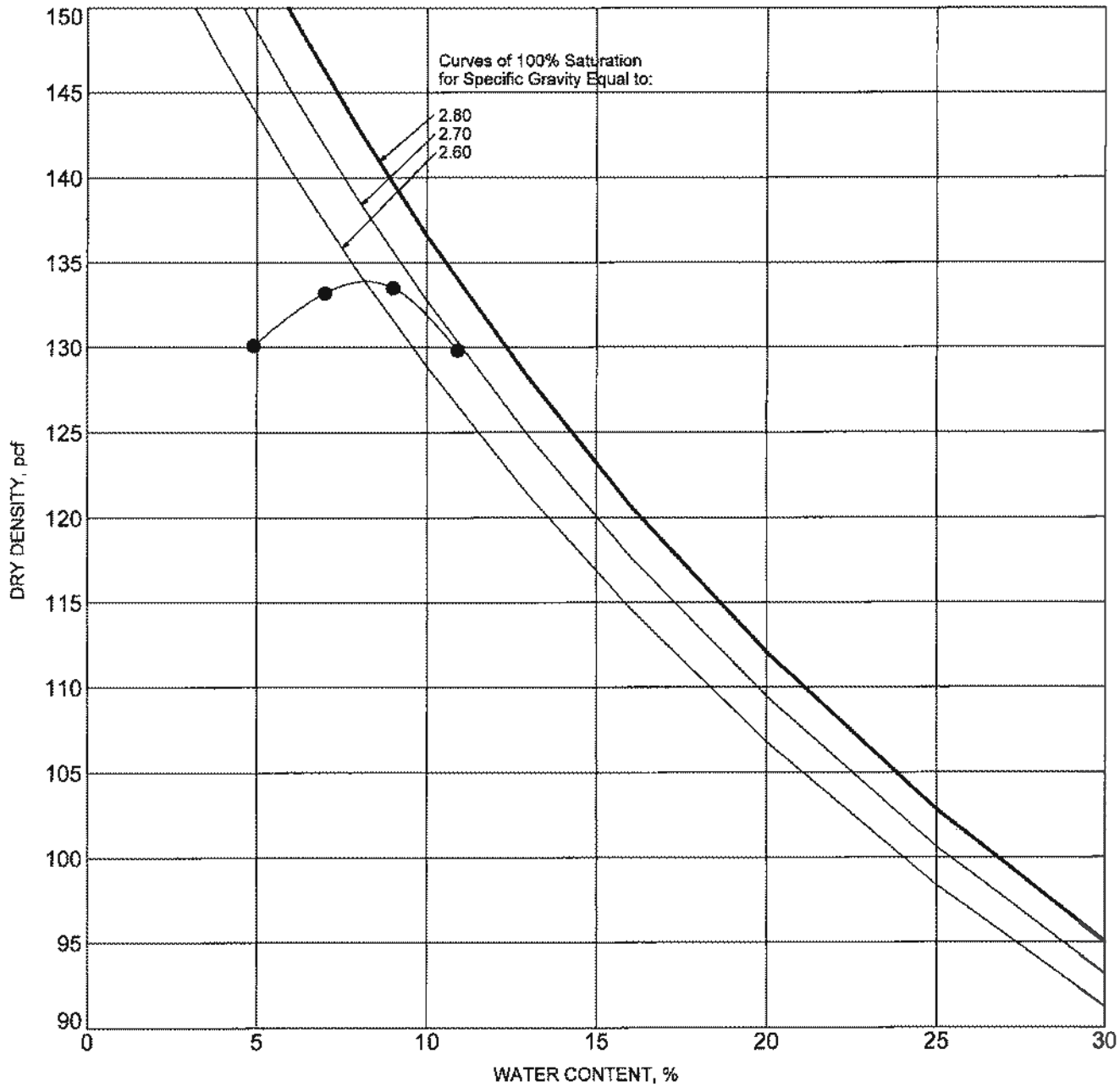
GRAIN SIZE DISTRIBUTION RESULTS

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. B - 1



SYMBOL	BORING NO.	DEPTH (ft)	DESCRIPTION	ASTM TEST METHOD	OPTIMUM WATER, %	MAXIMUM DRY DENSITY, pcf
●	BH - 4	0 - 5'	SILTY SAND (SM)	A	8.0	134.5

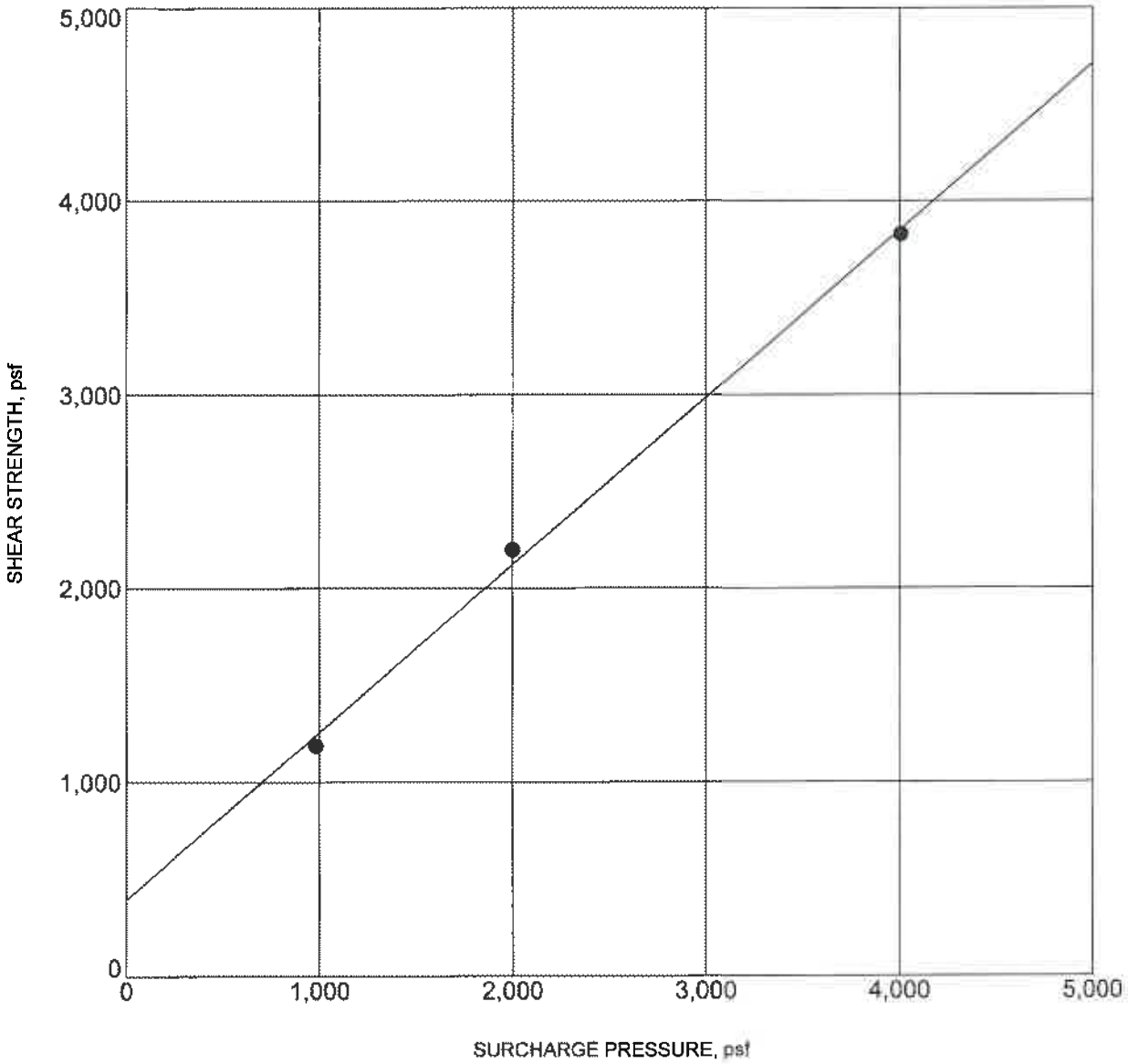
MOISTURE-DENSITY RELATIONSHIP RESULTS

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. B - 2



BORING NO. :	BH - 1	DEPTH (ft) :	5.0 - 6.5'
DESCRIPTION :	SAND WITH SILT (SP-SM)		
COHESION (psf) :	400	FRICTION ANGLE (degrees)	41
MOISTURE CONTENT (%) :	3.6	DRY DENSITY (pcf) :	107.4

NOTE: Ultimate Strength.

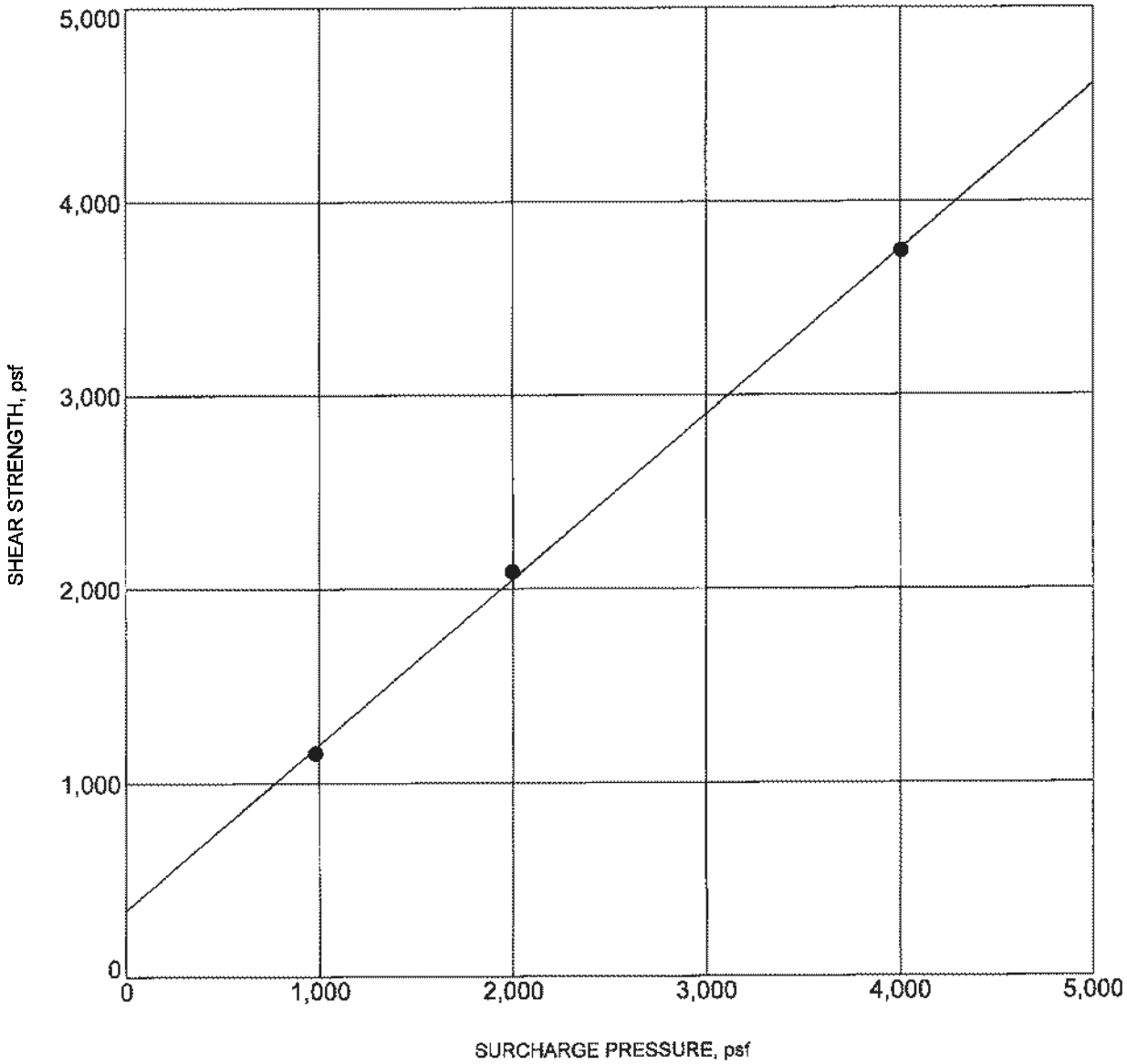
DIRECT SHEAR TEST RESULTS

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. B - 3



BORING NO. :	BH - 4	DEPTH (ft) :	0 - 5'
DESCRIPTION :	SILTY SAND (SM)		
COHESION (psf) :	350	FRICTION ANGLE (degrees)	40
MOISTURE CONTENT (%) :	8.5	DRY DENSITY (pcf) :	121.5

NOTE: Ultimate Strength, Sample Remolded to 90% Relative Compaction

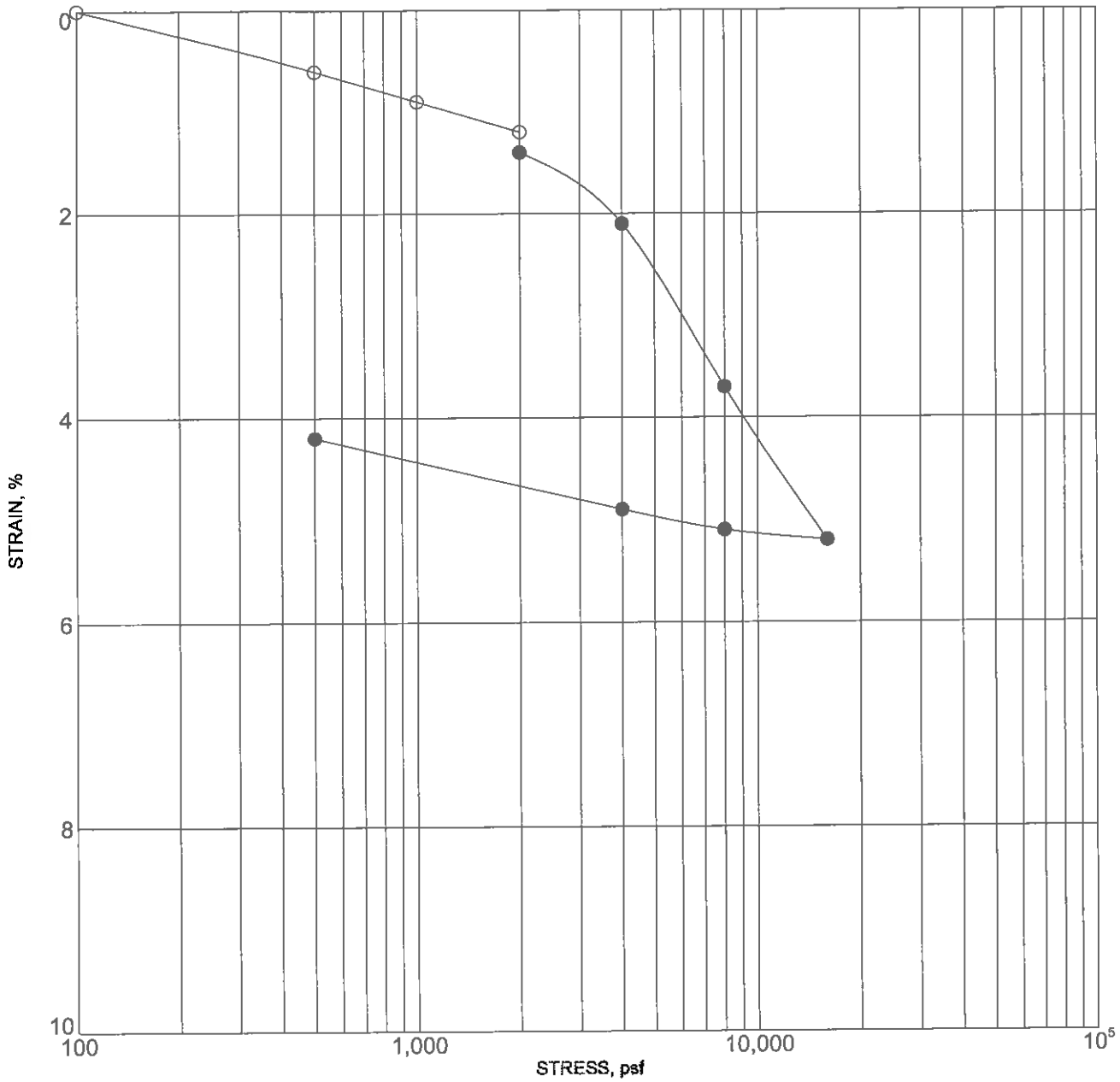
DIRECT SHEAR TEST RESULTS

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. B - 4



BORING NO. :	BH - 4	DEPTH (ft) :	5.0 - 6.5'
DESCRIPTION :	SILTY SAND (SM)		

	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	PERCENT SATURATION	VOID RATIO
INITIAL	5.8	119.8	41	0.377
FINAL	11.5	125	100	0.319

NOTE: Solid Circles Indicate Readings After Addition of Water

CONSOLIDATION TEST RESULTS

Converse Consultants

APRROXIMATELY 30 - ACRE SITE
City of Victorville, San Bernardino County, California
For: Victory Ridge

Project No. 05-81-351-01

Drawing No. B - 5

Appendix C

Water Filtration Testing

APPENDIX C

WATER INFILTRATION TESTING

Percolation testing was performed at two locations (PT-01 and PT-02) on June 10 and July 12, 2019 in general accordance with the San Bernardino County Technical Guidance Document for the Preparation of Conceptual/Preliminary and/or Project Water Quality Management Plans, Appendix VII, Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations (San Bernardino County, 2011) for using a percolation testing method to estimate infiltration rates.

Upon completion of drilling the test hole, a 2-inch thick gravel layer was placed at the bottom of the hole and a 3.0-inch diameter perforated pipe was installed above the gravel to the ground surface. The boring annulus around the pipe was filled with gravel. The purpose of the pipe and gravel was to reduce the potential for erosion and caving due to the addition of water to the hole.

June 10, 2019

The test holes were presoaked by filling with water to at least 5 times the radius of the test holes. More than 6 inches of water seeped away from PT-01 in less than 25 minutes for 2 consecutive measurements, meeting the criteria for testing as “sandy soil”. Less than 6 inches of water seeped away from PT-02 in less than 25 minutes for 2 consecutive measurements, meeting the criteria for testing as “soil with fines”. Percolation testing was conducted immediately after presoaking. During testing, the water level and total depth of PT-01 was measured from the top of the pipe every 10 minutes for one hour. The water level and total depth of PT-02 was measured from the top of the pipe every 30 minutes for six hours. Following the completion of percolation testing, the pipes were left in the ground and the percolation test hole was backfilled with cutting soils.

July 12, 2019

The test holes were presoaked by filling with water to at least 5 times the radius of the test holes. More than 6 inches of water seeped away from PT-01 (2) and PT-02 (2) in less than 25 minutes for 2 consecutive measurements, meeting the criteria for testing as “sandy soil”. Percolation testing was conducted immediately after presoaking. During testing, the water level and total depth was measured from the top of the pipe every 10 minutes for one hour. Following the completion of percolation testing, the pipes were removed, and the test hole was backfilled with soil cuttings.

Percolation rates describe the movement of water horizontally and downward into the soil from a boring. Infiltration rates describe the downward movement of water through a horizontal surface, such as the floor of a retention basin. Percolation rates are related to infiltration rates but are generally higher and require conversion before use in design. The

percolation test data was used to estimate infiltration rates using the Porchet Inverse Borehole Method, in accordance with the San Bernardino County guidelines. A conversion factor derived from California Test 750 (Caltrans, 1986) was applied to adjust for the presence of the gravel and pipe within the borehole. A factor of safety of 3 was applied to the measured infiltration rates to account for subsurface variations, uncertainty in the test method, and future siltation. The infiltration structure designer should determine whether additional design-related safety factors are appropriate.

The measured percolation test data and calculations for conversion to infiltration rate, porosity correction, and factor of safety are shown on Plates No. 1 through 4, *Estimated Infiltration Rate from Percolation Test Data* and graphically represented on Plates No. 5 through 8, *Infiltration Rate Versus Time.* The estimated infiltration rate at the test holes and depths are presented in the following table.

Table No. C-1, Estimated Infiltration Rates

Percolation Test	Depth (feet)	Soil Type	Infiltration Rate (inches/hour)
PT-01	8	Silty Sand (SM)	1.30
PT-02	8	Sandy Silt (ML)	0.17
PT-01	10	Silty Sand (SM)	1.27
PT-02	10	Silty Sand (SM)	1.01

Based on the calculated infiltration rate during the final respective intervals in each test, we recommend an infiltration rate of 0.17 inches per hour at a depth of 8 feet bgs and 1.01 inches per hour at a depth of 10 feet bgs in the area of the basin.

Estimated Infiltration Rate from Percolation Test Data, PT-01

Project Name	20.6-acre development
Project Number	19-81-173-01
Test Number	PT-01
Personnel	Catherine Nelson
Presoak Date	6/10/2019
Test Date	6/10/2019

Shaded cells contain calculated values.

Test Hole Radius, r (inches)	4
Total Depth of Test hole, D_T (inches)	96
Inside Diameter of Pipe, I (inches)	2.00
Outside Diameter of Pipe, O (inches)	2.40
Porosity of Gravel, n	0.48
Porosity Correction Factor, C	0.50
Factor of Safety (FOS), F	2

Interval No.	Time Interval, Δt (min)	Initial Depth to Water, D_0 (inches)	Final Depth to Water, D_f (inches)	Elapsed Time (min)	Initial Height of Water, H_0 (inches)	Final Height of Water, H_f (inches)	Change in Height of Water, ΔH (inches)	Average Head Height, H_{avg} (inches)	Infiltration Rate, I_t (inches/hr)	Corrected Infiltration Rate, I_c (inches/hr)	Infiltration Rate with FOS, I_f (inches/hr)
1	25.00	31.20	80.28	25.00	64.80	15.72	49.08	40.26	5.57	2.78	1.39
2	25.00	31.20	79.56	50.00	64.80	16.44	48.36	40.62	5.45	2.72	1.36
3	10.00	31.20	59.88	60.00	64.80	36.12	28.68	50.46	6.56	3.28	1.64
4	10.00	31.20	59.40	70.00	64.80	36.60	28.20	50.70	6.42	3.21	1.60
5	10.00	31.20	57.36	80.00	64.80	38.64	26.16	51.72	5.84	2.92	1.46
6	10.00	31.20	56.16	90.00	64.80	39.84	24.96	52.32	5.51	2.75	1.38
7	10.00	31.20	55.44	100.00	64.80	40.56	24.24	52.68	5.32	2.66	1.33
8	10.00	31.20	55.08	110.00	64.80	40.92	23.88	52.86	5.22	2.61	1.30

Recommended Design Infiltration Rate (inches/hr)	**1.30**

Infiltration calculations are based on the Porchet Inverse Borehole Method presented in Santa Ana Regional Water Quality Control Board Technical Guidance Document, Appendix VII, Example VII.1.

$H_0 = D_T - D_0$

$H_f = D_T - D_f$

$\Delta H = H_0 - H_f$

$H_{avg} = (H_0 + H_f) / 2$

$I_t = (\Delta H * (60 * r)) / (\Delta t * (r + (2 * H_{avg}))$

Porosity conversion calculations are based on the method provided in Caltrans California Test 750.

$C = n * (1 - (O / (2 * r))^2) + (I / (2 * r))^2$

$I_c = I_t * C$

$I_f = I_C * F$

Plate No.

1

Estimated Infiltration Rate from Percolation Test Data, PT-02

Project Name	20.6-acre development
Project Number	19-81-173-01
Test Number	PT-02
Personnel	Catherine Nelson
Presoak Date	6/10/2019
Test Date	6/10/2019

Shaded cells contain calculated values.

Test Hole Radius, r (inches)	4
Total Depth of Test hole, D_T (inches)	96
Inside Diameter of Pipe, I (inches)	2.00
Outside Diameter of Pipe, O (inches)	2.40
Porosity of Gravel, n	0.48
Porosity Correction Factor, C	0.50
Factor of Safety (FOS), F	2

Interval No.	Time Interval, Δt (min)	Initial Depth to Water, D_0 (inches)	Final Depth to Water, D_f (inches)	Elapsed Time (min)	Initial Height of Water, H_0 (inches)	Final Height of Water, H_f (inches)	Change in Height of Water, ΔH (inches)	Average Head Height, H_{avg} (inches)	Infiltration Rate, I_t (inches/hr)	Corrected Infiltration Rate, I_c (inches/hr)	Infiltration Rate with FOS, I_f (inches/hr)
1	30.00	31.20	44.52	30.00	64.80	51.48	13.32	58.14	0.89	0.44	0.22
2	30.00	31.20	43.44	60.00	64.80	52.56	12.24	58.68	0.81	0.40	0.20
3	30.00	31.20	48.96	90.00	64.80	47.04	17.76	55.92	1.23	0.61	0.31
4	30.00	31.20	44.52	120.00	64.80	51.48	13.32	58.14	0.89	0.44	0.22
5	30.00	31.20	43.56	150.00	64.80	52.44	12.36	58.62	0.82	0.41	0.20
6	30.00	31.20	43.44	180.00	64.80	52.56	12.24	58.68	0.81	0.40	0.20
7	30.00	31.20	42.84	210.00	64.80	53.16	11.64	58.98	0.76	0.38	0.19
8	30.00	31.20	41.76	240.00	64.80	54.24	10.56	59.52	0.69	0.34	0.17
9	30.00	31.20	42.36	270.00	64.80	53.64	11.16	59.22	0.73	0.36	0.18
10	30.00	31.20	44.28	300.00	64.80	51.72	13.08	58.26	0.87	0.43	0.22
11	30.00	31.20	42.96	330.00	64.80	53.04	11.76	58.92	0.77	0.39	0.19
12	30.00	31.20	42.84	360.00	64.80	53.16	11.64	58.98	0.76	0.38	0.19

Recommended Design Infiltration Rate (inches/hr)	**0.17**

Infiltration calculations are based on the Porchet Inverse Borehole Method presented in Santa Ana Regional Water Quality Control Board Technical Guidance Document, Appendix VII, Example VII.1.

$H_0 = D_T - D_0$

$H_f = D_T - D_f$

$\Delta H = H_0 - H_f$

$H_{avg} = (H_0 + H_f) / 2$

$I_t = (\Delta H * (60 * r)) / (\Delta t * (r + (2 * H_{avg}))$

Porosity conversion calculations are based on the method provided in Caltrans California Test 750.

$C = n * (1 - (O / (2 * r))^2) + (I / (2 * r))^2$

$I_c = I_t * C$

$I_f = I_C * F$

Plate No.
2

Estimated Infiltration Rate from Percolation Test Data, PT-01 (2)

Project Name	20.6-acre development
Project Number	19-81-173-01
Test Number	PT-01 (2)
Personnel	Jay Burnham
Presoak Date	7/12/2019
Test Date	7/12/2019

Shaded cells contain calculated values.

Test Hole Radius, r (inches)	4
Total Depth of Test hole, D_T (inches)	120
Inside Diameter of Pipe, I (inches)	2.00
Outside Diameter of Pipe, O (inches)	2.40
Porosity of Gravel, n	0.48
Porosity Correction Factor, C	0.50
Factor of Safety (FOS), F	2

Interval No.	Time Interval, Δt (min)	Initial Depth to Water, D_0 (inches)	Final Depth to Water, D_f (inches)	Elapsed Time (min)	Initial Height of Water, H_0 (inches)	Final Height of Water, H_f (inches)	Change in Height of Water, ΔH (inches)	Average Head Height, H_{avg} (inches)	Infiltration Rate, I_t (inches/hr)	Corrected Infiltration Rate, I_c (inches/hr)	Infiltration Rate with FOS, I_f (inches/hr)
1	25.00	78.00	113.40	25.00	42.00	6.60	35.40	24.30	6.46	3.23	1.61
2	25.00	78.00	108.48	50.00	42.00	11.52	30.48	26.76	5.09	2.54	1.27
3	10.00	78.24	94.80	60.00	41.76	25.20	16.56	33.48	5.60	2.80	1.40
4	10.00	76.80	93.60	70.00	43.20	26.40	16.80	34.80	5.48	2.74	1.37
5	10.00	78.00	93.84	80.00	42.00	26.16	15.84	34.08	5.27	2.63	1.32
6	10.00	78.00	93.36	90.00	42.00	26.64	15.36	34.32	5.07	2.53	1.27
7	10.00	78.72	93.60	100.00	41.28	26.40	14.88	33.84	4.98	2.49	1.24
8	10.00	78.00	93.36	110.00	42.00	26.64	15.36	34.32	5.07	2.53	1.27

Recommended Design Infiltration Rate (inches/hr)	**1.27**

Infiltration calculations are based on the Porchet Inverse Borehole Method presented in Santa Ana Regional Water Quality Control Board Technical Guidance Document, Appendix VII, Example VII.1.

$H_0 = D_T - D_0$

$H_f = D_T - D_f$

$\Delta H = H_0 - H_f$

$H_{avg} = (H_0 + H_f) / 2$

$I_t = (\Delta H * (60 * r)) / (\Delta t * (r + (2 * H_{avg}))$

Porosity conversion calculations are based on the method provided in Caltrans California Test 750.

$C = n * (1 - (O / (2 * r))^2) + (I / (2 * r))^2$

$I_c = I_t * C$

$I_f = I_C * F$

Plate No.

3

Estimated Infiltration Rate from Percolation Test Data, PT-02 (2)

Project Name	20.6-acre development
Project Number	19-81-173-01
Test Number	PT-02 (2)
Personnel	Jay Burnham
Presoak Date	7/12/2019
Test Date	7/12/2019

Shaded cells contain calculated values.

Test Hole Radius, r (inches)	4
Total Depth of Test hole, D_T (inches)	120
Inside Diameter of Pipe, I (inches)	2.00
Outside Diameter of Pipe, O (inches)	2.40
Porosity of Gravel, n	0.48
Porosity Correction Factor, C	0.50
Factor of Safety (FOS), F	2

Interval No.	Time Interval, Δt (min)	Initial Depth to Water, D_0 (inches)	Final Depth to Water, D_f (inches)	Elapsed Time (min)	Initial Height of Water, H_0 (inches)	Final Height of Water, H_f (inches)	Change in Height of Water, ΔH (inches)	Average Head Height, H_{avg} (inches)	Infiltration Rate, I_t (inches/hr)	Corrected Infiltration Rate, I_c (inches/hr)	Infiltration Rate with FOS, I_f (inches/hr)
1	25.00	72.00	106.20	25.00	48.00	13.80	34.20	30.90	4.99	2.49	1.25
2	25.00	72.00	103.20	50.00	48.00	16.80	31.20	32.40	4.35	2.17	1.09
3	10.00	72.24	88.20	60.00	47.76	31.80	15.96	39.78	4.58	2.29	1.14
4	10.00	72.00	87.60	70.00	48.00	32.40	15.60	40.20	4.44	2.21	1.11
5	10.00	73.20	87.48	80.00	46.80	32.52	14.28	39.66	4.11	2.05	1.03
6	10.00	73.44	87.84	90.00	46.56	32.16	14.40	39.36	4.18	2.09	1.04
7	10.00	72.00	86.52	100.00	48.00	33.48	14.52	40.74	4.08	2.04	1.02
8	10.00	72.00	86.40	110.00	48.00	33.60	14.40	40.80	4.04	2.02	1.01

Recommended Design Infiltration Rate (inches/hr)	**1.01**

Infiltration calculations are based on the Porchet Inverse Borehole Method presented in Santa Ana Regional Water Quality Control Board Technical Guidance Document, Appendix VII, Example VII.1.

$H_0 = D_T - D_0$

$H_f = D_T - D_f$

$\Delta H = H_0 - H_f$

$H_{avg} = (H_0 + H_f) / 2$

$I_t = (\Delta H * (60 * r)) / (\Delta t * (r + (2 * H_{avg}))$

Porosity conversion calculations are based on the method provided in Caltrans California Test 750.

$C = n * (1 - (O / (2 * r))^2) + (I / (2 * r))^2$

$I_c = I_t * C$

$I_f = I_C * F$

Plate No.

4

Infiltration Rate versus Time, PT-01

Project Name	20.6-acre development
Project Number	19-81-173-01
Test Number	PT-01
Personnel	Catherine Nelson
Presoak Date	6/10/2019
Test Date	6/10/2019

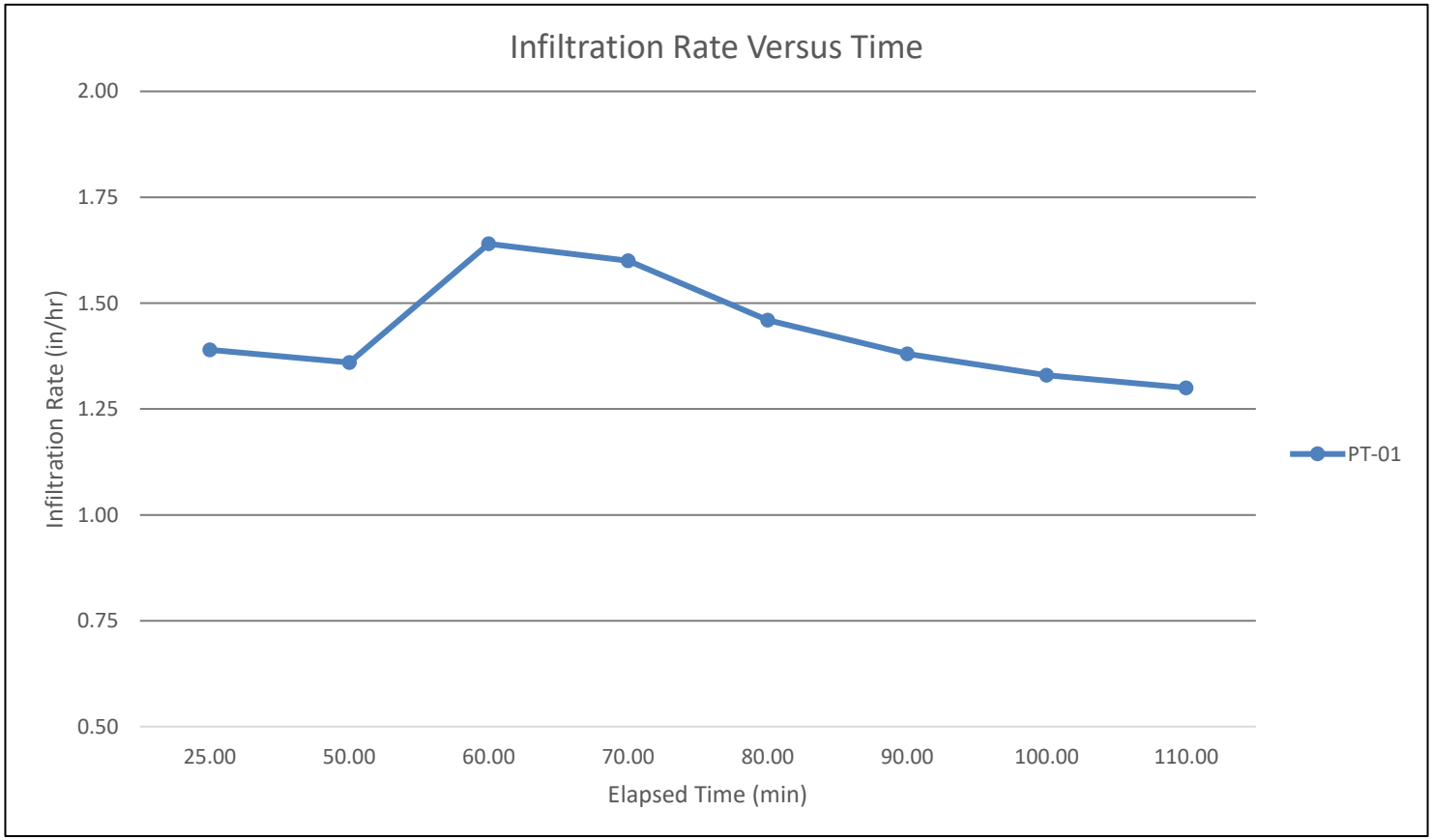


Plate No.
5

Infiltration Rate versus Time, PT-02

Project Name	20.6-acre development
Project Number	19-81-173-01
Test Number	PT-02
Test Location	
Personnel	Catherine Nelson
Presoak Date	6/10/2019
Test Date	6/10/2019

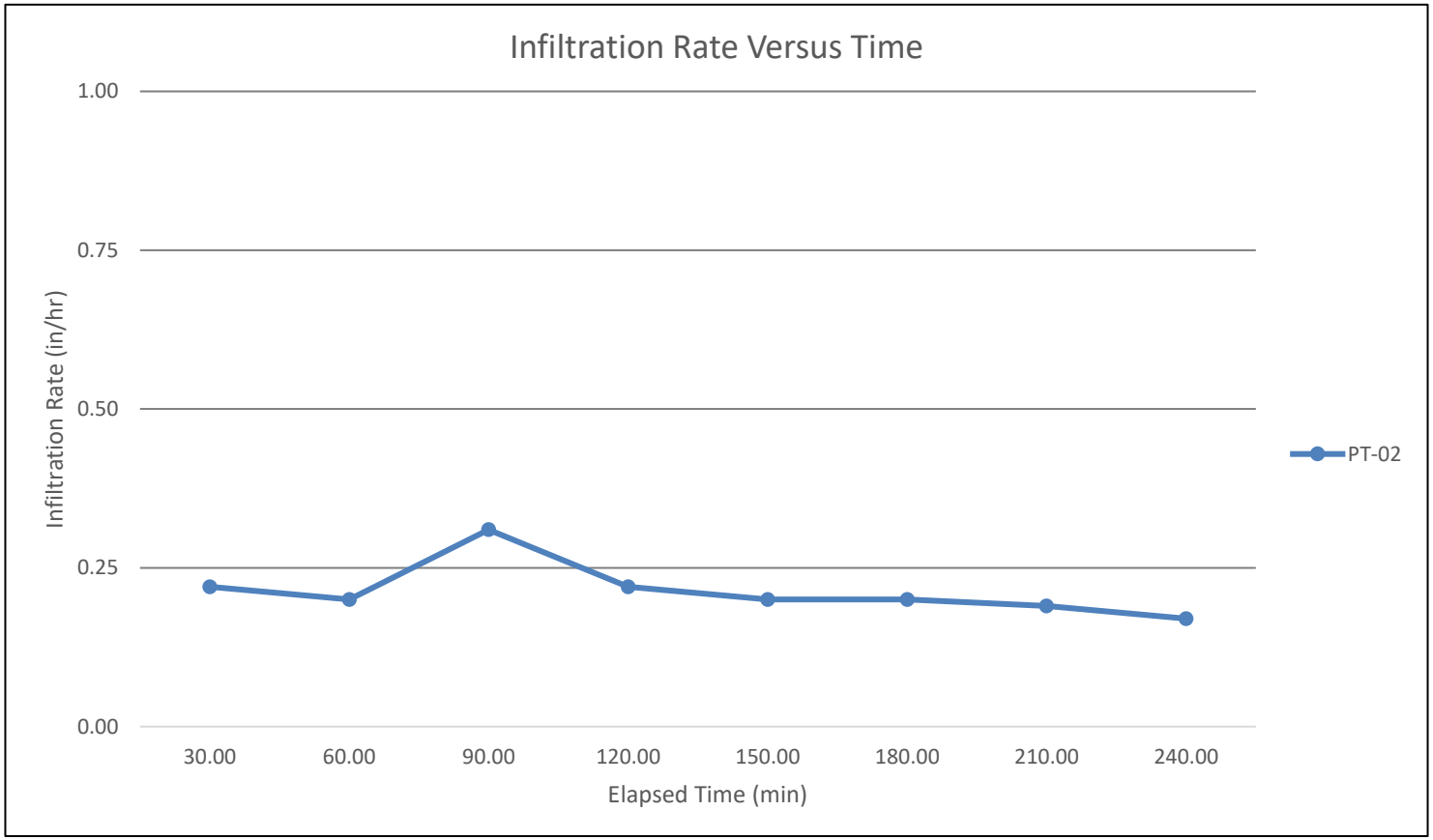


Plate No.
6

Infiltration Rate versus Time, PT-01

Project Name	20.6-acre development
Project Number	19-81-173-01
Test Number	PT-01 (2)
Personnel	Jay Burnham
Presoak Date	7/12/2019
Test Date	7/12/2019

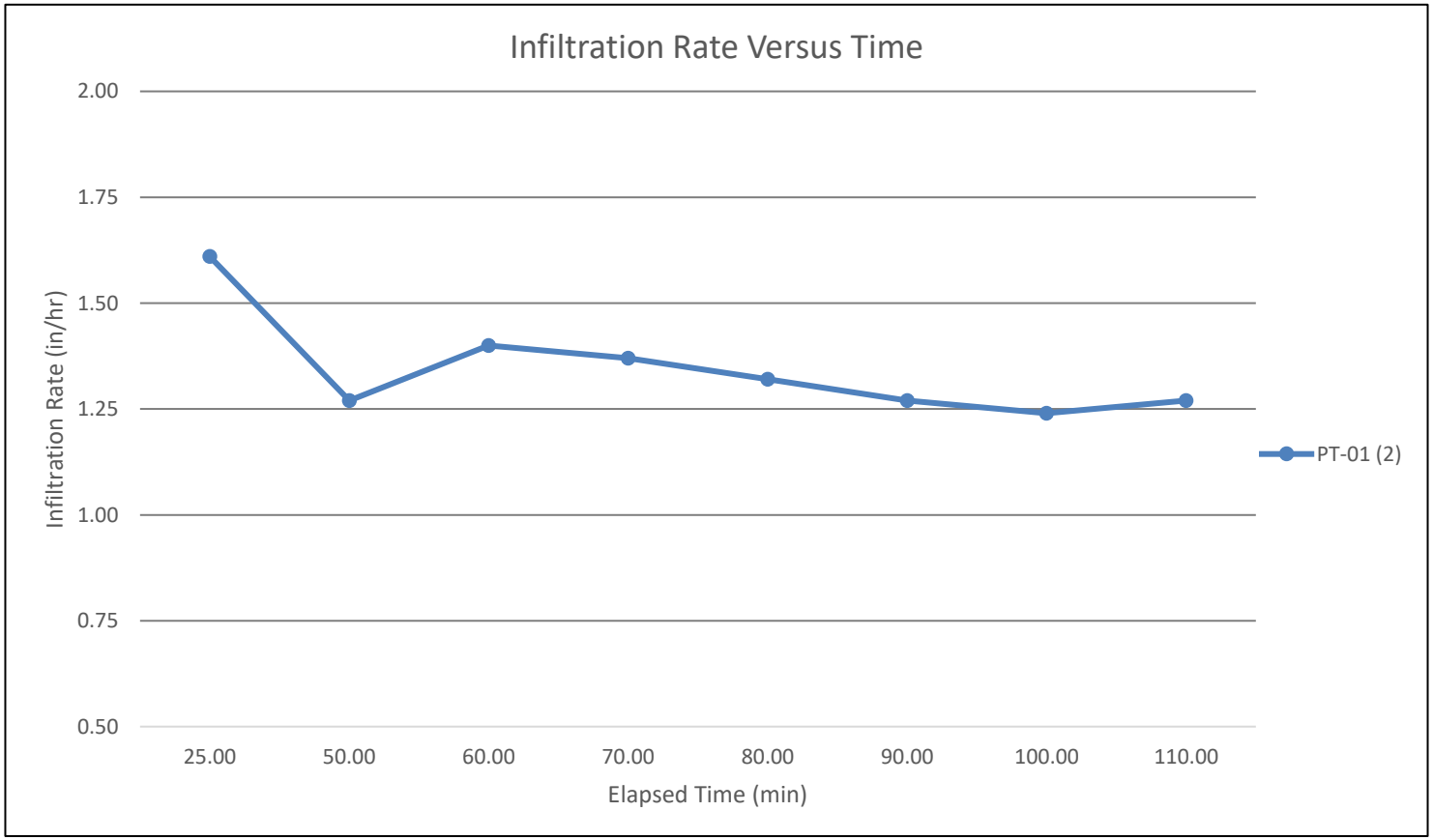


Plate No.
7

Infiltration Rate versus Time, PT-01

Project Name	20.6-acre development
Project Number	19-81-173-01
Test Number	PT-02 (2)
Personnel	Jay Burnham
Presoak Date	7/12/2019
Test Date	7/12/2019

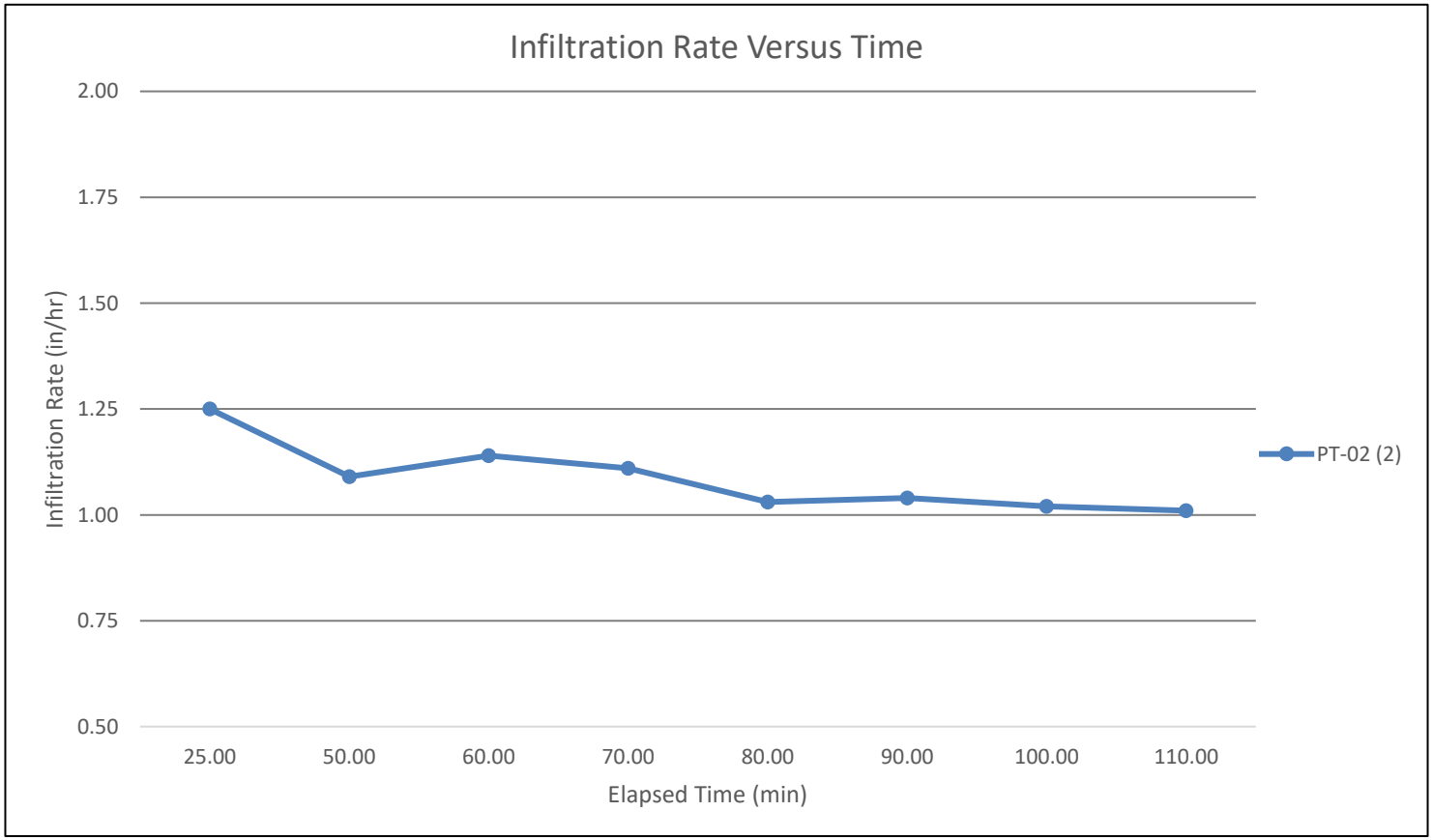
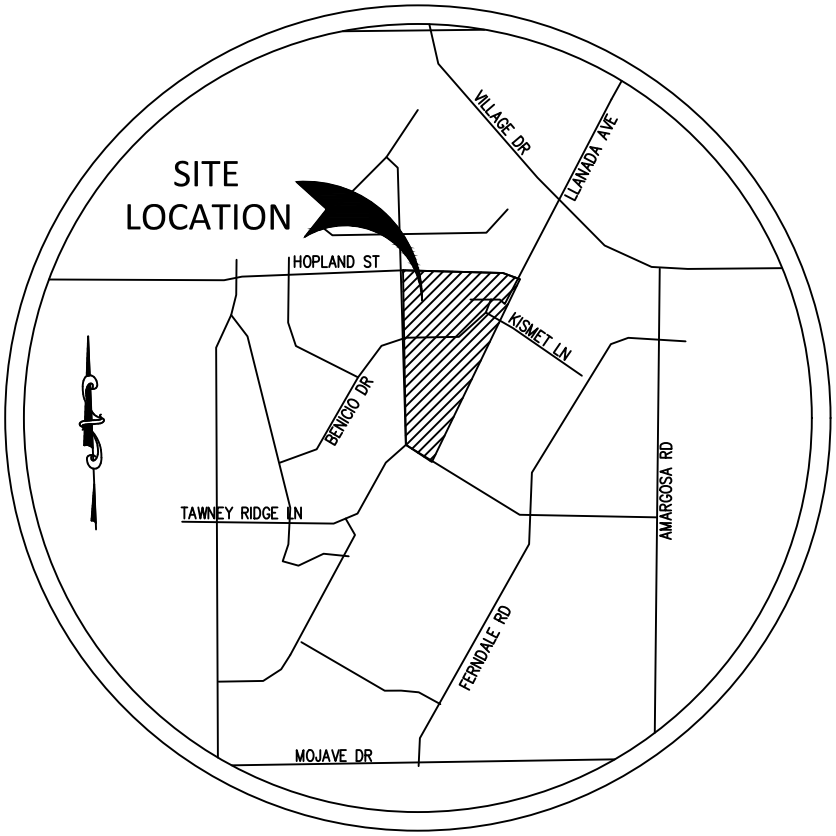


Plate No.
8

Appendix IV

- Vicinity Map
- Project Receiving Water Map
- Tentative Tract Map No. 20280
- Catch Basin Insert Filter Details



VICINITY MAP

NOT TO SCALE

STORMWATER FACILITY MAPPING TOOL

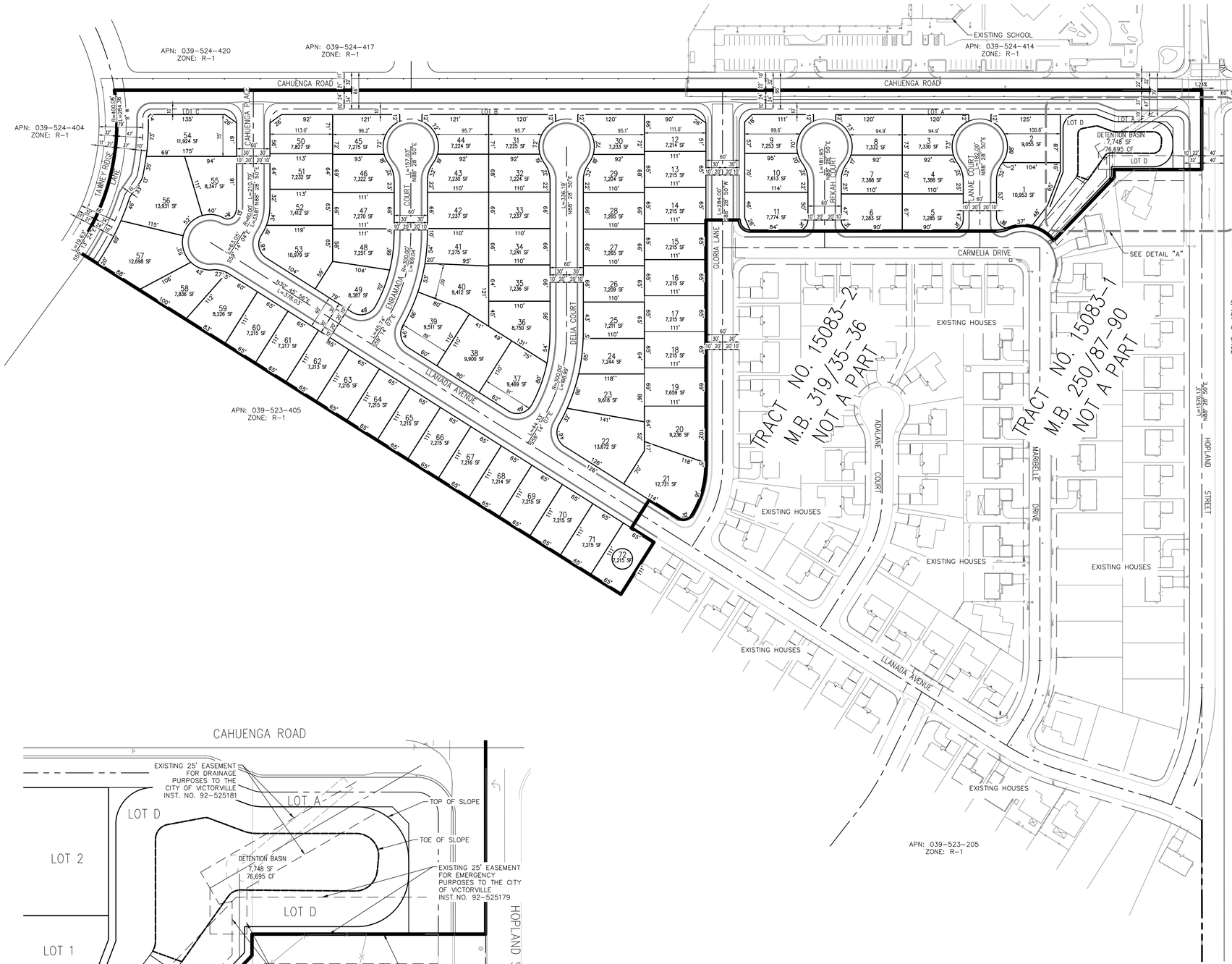
TOC | Find City | CITY OF VICTORVILLE | Locate | Clear

Clear All | Metadata

- Base Maps
  - Topo Map
  - Street Map
  - Aerial Map
- Base Data
  - Highways
    - Layer Info
  - Roads
  - County Maintained Roads
    - Metadata
  - City Limits
    - Metadata
  - Parcels
    - Metadata
  - County Owned Parcels
    - Metadata
  - SBCFCD Zones
    - Metadata
  - Thomas Brothers Index
    - Metadata
- Stormwater Data
  - Drainage Facilities
    - Metadata
    - EHM
    - Santa Ana River
    - Non-EHM (low)
    - Non-EHM (medium)
    - Non-EHM (high)
    - Non-EHM (default-high)
  - 2006 - 303d/TMDL
    - Metadata
  - Water Storage Facility
    - Metadata
    - Interim
    - Ultimate
    - Other

TENTATIVE TRACT NO. 20280

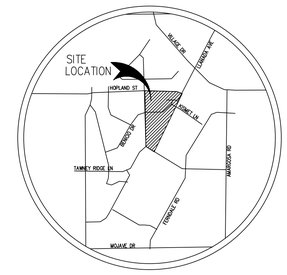
BEING A SUBDIVISION OF A PORTION OF LOTS 48, 54, 57, AND LOTS 76-82 INCLUSIVE OF TRACT NO. 8399 AS PER MAP FILED IN BOOK 115, PAGES 83 THROUGH 97, INCLUSIVE, OF MAPS IN THE OFFICE OF THE COUNTY RECORDER OF SAN BERNARDINO COUNTY, CALIFORNIA
SECTION 11, TOWNSHIP 5 NORTH, RANGE 5 WEST, SAN BERNARDINO MERIDIAN



DETAIL "A"
SCALE : 1"=30'

SCALE : 1"=80'

80 0 80 160
scale 1"= 80' feet



VICINITY MAP
NOT TO SCALE

GENERAL NOTES

DATE OF PREPARATION: APRIL 2, 2019

1. APPROXIMATE GROSS AREA = 20.6 AC.
2. EXISTING USE: VACANT
3. PROPOSED USE: SINGLE FAMILY RESIDENTIAL
4. PROPOSED DENSITY: 0.28 ACRES/LOT
5. EXISTING ZONING: R-1
6. PROPOSED ZONING: R-1
7. ADJACENT LAND USE: NORTH-RESIDENTIAL, SOUTH-VACANT, EAST-VACANT, WEST-SCHOOL/VACANT
8. EXISTING GENERAL PLAN: SPECIFIC PLAN
9. PROPOSED GENERAL PLAN: SPECIFIC PLAN
10. SPECIFIC PLAN DESIGNATION: LM1 (LOW MEDIUM 1)
11. FLOOD ZONE: X
12. ASSESSORS' PARCEL NUMBERS:
    0395-221-10
    0395-234-01,-11,-12
    0395-245-04
    0395-245-07
    0395-246-07,-08
    0395-254-02,-03
13. ALL DIMENSIONS ARE APPROXIMATE.
14. SLOPES WILL NOT EXCEED 2 FEET HORIZONTAL TO ONE FOOT VERTICAL.
15. CONTOURS BY ARROWHEAD MAPPING CO., 431 MAC KAY DRIVE, SUITE 100 SAN BERNARDINO, CA 92408. AERIAL PHOTO FLOWN ON 10-03. CONTOUR INTERVAL: 1 FOOT.
16. MINIMUM LOT SIZE: 6325 SQ. FT., AVERAGE LOT SIZE: 7876 SQ. FT., NUMBER OF LOTS: 72 RESIDENTIAL LOTS AND 2 PEDESTRIAN ACCESS LOTS AND 2 STORM DRAIN LOTS.
17. MINIMUM LOT DIMENSIONS FOR CORNER LOTS: 110 FT. WIDTH X 64 FT. DEPTH, MINIMUM LOT DIMENSIONS FOR INTERIOR LOTS: 65 FT. WIDTH X 101 FT. DEPTH.
18. SANITARY SEWER SYSTEM SHALL BE PUBLIC.
19. SCHOOL DISTRICT:
    VICTOR VALLEY UNION HIGH SCHOOL DISTRICT-GRADES 7-12
    ADELANTO SCHOOL DISTRICT - GRADES K-8

LEGEND

- EXISTING R/W OR PROPERTY LINE
- PROPOSED TRACT BOUNDARY LINE
- CENTERLINE
- -SD- EXISTING STORM DRAIN
- SD PROPOSED STORM DRAIN
- PROPOSED CATCH BASIN
- -W- EXISTING WATER
- W PROPOSED WATER LINE
- -S- EXISTING SEWER
- S PROPOSED SEWER
- PROPOSED SEWER MANHOLE
- TOE OF SLOPE
- (1150) EXISTING ELEVATION
- 1150 TS PROPOSED ELEVATION
- (0.50%) EXISTING STREET GRADE
- 0.50% PROPOSED STREET GRADE
- PROPOSED PAD ELEVATIONS

BENCHMARK

CITY OF VICTORVILLE BENCH MARK V-48
NORTH SIDE OF VILLAGE DRIVE AT AMARGOSA ROAD
IN TOP OF CURB IN LINE WITH EASTERLY POLE LINE.
ELEVATION = 2855.95

OWNER/DEVELOPER

VICTORVILLE 88 ESTATE PARTNERS, LLC
12671 HIGH BLUFF DRIVE
SUITE 150
SAN DIEGO, CA 92130
ATTN: CASEY MALONE
PHONE 858-699-7440
FAX 858-523-0826

ENGINEER

DAVID EVANS AND ASSOCIATES
14297 CAJON AVENUE
SUITE 101
VICTORVILLE, CALIFORNIA 92392
760-524-9100

SOILS ENGINEER

CONVERSE CONSULTANTS
2021 RANCHO DRIVE, SUITE 1
REDLANDS, CA 92373
PHONE 909-796-0544
FAX 909-796-7675

LEGAL DESCRIPTION:

BEING A SUBDIVISION OF A PORTION OF LOTS 48, 54, 57, AND LOTS 76-82 INCLUSIVE OF TRACT NO. 8399 AS PER MAP FILED IN BOOK 115, PAGES 83 THROUGH 97, INCLUSIVE, OF MAPS IN THE OFFICE OF THE COUNTY RECORDER OF SAN BERNARDINO COUNTY, CALIFORNIA SECTION 11, TOWNSHIP 5 NORTH, RANGE 5 WEST, SAN BERNARDINO MERIDIAN

BASIS OF BEARINGS:

BASIS OF BEARINGS IS THE NORTH LINE OF SECTION 7, TOWNSHIP 5 NORTH, RANGE 4 WEST, S.B.M., ALSO BEING THE CENTERLINE OF HOPLAND STREET, PER TRACT MAP NO. 15083-1, M.B. 250/87-90, SHOWN THEREON AS BEING NORTH 88° 28'50" EAST.

UTILITY PURVEYORS

ELECTRICITY
SOUTHERN CALIFORNIA EDISON CO.
12353 HESPERIA RD.
VICTORVILLE, CA 92392
(760) 951-3241

SEWER
CITY OF VICTORVILLE
14343 CIVIC DRIVE - P.O. BOX 5001
VICTORVILLE, CA 92393-5001
(760) 955-5087

WATER
CITY OF VICTORVILLE
14343 CIVIC DRIVE - P.O. BOX 5001
VICTORVILLE, CA 92393-5001
(760) 955-5087

GAS
SOUTHWEST GAS CORPORATION
13471 MARIPOSA ROAD
VICTORVILLE, CA 92392
(760) 951-4050

CABLE
CHARTER COMMUNICATIONS
9536 C AVENUE
HESPERIA, CA 92345
(866) 499-8080

TELEPHONE
FRONTIER COMMUNICATIONS
9 SOUTH 4TH STREET
REDLANDS, CA 92373
909-748-6640

REGISTERED PROFESSIONAL ENGINEER BRET JENSEN THORPE No. 82754 Exp. 9-30-20 CIVIL STATE OF CALIFORNIA

DAVID EVANS AND ASSOCIATES INC.
14297 Cajon Avenue Suite 101
Victorville California 92392-2335
Phone: 760.524.9100

PREPARED UNDER THE SUPERVISION OF:

BRET JENSEN THORPE R.C.E. NO. 82754 DATE

IN THE CITY OF VICTORVILLE, CA
TENTATIVE TRACT NO. 20280
MAP LOTTING

DRAWN BY: PDB	SCALE: 1"=80'
DESIGNED BY: SMSC	DATE: 1/29/2020
CHECKED BY: BJTH	SHT NO.: 1 OF 3

TENTATIVE TRACT NO. 20280

BEING A SUBDIVISION OF A PORTION OF LOTS 48, 54, 57, AND LOTS 76-82 INCLUSIVE OF TRACT NO. 8399 AS PER MAP FILED IN BOOK 115, PAGES 83 THROUGH 97, INCLUSIVE, OF MAPS IN THE OFFICE OF THE COUNTY RECORDER OF SAN BERNARDINO COUNTY, CALIFORNIA
SECTION 11, TOWNSHIP 5 NORTH, RANGE 5 WEST, SAN BERNARDINO MERIDIAN

SCALE : 1"=60'

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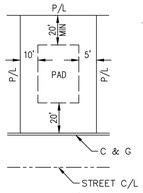
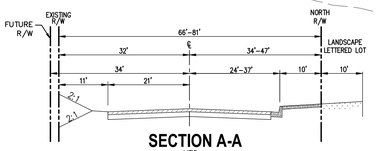
scale 1"= 60' feet

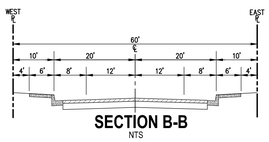


TYPICAL SETBACKS DETAIL

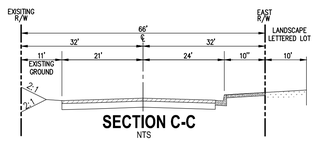


SECTION A-A
NTS

TAWNEY RIDGE LANE STREET SECTIONS



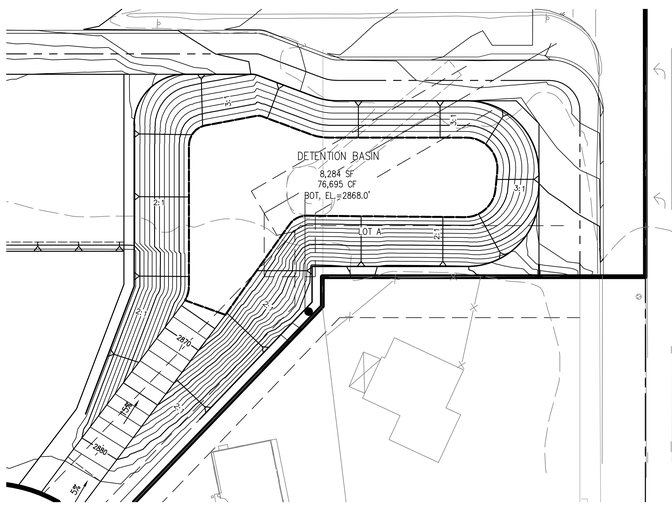
SECTION B-B
NTS



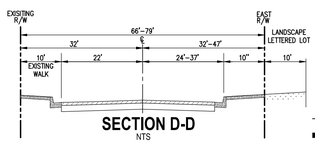
SECTION C-C
NTS

TYPICAL INTERIOR STREET SECTIONS

CAHUENGA ROAD

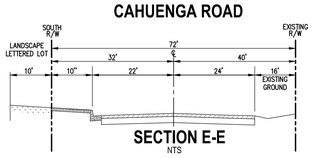


DETAIL "A"
SCALE : 1"=30'



SECTION D-D
NTS

CAHUENGA ROAD



SECTION E-E
NTS

HOPLAND STREET

LEGEND

- EXISTING R/W OR PROPERTY LINE
- PROPOSED TRACT BOUNDARY LINE
- CENTERLINE
- -SD- EXISTING STORM DRAIN
- SD PROPOSED STORM DRAIN
- PROPOSED CATCH BASIN
- -W- EXISTING WATER
- W PROPOSED WATER LINE
- -S- EXISTING SEWER
- S PROPOSED SEWER
- PROPOSED SEWER MANHOLE
- TOE OF SLOPE
- (1150) EXISTING ELEVATION
- 1150 PROPOSED ELEVATION
- (0.50%) EXISTING STREET GRADE
- 0.50% PROPOSED STREET GRADE
- PROPOSED PAD ELEVATIONS

REGISTERED PROFESSIONAL ENGINEER BRET JENSEN THORPE No. 82754 Exp. 9-30-20 CIVIL STATE OF CALIFORNIA

DAVID EVANS AND ASSOCIATES INC.
14297 Cajon Avenue Suite 101
Victorville California 92392-2335
Phone: 760.524.9100

PREPARED UNDER THE SUPERVISION OF:

BRET JENSEN THORPE R.C.E. NO. 82754 DATE

IN THE CITY OF VICTORVILLE, CA

TENTATIVE TRACT NO. 20280

PRELIMINARY GRADING AND STREET GRADES

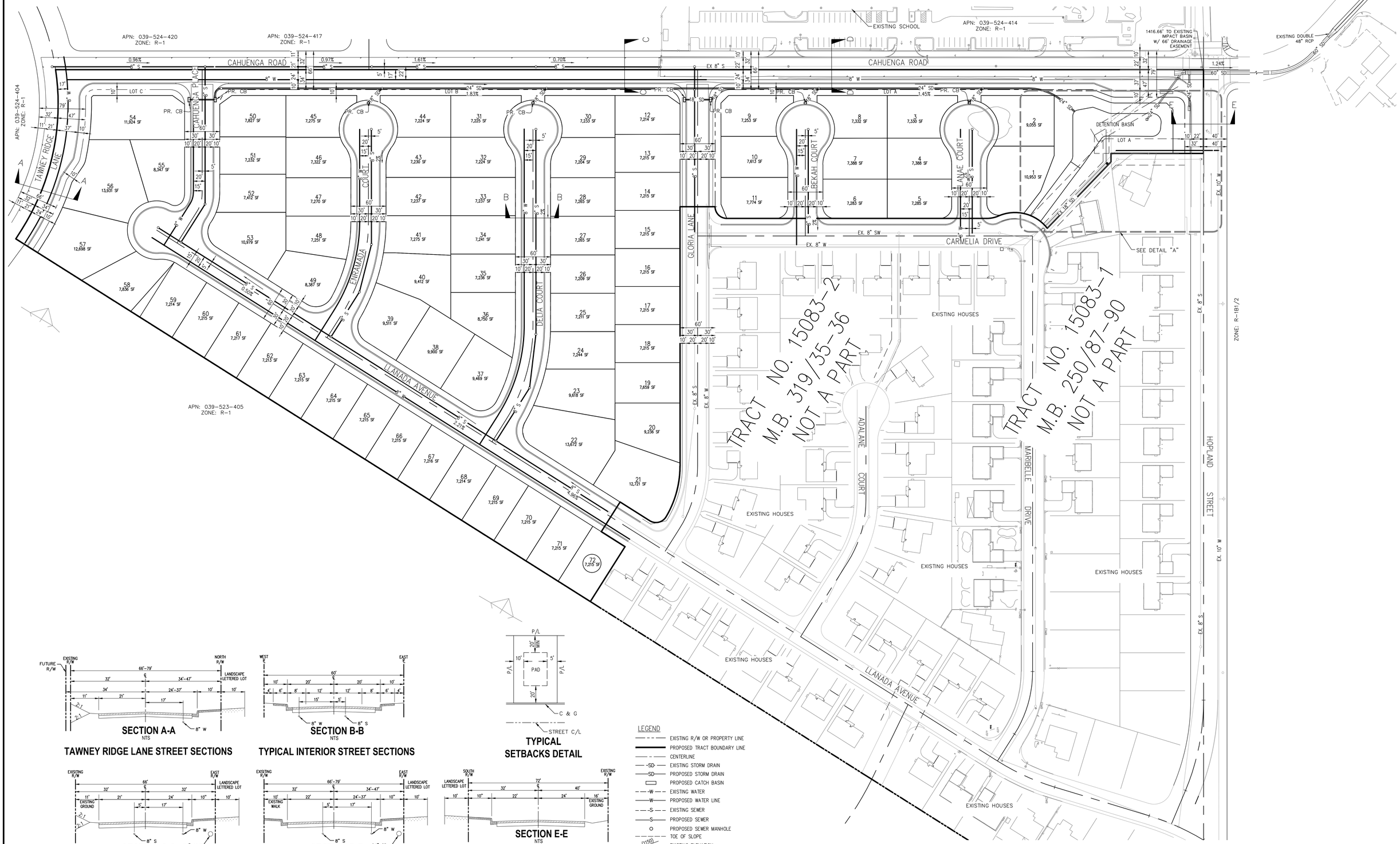
DRAWN BY:	SCALE:
PDB	1"=80'
DESIGNED BY:	DATE:
SMSC	4/02/2019
CHECKED BY:	SHT NO.:
BJTH	2 OF 3

TENTATIVE TRACT NO. 20280

BEING A SUBDIVISION OF A PORTION OF LOTS 48, 54, 57, AND LOTS 76-82 INCLUSIVE OF TRACT NO. 8399 AS PER MAP FILED IN BOOK 115, PAGES 83 THROUGH 97, INCLUSIVE, OF MAPS IN THE OFFICE OF THE COUNTY RECORDER OF SAN BERNARDINO COUNTY, CALIFORNIA
SECTION 11, TOWNSHIP 5 NORTH, RANGE 5 WEST, SAN BERNARDINO MERIDIAN

SCALE : 1"=80'

80 0 80 160
scale 1" = 80' feet



SECTION A-A
NTS

TAWNEY RIDGE LANE STREET SECTIONS

SECTION B-B
NTS

TYPICAL INTERIOR STREET SECTIONS

TYPICAL SETBACKS DETAIL

SECTION C-C
NTS

CAHUENGA ROAD

SECTION D-D
NTS

CAHUENGA ROAD

SECTION E-E
NTS

HOPLAND STREET

LEGEND

- EXISTING R/W OR PROPERTY LINE
- PROPOSED TRACT BOUNDARY LINE
- CENTERLINE
- -SD- EXISTING STORM DRAIN
- SD PROPOSED STORM DRAIN
- PROPOSED CATCH BASIN
- -W- EXISTING WATER
- W PROPOSED WATER LINE
- -S- EXISTING SEWER
- S PROPOSED SEWER
- PROPOSED SEWER MANHOLE
- TOE OF SLOPE
- (1150) EXISTING ELEVATION
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- (0.50%) EXISTING STREET GRADE
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Victorville California 92392-2335
Phone: 760.524.9100

PREPARED UNDER THE SUPERVISION OF:

BRET JENSEN THORPE R.C.E. NO. 82754 DATE

IN THE CITY OF VICTORVILLE, CA

TENTATIVE TRACT NO. 20280

UTILITY MAP

DRAWN BY: PDB	SCALE: 1"=80'
DESIGNED BY: SMSC	DATE: 1/29/2019
CHECKED BY: BJTH	SHT NO.: 3 OF 3

KRISTAR

FloGard®
+PLUS
Catch Basin Insert Filter

FloGard®+PLUS Catch Basin Insert Filter

GENERAL FILTER CONFIGURATION

FloGard®+PLUS catch basin insert filter shall provide solids filtration through a filter screen or filter liner, and hydrocarbon capture shall be effected using a non-leaching absorbent material contained in a pouch or similar removable restraint. Hydrocarbon absorbent shall not be placed at an exposed location at the entry to the filter that would allow blinding by debris and sediment without provision for self-cleaning in operation.

Filter shall conform to the dimensions of the inlet in which it is applied, allow removal and replacement of all internal components, and allow complete inspection and cleaning in the field.

FLOW CAPACITY

Filter shall provide two internal high-flow bypass locations that in total exceed the inlet peak flow capacity. Filter shall provide filtered flow capacity in excess of the required "first flush" treatment flow. Unit shall not impede flow into or through the catch basin when properly sized and installed.

MATERIALS

Filter support frame shall be constructed of type 304 stainless steel. Filter screen, when used in place of filter liner, shall be type 304 or 316 stainless steel, with an apparent opening size of not less than 4 U.S. mesh. Filter liner, when used in place of filter screen, shall be woven polypropylene geotextile fabric liner with an apparent opening size (AOS) of not less than 40 U.S. mesh as determined by ASTM D 4751. Filter liner shall include a support basket of polypropylene geogrid with stainless steel cable reinforcement.

Filter frame shall be rated at a minimum 25-year service life. All other materials, with the exception of the hydrocarbon absorbent, shall have a rated service life in excess of 2 years.

FloGard®+PLUS TEST RESULTS SUMMARY

Testing Agency	% TSS Removal	% Oil and Grease Removal	% PAH Removal
UCLA	80	70 to 80	
U of Auckland Tonking & Taylor Ltd. (for city of Auckland)	78 to 95		
U of Hawaii (for city of Honolulu)	80		20 to 40

FEATURES

- Easy to install, inspect and maintain
- Can be retrofitted to existing drain catch basins – or used in new projects
- Economical and efficient
- Catches pollutants where they are easiest to catch (at the inlet)
- No standing water – minimizes vector, bacteria and odor problems
- Can be incorporated as part of a "Treatment Train"

BENEFITS

- Lower installation, inspection and maintenance costs
- Versatile installation applications
- Higher return on investment
- Allows for installation on small and confined sites
- Minimizes vector, bacteria and odor problems
- Allows user to target specific pollutants

Innovative stormwater management products

FloGard® +PLUS
Catch Basin Insert Filter

INSTALLATION AND MAINTENANCE
Filter shall be installed and maintained in accordance with manufacturer's general instructions and recommendations.

PERFORMANCE
Filter shall provide 80% removal of total suspended solids (TSS) from treated flow with a particle size distribution consistent with typical urban street deposited sediments. Filter shall capture at least 70% of oil and grease and 40% of total phosphorus (TP) associated with organic debris from treated flow. Unit shall provide for isolation of trapped pollutants, including debris, sediments, and floatable trash and hydrocarbons, from bypass flow such that re-suspension and loss of pollutants is minimized during peak flow events.

FloGard®+PLUS COMPETITIVE FEATURE COMPARISON

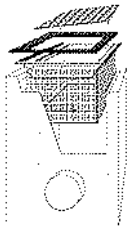
Evaluation of FloGard+PLUS Units (Based on flow-comparable units) (Scale 1-10, 10 being best)	**FloGard+PLUS**	**Other Insert Filter Types****
Flow Rate	10	7
Removal Efficiency*	80%	45%
Capacity – Sludge and Oil	7	7
Service Life	10	3
Installation – Ease of Handling / Installation	8	6
Ease of Inspections & Maintenance	7	7
Value	**10**	**2**

*approximate, based on field sediment removal testing in urban street application **average

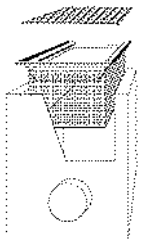
Long-Term Cost Comparison (Scale 1-10, 10 being lowest cost, higher number being best)	**FloGard+PLUS**	**Other Insert Filter Types**
Unit cost — initial ($/cfs treated)	10	4
Installation cost ($/cfs treated)	10	7
Adsorbent replacement (annual avg $/cfs treated)	10	2
Unit materials replacement (annual avg $/cfs treated)	10	10
Maintenance cost (annual avg $/cfs treated)	10	7
Total first yr ($/cfs treated)	10	5
Total Annual Avg ($/cfs treated, avg over 20 yrs)*	**10**	**5**

*assumes 3% annual inflation

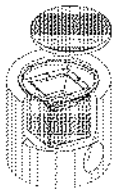
Captured debris from FloGard+PLUS, Dana Point, CA



FloGard+PLUS Combination Inlet



FloGard+PLUS Flat Grate



FloGard+PLUS Round Gated Inlet

KriStar Enterprises, Inc.
360 Sutton Place
Santa Rosa, CA 95407

PH: 800-579-8819
FAX: 707-524-8186
www.kristar.com

FGP-T 05.19.09.1M

Appendix V

Hydrology Exhibits

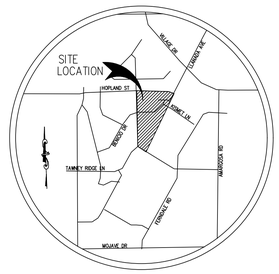
PRE-DEVELOPMENT CONDITION

HYDROLOGY EXHIBIT

FOR

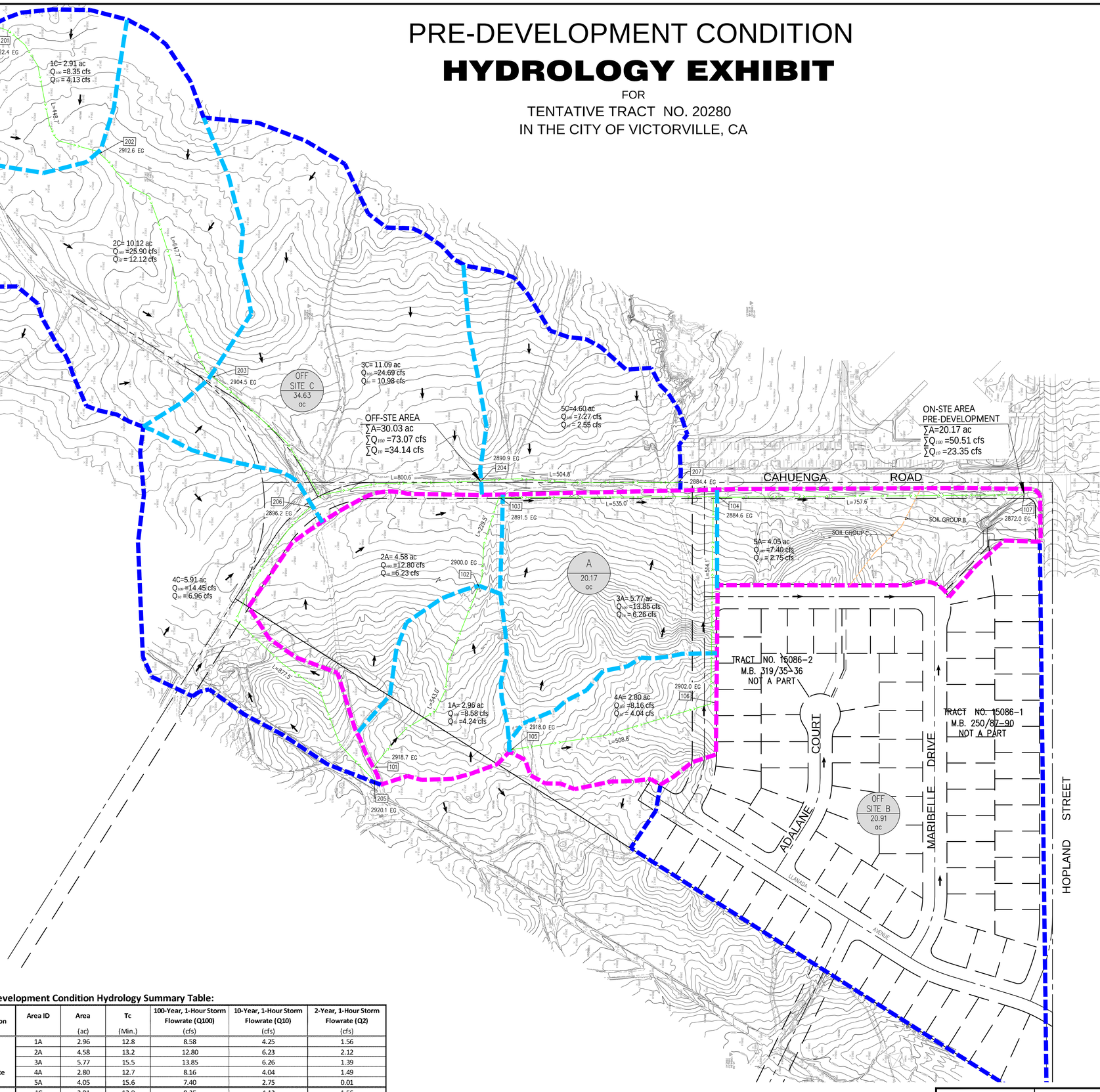
TENTATIVE TRACT NO. 20280

IN THE CITY OF VICTORVILLE, CA



VICINITY MAP

NOT TO SCALE



LEGEND:

- ON-SITE TRIBUTARY DRAINAGE AREA BOUNDARY
- OFF-SITE TRIBUTARY DRAINAGE AREA BOUNDARY
- SUB-DRAINAGE AREA BOUNDARY
- STORM DRAIN FLOW PATH
- SOIL BOUNDRAY
- EXISTING STORM DRAIN
- PROPOSED STORM DRAIN
- PROPOSED FLOW DIRECTION ARROW
- CATCH BASIN WITH FILTER INSERT
- X.X — NODE NUMBER
- 1A=4.2 ac, Q100 = 6.5 cfs, Q10 = 3.2 cfs — SUB- DRAINAGE AREA, 100-YEAR STORM PEAK FLOW RATE, 10-YEAR STORM PEAK FLOW RATE
- A / 21.17 — SUB-DRAINAGE AREA ID, AREA ACREAGE

HYDROLOGY INFORMATION

SITE AREA:	20.6 ACRE	
SOIL GROUP:	B & C	(PER NATIONAL SOIL SURVEY))
IMPERVIOUS:	0 %	(NATURAL LAND)
IMPERVIOUS:	50 %	(5-7 DWELLINS/ACRE)
ISOHYETALS:	1.11"	(100-YEAR 1 HOUR)
	0.63"	(10-YEAR 1 HOUR)
	0.37 "	(2-YEAR 1 HOUR)
AMC NUMBER:	1	(For 2-YEAR STORM)
	2	(For 10-YEAR STORM)
	3	(For 100-YEAR STORM)
FREQUENCY:	100 YEAR, 10 YEAR & 2 YEAR	
METHOD:	SAN BERNARDINO COUNTY HYDROLOGY MANUAL	

Pre-Development Condition Hydrology Summary Table:

Location	Area ID	Area (ac)	Tc (Min.)	100-Year, 1-Hour Storm Flowrate (Q100) (cfs)	10-Year, 1-Hour Storm Flowrate (Q10) (cfs)	2-Year, 1-Hour Storm Flowrate (Q2) (cfs)
On-site	1A	2.96	12.8	8.58	4.25	1.56
	2A	4.58	13.2	12.80	6.23	2.12
	3A	5.77	15.5	13.85	6.26	1.39
	4A	2.80	12.7	8.16	4.04	1.49
	5A	4.05	15.6	7.40	2.75	0.01
Off-Site	1C	2.91	13.0	8.35	4.13	1.56
	2C	10.12	14.7	25.90	12.12	2.12
	3C	11.09	16.3	24.09	10.98	1.39
	4C	5.91	16.2	14.45	6.96	1.49
	5C	4.60	17.2	7.27	2.55	0.01

SCALE : 1"=100'

DAVID EVANS AND ASSOCIATES INC.

25152 Springfield Court Suite 350
Santa Clarita California 91355-1096
Phone: 661.284.7400

PREPARED UNDER THE SUPERVISION OF:

BRET JENSEN THORPE R.C.E. NO. 82754 DATE

IN THE CITY OF VICTORVILLE, CA

TENTATIVE TRACT NO. 20280

PRE-DEVELOPMENT CONDITION HYDROLOGY EXHIBIT

DRAWN BY: H.Z.
DESIGNED BY: H.Z.
CHECKED BY: B.T.
SCALE: 1"=100'
DATE: 6/17/2019
SHT NO.: 1 OF 2

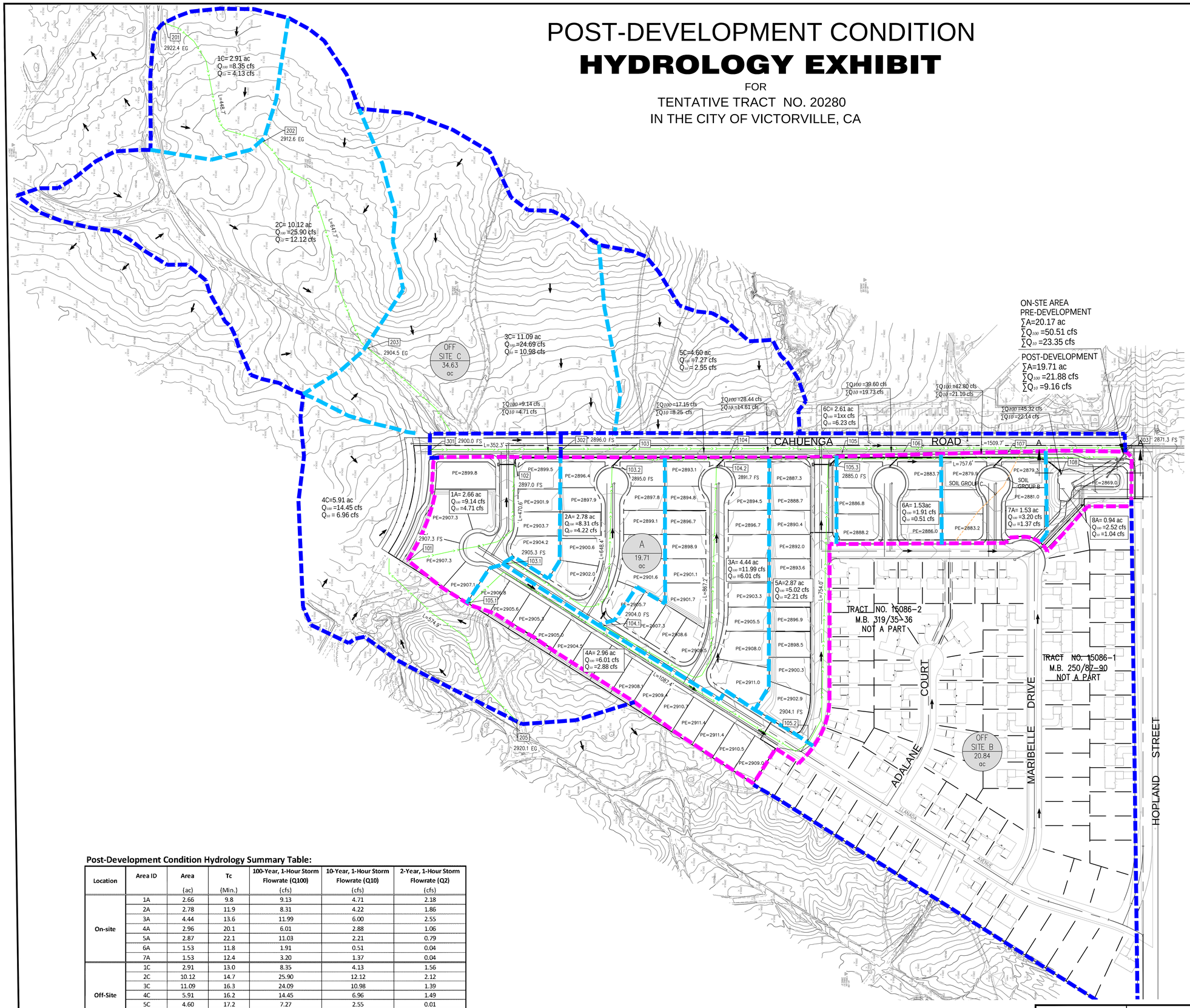
POST-DEVELOPMENT CONDITION

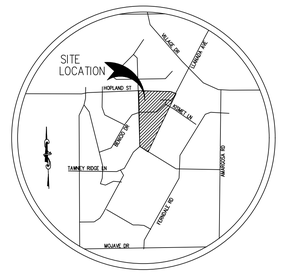
HYDROLOGY EXHIBIT

FOR

TENTATIVE TRACT NO. 20280

IN THE CITY OF VICTORVILLE, CA





VICINITY MAP

NOT TO SCALE

LEGEND:

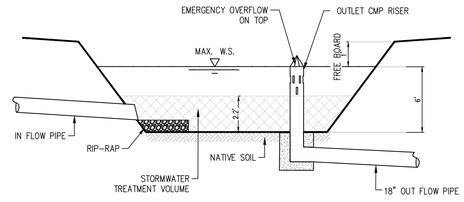
- ON-SITE TRIBUTARY DRAINAGE AREA BOUNDARY
- OFF-SITE TRIBUTARY DRAINAGE AREA BOUNDARY
- SUB-DRAINAGE AREA BOUNDARY
- STORM DRAIN FLOW PATH
- SOIL BOUNDRAY
- EXISTING STORM DRAIN
- PROPOSED STORM DRAIN
- PROPOSED FLOW DIRECTION ARROW
- CATCH BASIN WITH FILTER INSERT
- X.X NODE NUMBER
- 1A=4.2 ac, Q_{100} = 6.5 cfs, Q_{10} = 3.2 cfs — SUB- DRAINAGE AREA, 100-YEAR STORM PEAK FLOW RATE, 10-YEAR STORM PEAK FLOW RATE
- A / 20.17 — SUB-DRAINAGE AREA ID, AREA ACREAGE

HYDROLOGY INFORMATION

SITE AREA:	20.6 ACRE	
SOIL GROUP:	B & C	(PER NATIONAL SOIL SURVEY))
IMPERVIOUS:	0 %	(NATURAL LAND)
IMPERVIOUS:	50 %	(5-7 DWELLINS/ACRE)
ISOHYETALS:	1.11"	(100-YEAR 1 HOUR)
	0.63"	(10-YEAR 1 HOUR)
	0.37 "	(2-YEAR 1 HOUR)
AMC NUMBER:	1	(For 2-YEAR STORM)
	2	(For 10-YEAR STORM)
	3	(For 100-YEAR STORM)

FREQUENCY: 100 YEAR, 10 YEAR & 2 YEAR

METHOD: SAN BERNARDINO COUNTY HYDROLOGY MANUAL



A-A

INFILTRATION/DETENTION BASIN DETAIL

N.T.S

Post-Development Condition Hydrology Summary Table:

Location	Area ID	Area (ac)	Tc (Min.)	100-Year, 1-Hour Storm Flowrate (Q100) (cfs)	10-Year, 1-Hour Storm Flowrate (Q10) (cfs)	2-Year, 1-Hour Storm Flowrate (Q2) (cfs)
On-site	1A	2.66	9.8	9.13	4.71	2.18
	2A	2.78	11.9	8.31	4.22	1.86
	3A	4.44	13.6	11.99	6.00	2.55
	4A	2.96	20.1	6.01	2.88	1.06
	5A	2.87	22.1	11.03	2.21	0.79
	6A	1.53	11.8	1.91	0.51	0.04
	7A	1.53	12.4	3.20	1.37	0.04
Off-Site	1C	2.91	13.0	8.35	4.13	1.56
	2C	10.12	14.7	25.90	12.12	2.12
	3C	11.09	16.3	24.09	10.98	1.39
	4C	5.91	16.2	14.45	6.96	1.49
	5C	4.60	17.2	7.27	2.55	0.01
	6C	2.61	17.2	6.02	3.27	0.01

SCALE : 1"=100'

DAVID EVANS AND ASSOCIATES INC.

25152 Springfield Court Suite 350
Santa Clarita California 91355-1096
Phone: 661.284.7400

PREPARED UNDER THE SUPERVISION OF:

BRET JENSEN THORPE R.C.E. NO. 82754 DATE

IN THE CITY OF VICTORVILLE, CA

TENTATIVE TRACT NO. 20280

POST-DEVELOPMENT CONDITION HYDROLOGY EXHIBIT

DRAWN BY: H.Z.
DESIGNED BY: H.Z.
CHECKED BY: B.T.
SCALE: 1"=100'
DATE: 6/17/2019
SHT NO.: 2 OF 2

Appendix VI

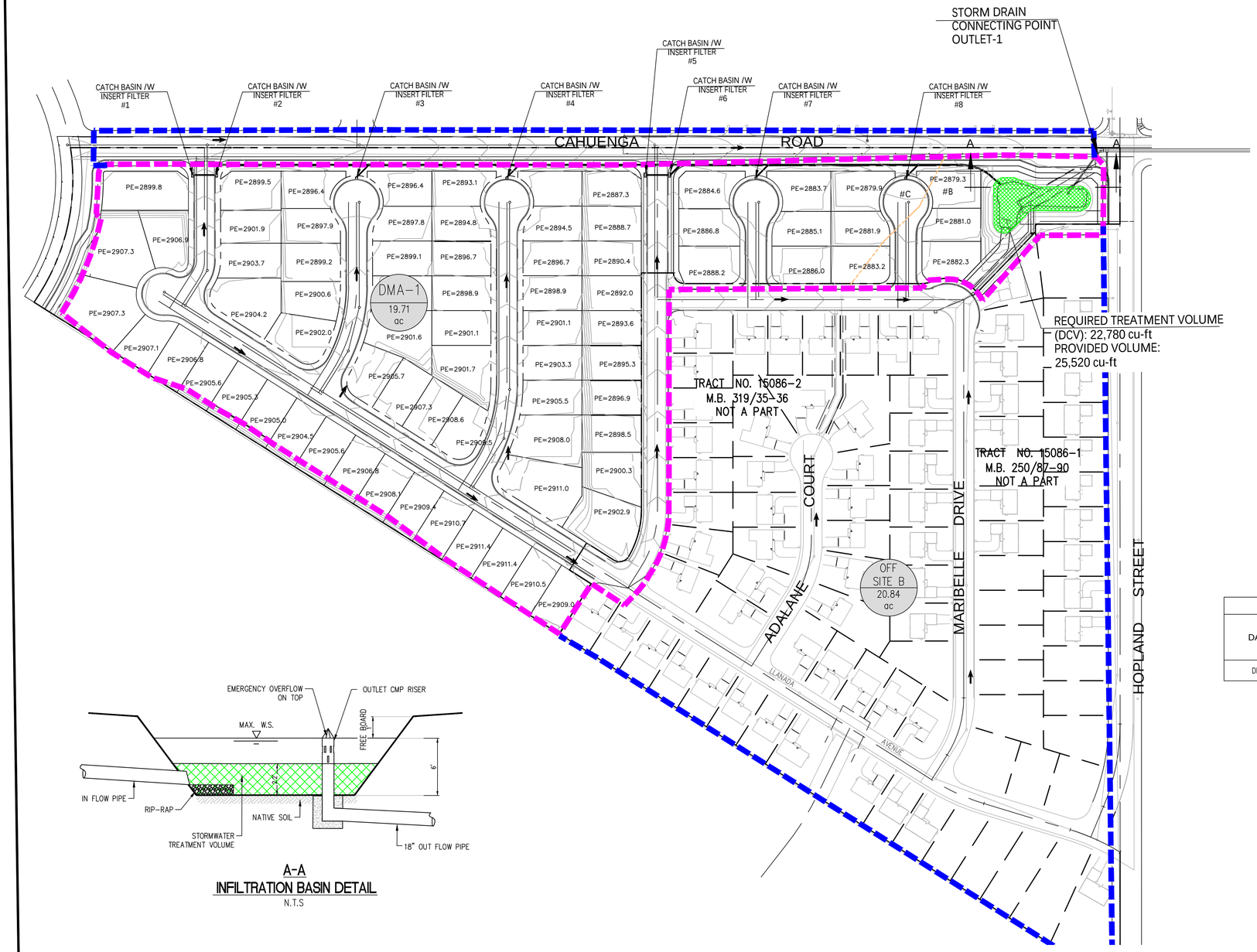
WQMP Exhibit

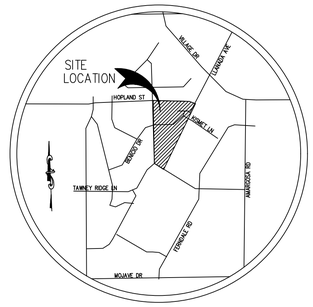
WQMP EXHIBIT

FOR

TENTATIVE TRACT NO. 20280

IN THE CITY OF VICTORVILLE, CA





VICINITY MAP

NOT TO SCALE

LEGEND:

- ON-SITE TRIBUTARY DRAINAGE AREA BOUNDARY
- OFF-SITE TRIBUTARY DRAINAGE AREA BOUNDARY
- SOIL BOUNDRAY
- EXISTING STORM DRAIN
- PROPOSED STORM DRAIN
- STORMWATER TREATMENT BASIN
- PROPOSED FLOW DIRECTION ARROW
- CATCH BASIN WITH INSERT FILTER
- DMA-1 / 20.17 — DRAINAGE MANAGE AREA ID / AREA ACREAGE

A-A

INFILTRATION BASIN DETAIL

N.T.S

WQMP SUMMARY Table:					
DA No.	TRIBUTARY AREA (AC)	IMPERVIOUS RATIO	Q_2 (cfs)	REQUIRED TREATMENT VOLUME (DCV) (cu-ft)	PROVIDE INFILTRATION VOLUME (cu-ft)
DMA-1	19.71	0.90	8.94	22,780	25,520

FloGard®+PLUS Catch Basin Insert Filter

SCALE : 1"=100'

DAVID EVANS AND ASSOCIATES INC.

25152 Springfield Court Suite 350
Santa Clarita California 91355-1096
Phone: 661.284.7400

PREPARED UNDER THE SUPERVISION OF:

BRET JENSEN THORPE R.C.E. NO. 82754 DATE

IN THE CITY OF VICTORVILLE, CA

TENTATIVE TRACT NO. 20280

POST-DEVELOPMENT CONDITION

WQMP EXHIBIT

DRAWN BY: H.Z.

DESIGNED BY: H.Z.

CHECKED BY: B.T.

SCALE: 1"=100'

DATE: 07/01/2019

SHT NO.: 1 OF 1