Preliminary Water Quality Management Plan

For:

Redlands City Center

212 & 213 Brookside Avenue

CRA xxxx

(APN 0171-211-11 through -21, -25 & 0171-101-01 through -05)

Prepared for:

Mr. Tom Robinson

VantageOne Real Estate Investments, LLC

4 Corporate Plaza, Suite 210

Newport Beach, CA 92660

(949)-903-3818

Prepared by:

Hicks & Hartwick, Inc.

37 E Olive Ave. STE C

Redlands, CA 92373

(909)-793-2257

Job No. 10160

Approval Date: To be Determined

HICKS & HARTWICK, INC.
ENGINEERS & SURVEYORS
ESTABLISHED 1902

Project Owner's Certification

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

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

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Project Data

Permit/Application Number(s):	CRA xxxx	Grading Permit Number(s):	
Tract/Parcel Map Number(s):	PM xxxxx	Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			**APN 0171-211-13 through -21, -25 & 0171-101-01 through 05**

Owner's Signature

Owner Name: VantageOne Real Estate Investments, LLC   Contact: Tom Robinson

Title	Owner		
Company	VantageOne Real Estate Investments, LLC		
Address	4 Corporate Plaza, Suite 210, Newport Beach, CA 92660		
Email	tom@vinvest.com		
Telephone #	(949) 903-3818		
Signature		Date	

Preparer's Certification

Project Data

Permit/Application Number(s):	**CRA xxxx**	Grading Permit Number(s):	
Tract/Parcel Map Number(s):	PM xxxxx	Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			**APN 0171-211-13 through -21, -25 & 0171-101-01 through 05**

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

Engineer: Matthew C. Hicks	
Title	Principal
Company	Hicks & Hartwick, Inc.
Address	37 E Olive Ave STE C Redlands, CA 92372
Email	matt@verycivil.com
Telephone #	909-793-2257
Signature	Matt C. Hicks
Date	**08/19/2019**

PE Stamp Below

REGISTERED PROFESSIONAL ENGINEER
MATTHEW C. HICKS
No. 63494
CIVIL
STATE OF CALIFORNIA

Table of Contents

Forms

Section 1 Discretionary Permit(s)

Form 1-1 Project Information

<table>
<tr><td colspan="2">Project Name</td><td colspan="4">Redlands City Center</td></tr>
<tr><td colspan="2">Project Owner Contact Name:</td><td colspan="4">VantageOne Real Estate Investments, LLC – Mr. Tom Robinson</td></tr>
<tr><td>Mailing Address:</td><td>4 Corporate Plaza, Suite 210,
Newport Beach, CA 92660</td><td>E-mail Address:</td><td>tom@vinvest.com</td><td>Telephone:</td><td>(949) 903-3818</td></tr>
<tr><td colspan="2">Permit/Application Number(s):</td><td colspan="2">**CRA xxxx**</td><td>Tract/Parcel Map Number(s):</td><td>**PM xxxxx**</td></tr>
<tr><td colspan="2">Additional Information/ Comments:</td><td colspan="4"></td></tr>
<tr><td colspan="2">Description of Project:</td><td colspan="4">The Redlands City Center project is a mixed-use multi-family residential and restaurant project comprised of one 135-unit 6-story (4 over 2 parking) apartment building and 3 small restaurants with approximately 289 parking spaces. The buildings will be constructed at the northwest corner of Brookside Avenue and North Eureka Street and will replace the former City of Redlands Safety Hall and County of San Bernardino Health Services buildings that formerly occupied the site.

The project is considered a significant re-development project that will replace more than 5,000 sf of impervious site area on an already developed site and is therefore categorized as a Category 1 Priority Project type as defined by the County of San Bernardino's Technical Guidance Document for Water Quality Management Plans. Site drainage will be from building roof or parking lot run-off that will sheet flow to gutter locations that terminate at catch basins located at gutter low points. The catch basins are located at project site low points adjacent to adjoining public streets. Any drainage run-off overflow from these low points leaving the site will be directly into either Citrus Avenue or North Eureka Street and drain to catch basins located on Citrus Avenue or State Street. These catch basins connect to storm drain systems that terminate in the Morrey Arroyo located just north of the site on the north side of State Street. The Morrey Arroyo connects downstream to the Mission Channel that is tributary to the Santa Ana River. The downstream outlet of this segment of the Santa Ana River is the Prado Basin Dam.

The site is within soil group B indicating infiltration feasibility. Infiltration testing of the site indicates suitable infiltration rates at shallow depths. The full LID DCV and HCOC requirements will be handled by underground HDPE storage systems located within the parking lot drive aisles at project entry and exit locations on Citrus Avenue and North Eureka Street.</td></tr>
<tr><td colspan="2">Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.</td><td colspan="4">**N/A FOR PRELIMINARY WQMP**</td></tr>
</table>

Section 2 Project Description

2.1 Project Information

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

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

Form 2.1-1 Description of Proposed Project

[1] Development Category (Select all that apply):

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

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

[2] Project Area (ft2):	131,798	[3] Number of Dwelling Units:	135	[4] SIC Code:	5812/722511

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

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

2.2 Property Ownership/Management

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

Form 2.2-1 Property Ownership/Management

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

The Redlands City Center is privately owned and operated. The property owner will manage and maintain the WQMP storm water facilities. No infrastructure will transfer to public agencies.

2.3 Potential Stormwater Pollutants

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

Form 2.3-1 Pollutants of Concern

Pollutant	Please check: E=Expected, N=Not Expected		Additional Information and Comments
Pathogens (Bacterial / Virus)	E ☒	N ☐	
Nutrients - Phosphorous	E ☒	N ☐	
Nutrients - Nitrogen	E ☒	N ☐	
Noxious Aquatic Plants	E ☒	N ☐	
Sediment	E ☒	N ☐	
Metals	E ☒	N ☐	
Oil and Grease	E ☒	N ☐	
Trash/Debris	E ☒	N ☐	
Pesticides / Herbicides	E ☒	N ☐	
Organic Compounds	E ☒	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	

2.4 Water Quality Credits

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

Form 2.4-1 Water Quality Credits

1 Project Types that Qualify for Water Quality Credits: *Select all that apply*			
☐ Redevelopment projects that reduce the overall impervious footprint of the project site. [Credit = % impervious reduced] Current= - SF New= - SF Credit=0%	Higher density development projects ☐Vertical density [20%] ☐7 units/ acre [5%]	☐ Mixed use development, (combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that demonstrate environmental benefits not realized through single use projects) [20%]	☐Brownfield redevelopment (redevelop real property complicated by presence or potential of hazardous contaminants) [25%]
☐ Redevelopment projects in established historic district, historic preservation area, or similar significant core city center areas [10%]	☐ Transit-oriented developments (mixed use residential or commercial area designed to maximize access to public transportation) [20%]	☐ In-fill projects (conversion of empty lots & other underused spaces < 5 acres, substantially surrounded by urban land uses, into more beneficially used spaces, such as residential or commercial areas) [10%]	☐ Live-Work developments (variety of developments designed to support residential and vocational needs) [20%]
2 Total Credit 0% *(Total all credit percentages up to a maximum allowable credit of 50 percent)*			
Description of Water Quality Credit Eligibility (if applicable)	N/A		

Section 3 Site and Watershed Description

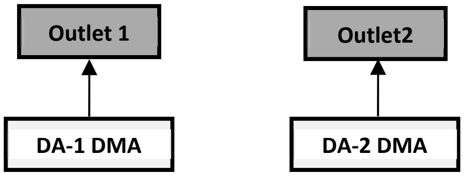
Describe the project site conditions that will facilitate the selection of BMP through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and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

Form 3-1 Site Location and Hydrologic Features

Site coordinates *take GPS measurement at approximate center of site*	Latitude 34.055537°	Longitude -117.186614°	Thomas Bros Map page 648

1 San Bernardino County climatic region: ☒ Valley ☐ Mountain

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



Example only – modify for project specific WQMP using additional form

Conveyance	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA
DA-1 DMA A flows to Outlet 1	Project flows from the apartment complex building and adjacent parking lot and drive aisles will sheet flow to gutters at the perimeter of the site. Drain inlets located at low points in the gutters will capture runoff and route drainage to a proposed underground infiltration storage system. Any overflow from DA-1 will outlet across landscape planters into Citrus Avenue.
DA-2 DMA A flows to Outlet 2	Project flows from DA-2 are primarily from the restaurant buildings and plaza area that will be collected in roof or building deck drains that connect to an underground infiltration system through a storm drain system. Additional run-off from adjacent planter and parking areas in DA-2 will also connect to the infiltration system. Any overflow from DA-2 will outlet across landscape planters into North Eureka Street.

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)	88,867			
2 Existing site impervious area (ft^2)	73,709			
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	II			
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	B			
5 Longest flowpath length (ft)	396			
6 Longest flowpath slope (ft/ft)	.0359			
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Commercial Landscaping			
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*	good			

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 2

For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA	DMA	DMA
1 DMA drainage area (ft²)	41,760			
2 Existing site impervious area (ft²)	21,658			
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	II			
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	B			
5 Longest flowpath length (ft)	139			
6 Longest flowpath slope (ft/ft)	.0625			
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Commercial Landscaping			
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*	Good			

NOTE: THE FOLLOWING SITE PHOTOS WERE TAKEN AFTER DEMOLITION OF THE SITE BUILDINGS AND PARKING LOT. REFER TO PROJECT TOPOGRAPHY FOR EXISTING SITE CONDITIONS USED AS THE BASIS FOR ANALYZING EXISTING HYDROLOGIC CHARACTERISTICS OF THE SITE.

Photo 1: On Citrus Avenue at the northwest corner of project site looking easterly along north property line and right of way.

Photo 2: On Brookside Avenue at southwest corner of site looking northerly along the west property line.

Photo 3: At Brookside Avenue/Eureka Street intersection looking westerly along south property line and right of way.

Photo 4: At Brookside Avenue/Eureka Street intersection looking northerly along east property line and right of way.

Photo 5: On Eureka Street at northeast corner of project site looking west along north property line.

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

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

Form 3-3 Watershed Description for Drainage Area

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

Section 4 Best Management Practices (BMP)

4.1 Source Control BMP

4.1.1 Pollution Prevention

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

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

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N1	Education of Property Owners, Tenants and Occupants on Stormwater BMPs	☒	☐	The project owner will provide water quality training for all employees of this project. The training shall be based on this WQMP and educational materials supplied herein. Initial training shall occur within six months of employment and shall be refreshed on a yearly basis.
N2	Activity Restrictions	☒	☐	All activities are restricted for which there isn't an appropriate BMP provided for in this WQMP.
N3	Landscape Management BMPs	☒	☐	Landscape Maintenance will shall be in accordance with SC-73 attached under the BMP section 6.4. This BMP applies to all landscaping, medians, parking islands and planter boxes.
N4	BMP Maintenance	☒	☐	The project owner will be responsible for BMP maintenance which includes regularly scheduled cleaning and repair of BMPs, and replacement when needed.
N5	Title 22 CCR Compliance (How development will comply)	☒	☐	The project owner and employees must comply with City of Redlands ordinances for Hazardous waste and waste disposal. The City of Redlands through the Fire Department provides for hazardous waste collection. The project owner and employees shall comply by using this facility to dispose of all leftover pesticides, fertilizers, herbicides, oil, paints, antifreeze, batteries, corrosives and flammables. Alternate approved sites for disposal are available. See the San Bernardino County stormwater website for additional disposal locations. Additionally, there are educational material covering hazardous waste covered under N1. The current educational materials are attached to this WQMP.
N6	Local Water Quality Ordinances	☒	☐	The Project must comply with any applicable local water quality ordinances. The local jurisdiction (City of Redlands), under local water quality ordinances (Ord. 13.54), have authority to ensure clean stormwater discharges from areas of concern to public properties.
N7	Spill Contingency Plan	☐	☒	There are no hazardous materials to be stored on-site.

Form 4.1-1 Non-Structural Source Control BMPs

N8	Underground Storage Tank Compliance	☐	☒	No underground storage tanks on this site.
N9	Hazardous Materials Disclosure Compliance	☐	☒	There are no hazardous materials to be stored on-site.

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	☐	☒	Fire Code compliance with Article 80 of the Uniform Fire Code is enforced by the City of Redlands Fire department and generally applies to commercial sites where significant amounts of hazardous materials may be stored. The storage of this amount of hazardous materials is not anticipated for the museum project and therefore not applicable.
N11	Litter/Debris Control Program	☒	☐	The project owner will be responsible for contracting with a landscape maintenance company or hiring a groundskeeper to provide litter and debris control on the property limits.
N12	Employee Training	☒	☐	The project owner will provide water quality training for all employees of this project. The training shall be based on this WQMP and educational materials supplied herein. Initial training shall occur within six months of employment and shall be refreshed on a yearly basis.
N13	Housekeeping of Loading Docks	☐	☒	There are no onsite loading docks.
N14	Catch Basin Inspection Program	☒	☐	The project owner is required to have the drainage facilities inspected, cleaned and maintained on a semi-annual basis. Cleaning shall take place in the late summer/early

				fall prior to the start of the rainy season and mid-winter during the rainy season. Drainage facilities include all catch basins (storm drain inlets) on site.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	The project owner shall have the project parking and drive areas swept on a regular frequency based on usage and field observations of waste accumulation, using a vacuum assisted sweeper.
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	This is not a public agency project.
N17	Comply with all other applicable NPDES permits	☒	☐	A SWPPP will be prepared for construction activities and a notice of intent will be filed with the State Water Resources Control Board.

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)	☒	☐	Signage notices regarding discharge prohibitions will be placed at storm drain inlets to eliminate or reduce dumping and littering. The phrase “No Dumping – Drains to River,” or an equally effective phrase as approved by the City of Redlands, will be stenciled on catch basins (inlets) to alert the public as to the destination of pollutants discharged into storm drains. The stencil shall be blue on a white background with lettering 2-1/2” in height or a catch basin curb marker, circular or rectangular, at least 4” in height or diameter may be used. This signage will be maintained by the owner. This project site will include storm drain signage implemented consistent with BMP SD-13 (Reference SD-13 attached under the BMP section 6.4B). The above phrase has been approved by the City of Redlands.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	There will be no outdoor material storage on this site.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	The trash and waste storage areas will be walled to prevent off-site transport of trash. The trash enclosure will have a roof or awning cover with fixed lids attached to the trash containers. They are located to avoid drainage run-on from the project site and no storm drain systems are in the immediate vicinity of the storage area.
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 methods will be utilized to minimize runoff of excess irrigation water across impervious surfaces and into the storm water conveyance system. Such measures shall include employing rain-triggered shutoff devices to eliminate or reduce irrigation during and immediately after precipitation, using mulches (such as wood chips) to minimize sediment in runoff and to maintain soil infiltration capacity, and coordinating design of the irrigation system and landscape to minimize overspray and runoff. Irrigation systems shall flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or water supply lines. Water conservation devices such as programmable irrigation timers and soil moisture sensors shall be used. This project will be designed for efficient irrigation by implementation of BMP SD-12. Reference SD-12 attached under the BMP section 6.4B.

S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	All planter areas of the site shall be finish-graded at a minimum of 1-2 inches below top of curb or sidewalk for increased retention/infiltration of stormwater and irrigation water.
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☒	☐	Energy dissipaters (riprap or concrete pad) are provided at roof drain outlet locations.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	There will be no covered dock areas on this site.
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	There will be no maintenance bays on this site.
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	There will be no vehicle wash areas on this site
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	There are no outdoor processing areas.
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	None on this site.
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	None on this site.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	None on this site.
S14	Wash water control for food preparation areas	☒	☐	Restaurant kitchens will be equipped with sinks connected to the plumbing system with outlet to the sanitary sewer system for disposal of wash waters containing kitchen and food wastes.
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	None on this site.

4.1.2 Preventative LID Site Design Practices

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

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

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

Form 4.1-3 Preventative LID Site Design Practices Checklist

Site Design Practices

If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets

Minimize impervious areas: Yes ☒ No ☐

Explanation: Site design practices are used to maximize the retention of existing pervious areas that would potentially be impervious if said practices were not implemented, thereby minimizing the addition of new impervious areas. The following site design practices will be implemented to minimize addition of impervious area to the site:

- The minimum amount of required parking spaces allowed by City code and a parking garage within the apartment building footprint are being used to provide a smaller parking lot area.

Maximize natural infiltration capacity: Yes ☒ No ☐

Explanation: The areas around the perimeter of the proposed buildings and parking lots will remain as landscape planter areas and lowered to a minimum of 1” below the existing sidewalk and parking lot grades to maximize the potential for infiltration.

Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐

Explanation: The project maintains the existing site drainage pattern and the use of underground infiltration is intended to preserve the existing time of concentration that typically decreases due to the addition of impervious site area.

Disconnect impervious areas: Yes ☒ No ☐

Explanation: The project is proposing to direct runoff from some of the building roof drains and project walkways to planter areas before connecting to gutters or drain inlets that drain to the proposed underground infiltration system.

Protect existing vegetation and sensitive areas: Yes ☐ No ☒

Explanation: There are no existing vegetative or sensitive areas on this site.

Re-vegetate disturbed areas: Yes ☒ No ☐

Explanation: All disturbed areas without impervious construction will be revegetated.

Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☐ No ☒

Explanation: There are no proposed basins on this project and proposed infiltration for this site will occur at depths beyond what is anticipated to be influenced by compaction of construction equipment.

Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes ☒ No ☐

Explanation: Vegetated drainage swales will be used along the back of sidewalk on Brookside Ave. and Eureka St. in lieu of using an impervious lined swale or piping system. No BMP credit is proposed for this use however the swales will be planted.

Stake off areas that will be used for landscaping to minimize compaction during construction: Yes ☐ No ☒
Explanation: Due to the limited footprint of the proposed landscaping areas it is anticipated that the entire site will be subject to construction equipment compaction and staking the landscape areas off would be infeasible for this project.

4.2 Project Performance Criteria

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

Methods applied in the following forms include:

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

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

<table>
<tr><th colspan="3">Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1)</th></tr>
<tr><td>1 Project area DA 1 (ft^2):
103,792</td><td>2 Imperviousness after applying preventative site design practices (Imp%): 90.66%</td><td>3 Runoff Coefficient (Rc): 0.74
<i>$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$</i></td></tr>
<tr><td colspan="3">4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr-1hr}$ (in): 0.464 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html</td></tr>
<tr><td colspan="3">5 Compute P_6, Mean 6-hr Precipitation (inches): 0.69
<i>P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)</i></td></tr>
<tr><td colspan="2">6 Drawdown Rate
<i>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.</i></td><td>24-hrs ☐
48-hrs ☒</td></tr>
<tr><td colspan="3">7 Compute design capture volume, DCV (ft^3): 8,631
<i>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)</i>
<i>Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2</i></td></tr>
</table>

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA-2)

1 Project area DA 1 (ft^2): 26,835	**2** Imperviousness after applying preventative site design practices (Imp%): 93.02%	**3** Runoff Coefficient (Rc): 0.78 *$R_c = 0.858(Imp\%)^{\wedge 3} - 0.78(Imp\%)^{\wedge 2} + 0.774(Imp\%) + 0.04$*

4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.464 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

5 Compute P_6, Mean 6-hr Precipitation (inches): 0.69

*P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)*

6 Drawdown Rate *Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.*	24-hrs ☐ 48-hrs ☒

7 Compute design capture volume, DCV (ft^3): 2,339

*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 HCOC Assessment (DA-1)

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

Go to: *http://sbcounty.permitrack.com/WAP*

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

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

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

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** 10,143 *Form 4.2-3 Item 12*	**2** 6.5 *Form 4.2-4 Item 13*	**3** 3.54 *Form 4.2-5 Item 10*
Post-developed	**4** 12,563 *Form 4.2-3 Item 13*	**5** 7.4 *Form 4.2-4 Item 14*	**6** 3.70 *Form 4.2-5 Item 14*
Difference	**7** 2,420 *Item 4 – Item 1*	**8** *-0.9* *Item 2 – Item 5*	**9** *0.16* *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** *23.9%* *Item 7 / Item 1*	**11** *-13.8%* *Item 8 / Item 2*	**12** *4.5%* *Item 9 / Item 3*

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

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

Go to: *http://sbcounty.permitrack.com/WAP*

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

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

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

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** 1,942 *Form 4.2-3 Item 12*	**2** 5.0 *Form 4.2-4 Item 13*	**3** 1.42 *Form 4.2-5 Item 10*
Post-developed	**4** 3,444 *Form 4.2-3 Item 13*	**5** 7.0 *Form 4.2-4 Item 14*	**6** 1.29 *Form 4.2-5 Item 14*
Difference	**7** *1,502* *Item 4 – Item 1*	**8** *-2.0* *Item 2 – Item 5*	**9** *-0.13* *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** *77.3%* *Item 7 / Item 1*	**11** *-40.0%* *Item 8 / Item 2*	**12** *-9.2%* *Item 9 / Item 3*

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

Weighted Curve Number Determination for: Pre-developed DA	DMA A				DMA B	DMA C	DMA D
1a Land Cover type	Turf Poor Cover	Commercial Landscaping	Commercial	Turf Good Cover			
2a Hydrologic Soil Group (HSG)	B	B	B	B			
3a DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	8,712	6,534	73,621	0			
4a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	78	56	98	58			
Weighted Curve Number Determination for: Post-developed DA	DMA A				DMA B	DMA C	DMA D
1b Land Cover type	Turf Poor Cover	Commercial Landscaping	Commercial	Turf Good Cover			
2b Hydrologic Soil Group (HSG)	B	B	B	B			
3b DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	0	9,583	94,090	0			
4b Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	78	56	98	58			

5 Pre-Developed area-weighted CN: 93

7 Pre-developed soil storage capacity, S (in): 0.75
S = (1000 / Item 5) - 10

9 Initial abstraction, I_a (in): 0.15
*I_a = 0.2 * Item 7*

6 Post-Developed area-weighted CN: 94

8 Post-developed soil storage capacity, S (in): 0.64
S = (1000 / Item 6) - 10

10 Initial abstraction, I_a (in): 0.13
*I_a = 0.2 * Item 8*

11 Precipitation for 2 yr, 24 hr storm (in): 2.06
Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

12 Pre-developed Volume (ft^3): 10,143
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*

13 Post-developed Volume (ft^3): 12,563
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*

14 Volume Reduction needed to meet HCOC Requirement, (ft^3): 1,793
*V_{HCOC} = (Item 13 * 0.95) – Item 12*

Form 4.2-3 HCOC Assessment for Runoff Volume (DA-2)

Weighted Curve Number Determination for: Pre-developed DA	DMA A				DMA B	DMA C	DMA D
1a Land Cover type	Grass Poor Cover	Commercial Landscaping	Commercial	Turf Good Cover			
2a Hydrologic Soil Group (HSG)	B	B	B	B			
3a DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	0	1,057	21,657	19,046			
4a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	78	56	98	58			
Weighted Curve Number Determination for: Post-developed DA	DMA A				DMA B	DMA C	DMA D
1b Land Cover type	Grass Poor Cover	Commercial Landscaping	Commercial	Turf Good Cover			
2b Hydrologic Soil Group (HSG)	B	B	B	B			
3b DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	0	1,874	24,961	0			
4b Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	78	56	98	58			

5 Pre-Developed area-weighted CN: 79

7 Pre-developed soil storage capacity, S (in): 2.66
S = (1000 / Item 5) - 10

9 Initial abstraction, I_a (in): 0.53
$I_a = 0.2 * \text{Item } 7$

6 Post-Developed area-weighted CN: 95

8 Post-developed soil storage capacity, S (in): 0.53
S = (1000 / Item 6) - 10

10 Initial abstraction, I_a (in): 0.11
$I_a = 0.2 * \text{Item } 8$

11 Precipitation for 2 yr, 24 hr storm (in): 2.06
Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

12 Pre-developed Volume (ft^3): 1,942
V_{pre} *=(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*

13 Post-developed Volume (ft^3): 3,444
V_{pre} *=(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*

14 Volume Reduction needed to meet HCOC Requirement, (ft^3): 1,330
V_{HCOC} *= (Item 13 * 0.95) – Item 12*

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

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

Variables	Pre-developed DA1 *Use additional forms if there are more than 4 DMA*				Post-developed DA1 *Use additional forms if there are more than 4 DMA*			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*	396				483			
2 Change in elevation (ft)	14.2				15.1			
3 Slope (ft/ft), S_o *= Item 2 / Item 1*	.036				.031			
4 Land cover	Commercial				Commercial			
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*	6.5				7.4			
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*	0				0			
7 Cross-sectional area of channel (ft^2)	N/A				N/A	-		
8 Wetted perimeter of channel (ft)	N/A				N/A	-		
9 Manning's roughness of channel (n)	N/A				N/A	-		
10 Channel flow velocity (ft/sec) V_{fps} *= (1.49 / Item 9) * (Item 7/Item 8)*$^{\wedge 0.67}$ ** (Item 3)*$^{\wedge 0.5}$	N/A				N/A	-		
11 Travel time to outlet (min) T_t *= Item 6 / (Item 10 * 60)*	N/A				N/A	-		
12 Total time of concentration (min) T_c *= Item 5 + Item 11*	N/A				N/A			

13 Pre-developed time of concentration (min): 6.5 *Minimum of Item 12 pre-developed DMA*

14 Post-developed time of concentration (min): 7.4 *Minimum of Item 12 post-developed DMA*

15 Additional time of concentration needed to meet HCOC requirement (min): -1.2 $T_{C\text{-}HCOC}$ *= (Item 13 * 0.95) – Item 14*

Form 4.2-4 HCOC Assessment for Time of Concentration (DA 2)

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

Variables	Pre-developed DA2 *Use additional forms if there are more than 4 DMA*				Post-developed DA2 *Use additional forms if there are more than 4 DMA*			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*	139				363			
2 Change in elevation (ft)	2.7				7.8			
3 Slope (ft/ft), S_o *= Item 2 / Item 1*	.019				.021			
4 Land cover	Commercial				Commercial			
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*	5.0				7.0			
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*	0				0			
7 Cross-sectional area of channel (ft^2)	N/A				N/A	-		
8 Wetted perimeter of channel (ft)	N/A				N/A	-		
9 Manning's roughness of channel (n)	N/A				N/A	-		
10 Channel flow velocity (ft/sec) V_{fps} *= (1.49 / Item 9) * (Item 7/Item 8)^0.67 * (Item 3)^0.5*	N/A				N/A	-		
11 Travel time to outlet (min) T_t *= Item 6 / (Item 10 * 60)*	N/A				N/A	-		
12 Total time of concentration (min) T_c *= Item 5 + Item 11*	N/A				N/A			

13 Pre-developed time of concentration (min): 5.0 *Minimum of Item 12 pre-developed DMA*

14 Post-developed time of concentration (min): 7.0 *Minimum of Item 12 post-developed DMA*

15 Additional time of concentration needed to meet HCOC requirement (min): -2.3 $T_{C\text{-}HCOC}$ *= (Item 13 * 0.95) – Item 14*

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

Compute peak runoff for pre- and post-developed conditions

Variables		Pre-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*			Post-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*		
		DMA A	DMA B	DMA C	DMA A	DMA B	DMA C
1 Rainfall Intensity for storm duration equal to time of concentration *I_{peak} = 10^(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 /60)*		2.00			1.79		
2 Drainage Area of each DMA (Acres) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		2.04			2.38		
3 Ratio of pervious area to total area *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.17			0.09		
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*		0.42			0.74		
5 Maximum loss rate (in/hr) *F_m = Item 3 * Item 4* *Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.07			0.07		
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		3.54			3.70		
7 Time of concentration adjustment factor for other DMA to site discharge point *Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)*	DMA A	*n/a*			*n/a*		
	DMA B		*n/a*			*n/a*	
	DMA C			*n/a*			*n/a*

8 Pre-developed Q_p at T_c for DMA A: 3.54 *Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAA/2}$] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAA/3}$]*	9 Pre-developed Q_p at T_c for DMA B: *Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAB/1}$] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAB/3}$]*	10 Pre-developed Q_p at T_c for DMA C: *Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAC/1}$] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAC/2}$]*

10 Peak runoff from pre-developed condition confluence analysis (cfs): 3.54 *Maximum of Item 8, 9, and 10 (including additional forms as needed)*

11 Post-developed Q_p at T_c for DMA A: 3.70 *Same as Item 8 for post-developed values*	12 Post-developed Q_p at T_c for DMA B: *Same as Item 9 for post-developed values*	13 Post-developed Q_p at T_c for DMA C: *Same as Item 10 for post-developed values*

14 Peak runoff from post-developed condition confluence analysis (cfs): 3.70 *Maximum of Item 11, 12, and 13 (including additional forms as needed)*

15 Peak runoff reduction needed to meet HCOC Requirement (cfs): -0.03 *Q_{p-HCOC} = (Item 14 * 0.95) – Item 10*

Form 4.2-5 HCOC Assessment for Peak Runoff (DA 2)

Compute peak runoff for pre- and post-developed conditions

Variables		Pre-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*			Post-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*		
		DMA A	DMA B	DMA C	DMA A	DMA B	DMA C
1 Rainfall Intensity for storm duration equal to time of concentration *I_{peak} = 10^(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 /60)*		1.99			2.36		
2 Drainage Area of each DMA (Acres) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.96			0.62		
3 Ratio of pervious area to total area *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.48			0.06		
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*		0.72			0.74		
5 Maximum loss rate (in/hr) *F_m = Item 3 * Item 4* *Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.35			0.04		
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		1.42			1.29		
7 Time of concentration adjustment factor for other DMA to site discharge point *Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)*	DMA A	*n/a*			*n/a*		
	DMA B		*n/a*			*n/a*	
	DMA C			*n/a*			*n/a*

8 Pre-developed Q_p at T_c for DMA A: 1.42 *Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAA/2}$] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAA/3}$]*	9 Pre-developed Q_p at T_c for DMA B: *Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAB/1}$] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAB/3}$]*	10 Pre-developed Q_p at T_c for DMA C: *Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAC/1}$] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAC/2}$]*

10 Peak runoff from pre-developed condition confluence analysis (cfs): 1.42 *Maximum of Item 8, 9, and 10 (including additional forms as needed)*

11 Post-developed Q_p at T_c for DMA A: 1.29 *Same as Item 8 for post-developed values*	12 Post-developed Q_p at T_c for DMA B: *Same as Item 9 for post-developed values*	13 Post-developed Q_p at T_c for DMA C: *Same as Item 10 for post-developed values*

14 Peak runoff from post-developed condition confluence analysis (cfs): 1.29 *Maximum of Item 11, 12, and 13 (including additional forms as needed)*

15 Peak runoff reduction needed to meet HCOC Requirement (cfs): -0.20 *Q_{p-HCOC} = (Item 14 * 0.95) – Item 10*

4.3 Project Conformance Analysis

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

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

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

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

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

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

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

Form 4.3-1 Infiltration BMP Feasibility (DA 1)

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

[1] Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☐ No ☒

Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach)

[2] Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☐ No ☒

(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

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

If Yes, Provide basis: (attach)

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

If Yes, Provide basis: (attach)

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

If Yes, Provide basis: (attach)

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

If Yes, Provide basis: (see infiltration testing results in appendix)

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

See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

[7] Any answer from Item 1 through Item 3 is "Yes": Yes ☐ No ☒

If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 8 below.

[8] Any answer from Item 4 through Item 6 is "Yes": Yes ☐ No ☒

If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Hydrologic Source Control BMP.
If no, then proceed to Item 9, below.

[9] All answers to Item 1 through Item 6 are "No":

Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.
Proceed to Form 4.3-2, Hydrologic Source Control BMP.

Form 4.3-1 Infiltration BMP Feasibility (DA 2)

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

1 Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☐ No ☒

Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach)

2 Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☐ No ☒

(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

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

If Yes, Provide basis:

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: (see infiltration testing results in appendix)

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

See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

7 Any answer from Item 1 through Item 3 is "Yes": Yes ☐ No ☒

If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 8 below.

8 Any answer from Item 4 through Item 6 is "Yes": Yes ☐ No ☒

If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Hydrologic Source Control BMP.
If no, then proceed to Item 9, below.

9 All answers to Item 1 through Item 6 are "No":

Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.
Proceed to Form 4.3-2, Hydrologic Source Control BMP.

4.3.1 Site Design Hydrologic Source Control BMP

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

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

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

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

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

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

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 Impervious Area Dispersion	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Total impervious area draining to pervious area (ft^2)			
3 Ratio of pervious area receiving runoff to impervious area			
4 Retention volume achieved from impervious area dispersion (ft^3) *V = Item2 * Item 3 * (0.5/12), assuming retention of 0.5 inches of runoff*			

5 Sum of retention volume achieved from impervious area dispersion (ft^3): 0 $V_{retention}$ =*Sum of Item 4 for all BMPs*

6 Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☒ *If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
7 Ponding surface area (ft^2)			
8 Ponding depth (ft)			
9 Surface area of amended soil/gravel (ft^2)			
10 Average depth of amended soil/gravel (ft)			
11 Average porosity of amended soil/gravel			
12 Retention volume achieved from on-lot infiltration (ft^3) $V_{retention}$ = *(Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)*			

13 Runoff volume retention from on-lot infiltration (ft^3): 0 $V_{retention}$ =*Sum of Item 12 for all BMPs*

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

14 Implementation of evapotranspiration BMP (green, brown, or blue roofs): Yes ☐ No ☒ *If yes, complete Items 15-20. If no, proceed to Item 21*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
15 Rooftop area planned for ET BMP (ft^2)			
16 Average wet season ET demand (in/day) *Use local values, typical ~ 0.1*			
17 Daily ET demand (ft^3/day) *Item 15 * (Item 16 / 12)*			
18 Drawdown time (hrs) *Copy Item 6 in Form 4.2-1*			
19 Retention Volume (ft^3) $V_{retention}$ *= Item 17 * (Item 18 / 24)*			

20 Runoff volume retention from evapotranspiration BMPs (ft^3): 0 $V_{retention}$ *=Sum of Item 19 for all BMPs*

21 Implementation of Street Trees: Yes ☐ No ☒ *If yes, complete Items 22-25. If no, proceed to Item 26*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
22 Number of Street Trees			
23 Average canopy cover over impervious area (ft^2)			
24 Runoff volume retention from street trees (ft^3) $V_{retention}$ *= Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches*			

25 Runoff volume retention from street tree BMPs (ft^3): 0 $V_{retention}$ *= Sum of Item 24 for all BMPs*

26 Implementation of residential rain barrel/cisterns: Yes ☐ No ☒ *If yes, complete Items 27-29; If no, proceed to Item 30*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
27 Number of rain barrels/cisterns			
28 Runoff volume retention from rain barrels/cisterns (ft^3) $V_{retention}$ *= Item 27 * 3*			

29 Runoff volume retention from residential rain barrels/Cisterns (ft3): 0 $V_{retention}$ *=Sum of Item 28 for all BMPs*

30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: 0 *Sum of Items 5, 13, 20, 25 and 29*

4.3.2 Infiltration BMPs

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

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

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

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

1 Remaining LID DCV not met by site design HSC BMP (ft^3): *V_{unmet} = 8,631 Form 4.2-1 Item 7 - Form 4.3-2 Item 30*

BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs*	DA 1 DMA A BMP Type (Underground Infiltration)	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods*	0.90		
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*	2.5		
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*	0.36		
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*	72		
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*	2.16		
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*	2.16		
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*	-		
9 Amended soil depth, *d_{media}* (ft) *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*	0		
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))]*	0		
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*	8,746		

16 Total Retention Volume from LID Infiltration BMPs: *8,746 (Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 101.33% *Retention% = Item 16 / Form 4.2-1 Item 7*

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

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

Form 4.3-3 Infiltration LID BMP - including underground BMPs (DA-2)

1 Remaining LID DCV not met by site design HSC BMP (ft^3): *V_{unmet} =2,339 Form 4.2-1 Item 7 - Form 4.3-2 Item 30*

BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs*	DA 2 DMA A BMP Type (Underground Infiltration)	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods*	0.90		
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*	2.5		
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*	0.36		
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*	72		
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*	2.16		
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*	2.16		
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*	-		
9 Amended soil depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*	0		
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))]*	0		
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*	2,357		

16 Total Retention Volume from LID Infiltration BMPs: 2,357 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 100.77% *Retention% = Item 16 / Form 4.2-1 Item 7*

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

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

4.3.3 Harvest and Use BMP

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

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

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

1 Remaining LID DCV not met by site design HSC or infiltration BMP (ft^3): 0 V_{unmet} = *Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16*			
BMP Type(s) *Compute runoff volume retention from proposed harvest and use BMP (Select BMPs from Table 5-4 of the TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Describe cistern or runoff detention facility			
3 Storage volume for proposed detention type (ft^3) *Volume of cistern*			
4 Landscaped area planned for use of harvested stormwater (ft^2)			
5 Average wet season daily irrigation demand (in/day) Use local values, typical ~ 0.1 in/day			
6 Daily water demand (ft^3/day) *Item 4 * (Item 5 / 12)*			
7 Drawdown time (hrs) *Copy Item 6 from Form 4.2-1*			
8 Retention Volume (ft^3) $V_{retention}$ = *Minimum of (Item 3) or (Item 6 * (Item 7 / 24))*			
9 Total Retention Volume (ft^3) from Harvest and Use BMP 0 *Sum of Item 8 for all harvest and use BMP included in plan*			
10 Is the full DCV retained with a combination of LID HSC, retention and infiltration, and harvest and use BMPs? Yes ☐ No ☐ *If yes, demonstrate conformance using Form 4.3-10. If no, then re-evaluate combinations of all LID BMP and optimize their implementation such that the maximum portion of the DCV is retained on-site (using a single BMP type or combination of BMP types). If the full DCV cannot be mitigated after this optimization process, proceed to Section 4.3.4.*			

4.3.4 Biotreatment BMP

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

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

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

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

1 Remaining LID DCV not met by site design HSC, infiltration, or harvest and use BMP for potential biotreatment (ft^3): 0 *Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9*

List pollutants of concern *Copy from Form 2.3-1.*
Pathogens (Bacterial / Virus), Nutrients – Phosphorous and Nitrogen, Noxious Aquatic Plants, Sediment, Metals, Oil and Grease, Trash/Debris, Pesticides / Herbicides, Organic Compounds

2 Biotreatment BMP Selected
(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)

Volume-based biotreatment
Use Forms 4.3-6 and 4.3-7 to compute treated volume
☐ Bioretention with underdrain
☐ Planter box with underdrain
☐ Constructed wetlands
☐ Wet extended detention
☐ Dry extended detention

Flow-based biotreatment
Use Form 4.3-8 to compute treated volume
☐ Vegetated swale
☐ Vegetated filter strip
☐ Proprietary biotreatment

3 Volume biotreated in volume based biotreatment BMP (ft^3): *Form 4.3-6 Item 15 + Form 4.3-7 Item 13*

4 Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft^3): *Item 1 – Item 3*

5 Remaining fraction of LID DCV for sizing flow based biotreatment BMP: % *Item 4 / Item 1*

6 Flow-based biotreatment BMP capacity provided (cfs): 0 *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)*

7 Metrics for MEP determination:

- Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.*

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

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

15 Total biotreated volume from bioretention and/or planter box with underdrains BMP: 0
Sum of Item 14 for all volume-based BMPs included in this form

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

Biotreatment BMP Type *Constructed wetlands, extended wet detention, extended dry detention, or other comparable proprietary BMP. If BMP includes multiple modules (e.g. forebay and main basin), provide separate estimates for storage and pollutants treated in each module.*	DA DMA BMP Type		DA DMA BMP Type *(Use additional forms for more BMPs)*	
	Forebay	Basin	Forebay	Basin
1 Pollutants addressed with BMP forebay and basin *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*				
2 Bottom width (ft)				
3 Bottom length (ft)				
4 Bottom area (ft^2) A_{bottom} *= Item 2 * Item 3*				
5 Side slope (ft/ft)				
6 Depth of storage (ft)				
7 Water surface area (ft^2) $A_{surface}$ *=(Item 2 + (2 * Item 5 * Item 6)) * (Item 3 + (2 * Item 5 * Item 6))*				
8 Storage volume (ft^3) *For BMP with a forebay, ensure fraction of total storage is within ranges specified in BMP specific fact sheets, see Table 5-6 of the TGD for WQMP for reference to BMP design details* V *=Item 6 / 3 * [Item 4 + Item 7 + (Item 4 * Item 7)^0.5]*				
9 Drawdown Time (hrs) *Copy Item 6 from Form 2.1*				
10 Outflow rate (cfs) Q_{BMP} *= (Item* $8_{forebay}$ *+ Item* 8_{basin}*) / (Item 9 * 3600)*				
11 Duration of design storm event (hrs)				
12 Biotreated Volume (ft^3) $V_{biotreated}$ *= (Item* $8_{forebay}$ *+ Item* 8_{basin}*) +(Item 10 * Item 11 * 3600)*				
13 Total biotreated volume from constructed wetlands, extended dry detention, or extended wet detention : 0 *(Sum of Item 12 for all BMP included in plan)*				

Form 4.3-8 Flow Based Biotreatment (DA 1)

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

4.3.5 Conformance Summary

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

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

1 Total LID DCV for the Project DA-1 (ft^3): 8,631 *Copy Item 7 in Form 4.2-1*

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

3 On-site retention with LID infiltration BMP (ft^3): 8,746 *Copy Item 16 in Form 4.3-3*

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

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

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

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

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

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

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

Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DA-2)

1 Total LID DCV for the Project DA-2 (ft^3): 2,339 *Copy Item 7 in Form 4.2-1*

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

3 On-site retention with LID infiltration BMP (ft^3): 2,343 *Copy Item 16 in Form 4.3-3*

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

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

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

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

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

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

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

4.3.6 Hydromodification Control BMP

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

Form 4.3-10 Hydromodification Control BMPs (DA 1)

1 Volume reduction needed for HCOC performance criteria (ft^3): 1,793 *(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1*	2 On-site retention with site design hydrologic source control, infiltration, and harvest and use LID BMP (ft^3): 8,746 *Sum of Form 4.3-9 Items 2, 3, and 4 Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving HCOC volume reduction*
3 Remaining volume for HCOC volume capture (ft^3): -6,953 *Item 1 – Item 2*	4 Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft^3): 0 *Existing downstream BMP may be used to demonstrate additional volume capture (if so, attach to this WQMP a hydrologic analysis showing how the additional volume would be retained during a 2-yr storm event for the regional watershed)*

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

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

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

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

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

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

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

Form 4.3-10 Hydromodification Control BMPs (DA 2)

1 Volume reduction needed for HCOC performance criteria (ft^3): 1,330 *(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1*	2 On-site retention with site design hydrologic source control, infiltration, and harvest and use LID BMP (ft^3): 2,343 *Sum of Form 4.3-9 Items 2, 3, and 4 Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving HCOC volume reduction*
3 Remaining volume for HCOC volume capture (ft^3): -1,013 *Item 1 – Item 2*	4 Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft^3): 0 *Existing downstream BMP may be used to demonstrate additional volume capture (if so, attach to this WQMP a hydrologic analysis showing how the additional volume would be retained during a 2-yr storm event for the regional watershed)*

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

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

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

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

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

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

- Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site or off-site retention BMPs ☐

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

4.4 Alternative Compliance Plan (if applicable)

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

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

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

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

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

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

BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
Education of Property Owners, Tenants and Occupants	Project Owner	Renew and update educational materials. Copies of current materials are provided in Section 6.4C. Download the latest educational material published by the County of San Bernardino and available on the County's website at: http://www.sbcountystormwater.org/agency.	Yearly
Activity Restrictions	Project Owner	Project owner to review activity restrictions identified in City of Redlands Ordinance and Codes, specifically those that would violate the ordinances in Chapter 13.54 of the City Municipal Code. Any violation of these codes are to be reported to the City of Redlands.	Daily
Local Water Quality Ordinances	Project Owner	Check the City of Redlands web site at the address below regarding changes in local water quality ordinance on annual basis. https://www.cityofredlands.org/cms/One.aspx?portalId=6255746&pageId=7308741	Yearly
Spill Contingency Plan	Project Owner	Not applicable for mixed use apartment/restuarant project where storage of hazardous materials is not anticipated or permitted.	N/A
Litter / Debris Control Program	Project Owner	Maintenance shall consist of litter patrol, emptying of trash receptacles, picking up pet waste and using the proper containers for trash pickup. Containers should be cleaned at least every six months	Daily & 6 Months
Landscape Finished Grade	Project Owner	This inspection and maintenance normally refers to some landscape areas and parkway grade held at a lower grade than the surrounding area. Verfify landscaping is 1-2" below the adjacent finished surface grade to allow for ponding. Remove excessive soil and/or vegetation to restore 1" minimum depth of lanscaping area below adjacent grade. Replant landscaping areas disturbed during soil removal.	Monthly

Form 5-1 BMP Inspection and Maintenance **(use additional forms as necessary)**			
BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
Protect Slopes and Channels and provide Energy Dissipation	Project Owner	Channels (Drainage Swales) - inspect for debris and/or overgrowth, clean, repair and replace all channel stabilization and vegetation.	Monthly
Landscape Maintenance	Project Owner	Landscapes shall be maintained to ensure water efficiency and healthy appearance. A regular maintenance schedule shall include, but not be limited to: 1. Checking, adjusting, and repairing the irrigation equipment; 2. Resetting the automatic controller; 3. Aerating and dethatching turf areas; 4. Replenishing mulch; 5. Fertilizing; 6. Pruning, weeding, removing litter and replacement of plants as required. Verify fertilizer and pesticide usage requirements consistent with the instructions contained on product labels and with the regulations administered by the State Department of Pesticide Regulation Comply with product labels as new products are purchased and update new regulations by the State Department of Pesticide Regulation (http://www.cdpr.ca.gov/)	Weekly
Roof Runoff Controls	Project Owner	Roof Inlets and Outlets - Inspect and clean as necessary all roof inlets, outlets and drains (CASQA New Development BMP Handbook SD-11)	Twice a year – once in October and once in April/May
Vacuum Sweeping of Parking Lot	Project Owner	Project parking and drive areas to be swept and debris removed.	Monthly
Efficient Irrigation	Project Owner	1. Rain and pressure shutoff devices inspect and replace as necessary 2. Timers inspect and replace as necessary 3. Add mulch (wood chips) 4. Overspray Inspect and adjust system	Monthly
SD-20 Pervious Pavements	Project Owner	Vacuum clean surface using commercially available sweeping machines.	2x Yearly
SD-21 Alternative Building Materials	Project Owner	Decking & Fencing - inspect, repair and replace. Use no Chromated Copper Arsenate products for repair or replacement. Roofing - inspect, repair and replace. If repair or replacement product is metal, use only appropriately coated products.Paved areas - see pervious pavement maintenance. Building siding - inspect, repair and replace. Pesticide reduction - inspect, repair and replace termite barriers	Yearly

Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)			
BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
Underground Infiltration System (Subsurface Infiltration)	Project Owner	Inspect for standing water 72 hours after the finish of every rainstorm. If ponding water is present use pump or vactor truck to pump water to surface.	72 Hours after every Rainstorm
MP-51 Vortex Separator	Project Owner	Remove accumulated sediment, litter and other floatables with vactor truck.	Inpsect three times a year and vactor truck annually.

Section 6 WQMP Attachments

6.1. Site Plan and Drainage Plan

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

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

6.2 Electronic Data Submittal

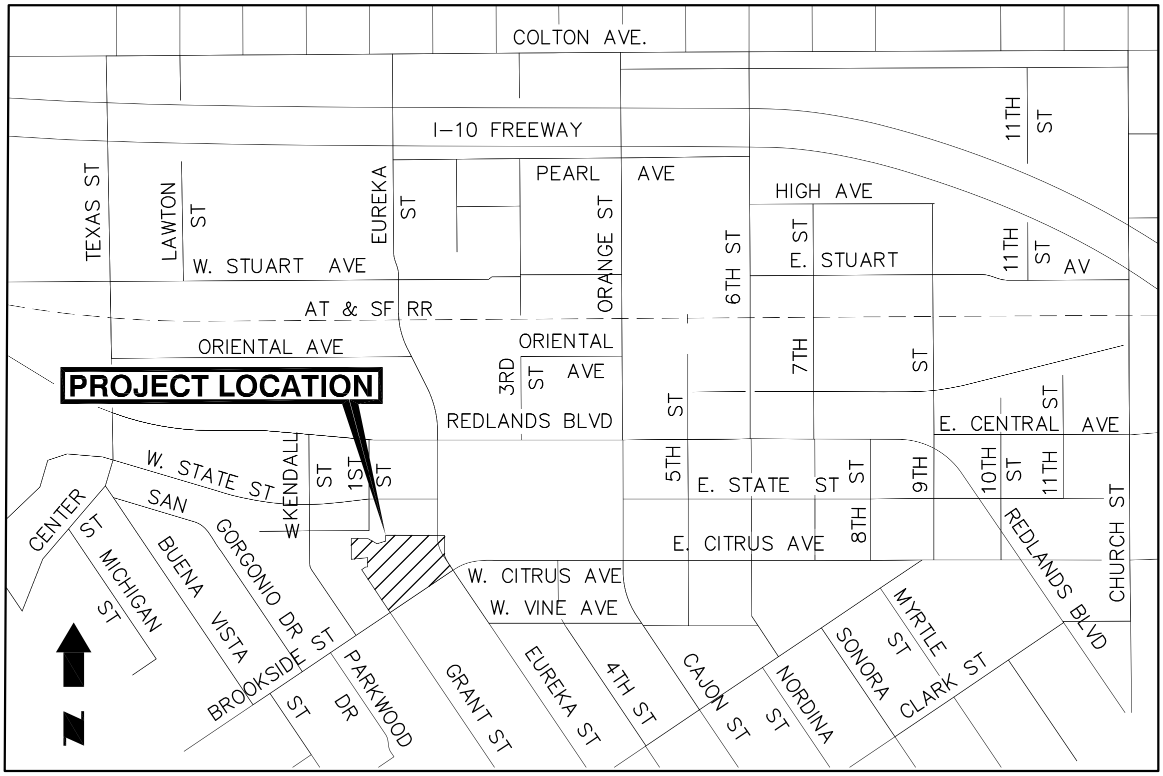
Minimum requirements include submittal of PDF exhibits in addition to hard copies. Format must not require specialized software to open. If the local jurisdiction requires specialized electronic document formats (as described in their local Local Implementation Plan), this section will describe the contents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

6.3 Post Construction

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

6.4 Other Supporting Documentation

- BMP Exhibits
- BMP Educational Materials

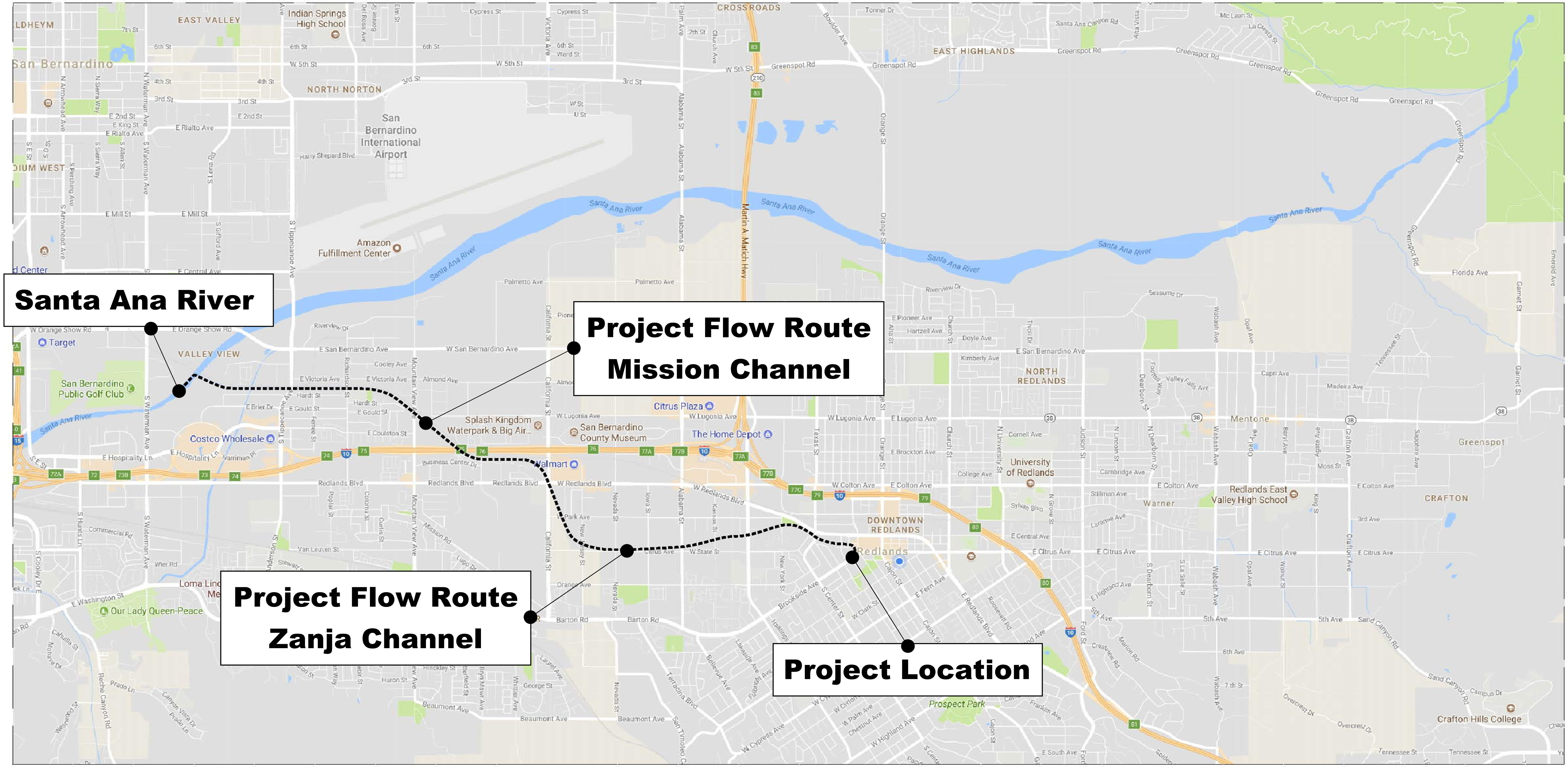


VICINITY MAP

CITY OF REDLANDS, CALIFORNIA
SCALE: NTS

\\T1\acaddata_10000_\10160 Redlands Safety Hall (City Center)\k_HYDRO\03 WQMP\PWQMP\DWG Files\ 10160_VMAP.dwg 9:53am - Nov 05, 2019

Project Drainage Path



Hicks & Hartwick, Inc.
37 East Olive Ave. Ste C
Redlands, CA. 92373
909.793.2257

Project Drainage Path
City of Redlands
Redlands City Center

PRELIMINARY GRADING PLAN
REDLANDS CITY CENTER - 212 & 213 BROOKSIDE AVENUE
APN 0171-211-11 THROUGH -21, -25 & 0171-101-01 THROUGH -05

OWNER / APPLICANT

VANTAGEONE REAL ESTATE INVESTMENTS, LLC
THOMAS N. ROBINSON
4 CORPORATE PLAZA, SUITE 210
NEWPORT BEACH, CA 92660

CIVIL ENGINEER

HICKS & HARTWICK, INC.
37 EAST OLIVE AVENUE, SUITE C
REDLANDS, CA 92373
PH: (909) 793-2257

TENTATIVE MAP PREPARED BY:

Hicks & Hartwick, Inc.
37 East Olive Ave. Ste C
Redlands, CA. 92373
909.793.2257

REGISTERED PROFESSIONAL ENGINEER
MATTHEW C. HICKS
No. 63494
CIVIL
STATE OF CALIFORNIA

LEGAL DESCRIPTION

PARCEL NO. 1:
THAT PORTION OF LOT 7, STONE'S SUBDIVISION, IN THE CITY OF REDLANDS, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS PER PLAT RECORDED IN BOOK 5 OF MAPS, PAGE 37, RECORDS OF SAID COUNTY, DESCRIBED AS FOLLOWS:
BEGINNING AT THE NORTHERLY CORNER OF THE EASTERLY LINE OF LOT 1, BLOCK "C', PRELLER, PRATTS AND KENDALLS SUBDIVISION, THENCE ALONG THE EAST LINE OF LOT 1, 97.1 FEET; THENCE NORTH 15° 31' EAST 88.3 FEET TO FIRST STREET; THENCE NORTH 62° 17' WESTERLY ON THE SOUTHWESTERLY LINE OF FIRST STREET, 25.83 FEET TO THE POINT OF BEGINNING.
APN: 0171-211-14

PARCEL NO. 2:
LOT 1, BLOCK "C", PRELLER, PRATTS AND KENDALLS SUBDIVISION, IN THE CITY OF REDLANDS, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS PER PLAT RECORDED IN BOOK 5 OF MAPS, PAGE 22, RECORDS OF SAID COUNTY.
EXCEPT THE FOLLOWING:
BEGINNING AT THE NORTHEAST CORNER OF SAID LOT; THENCE SOUTH ALONG THE EAST LINE 26.70 FEET; THENCE NORTHWESTERLY 53.97 FEET TO THE POINT ON THE NORTH LINE OF SAID LOT; THENCE ALONG SAID NORTH LINE EASTERLY 46.90 FEET TO THE POINT OF BEGINNING.
APN: 0171-211-13

PARCEL NO. 3:
LOT 6, STONE'S SUBDIVISION OF LOTS NO. 12, 13 AND 14, BLOCK "C" PRELLER, PRATTS AND KENDALLS SUBDIVISION OF PART OF LOT 27, BLOCK 77, SAN BERNARDINO RANCHO, SAN BERNARDINO COUNTY, CALIFORNIA AND A PART OF LOT 1, BLOCK 27, REDLANDS, IN THE CITY OF REDLANDS, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS PER PLAT RECORDED IN BOOK 5 OF MAPS, PAGE 37, OF THE RECORDS OF SAID COUNTY.
TOGETHER WITH THE NORTHERLY 6 FEET OF THE UN-NAMED ALLEY ADJOINING SAID LAND ON THE SOUTH AS VACATED BY RESOLUTION NO. 7667, RECORDED SEPTEMBER 8, 2016 AS INSTRUMENT NO. 2016-0368219, OFFICIAL RECORDS OF SAID COUNTY.
EXCEPTING THEREFROM THAT PORTION THEREOF CONVEYED BY F. P MORRISON, TRUSTEE, TO HALSEY W. ALLEN, BY DEED RECORDED IN BOOK 311 OF DEEDS, PAGE 400, RECORDS OF SAID COUNTY, DESCRIBED AS FOLLOWS:
THE WESTERLY PORTION OF SAID LOT 6, DESCRIBED AS FOLLOWS, WHICH SAID PORTION IS A TRAPEZOID LYING IMMEDIATELY IN REAR OF LOT 1, FRONTING 50 FEET ON ALLEY, THE WESTBOUNDARY LINE BEING 93 FEET; THE NORTHERLY BOUNDARY LINE BEING 59.6 FEET; THE EASTERLY BOUNDARY LINE BEING 60.9 FEET.
APN: 0171-211-16

PARCEL NO.4:
LOT 2, BROOKSIDE AVENUE SUBDIVISION, IN THE CITY OF REDLANDS, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS PER PLAT RECORDED IN BOOK 17 OF MAPS, PAGE 1, RECORDS OF SAID COUNTY.
TOGETHER WITH THE SOUTHERLY 6 FEET OF THE UN-NAMED ALLEY ADJOINING SAID LAND ON THE NORTH AS VACATED BY RESOLUTION NO. 7667, RECORDED SEPTEMBER 8, 2016 AS INSTRUMENT NO. 2016-0368219, OFFICIAL RECORDS OF SAID COUNTY.
APN: 0171-211-18

PARCEL NO. 5:
LOT 2, OF STONE'S SUBDIVISION, IN THE CITY OF REDLANDS, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS PER PLAT RECORDED IN BOOK 5 OF MAPS, PAGE 37, RECORDS OF SAID COUNTY.
TOGETHER WITH THE SOUTHERLY 6 FEET OF THE UN-NAMED ALLEY ADJOINING SAID LAND ON THE NORTH AS VACATED BY RESOLUTION NO. 7667, RECORDED SEPTEMBER 8, 2016 AS INSTRUMENT NO. 2016-0368219, OFFICIAL RECORDS OF SAID COUNTY.
APN: 0171-211-19

PARCEL NO. 6:
LOT 1 OF STONE'S SUBDIVISION OF LOTS 12, (3, AND 14, BLOCK "C" PRELLER, PRATTS AND KENDALLS SUBDIVISION OF PART OF LOT 27, BLOCK 77, SAN BERNARDINO RANCHO, AND A PART OF LOT 1, BLOCK 27 REDLANDS SURVEY, IN THE CITY OF REDLANDS, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS PER PLAT RECORDED IN BOOK 5 OF MAPS, PAGE 37, RECORDS OF SAID COUNTY.
ALSO THAT PORTION OF LOT 6 OF SAID STONE'S SUBDIVISION, LYING WEST OF THE EAST LINE OF SAID LOT 1 OF SAID STONE'S SUBDIVISION PRODUCED NORTHERLY.
ALSO THAT PORTION OF 12 FOOT ALLEY (NOW VACATED) AS SHOWN ON SAID MAP OF STONE'S SUBDIVISION, LYING BETWEEN SAID LOT 1 OF SAID STONE'S SUBDIVISION AND THAT PORTION OF LOT 6 ABOVE DESCRIBED.
ALSO THAT PORTION OF BLOCK "D" OF FELLER'S SUBDIVISION NO. 2 OF PART OF LOT 1, BLOCK 27, REDLANDS SURVEY, IN THE CITY OF REDLANDS, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS PER PLAT RECORDED IN BOOK 8 OF MAPS, PAGE 45, RECORDS OF SAID COUNTY, DESCRIBED AS FOLLOWS:
BEGINNING AT A POINT AT THE INTERSECTION OF THE LINE OF THE NORTHEASTERLY SIDE OF SAID BLOCK "D" WITH THE NORTHWESTERLY SIDE OF BROOKSIDE AVENUE (SAID POINT ALSO BEING THE SOUTHWESTERLY CORNER OF SAID LOT 1 OF SAID STONE SUBDIVISION); THENCE RUNNING IN A SOUTHWESTERLY DIRECTION ALONG THE NORTHWESTERLY SIDE OF BROOKSIDE AVENUE, 25 FEET; THENCE AT RIGHT ANGLES IN A NORTHWESTERLY DIRECTION 265 FEET; THENCE AT RIGHT ANGLES NORTHEASTERLY 25 FEET TO THE NORTHEASTERLY LINE OF SAID BLOCK "D"; THENCE RUNNING SOUTHEASTERLY ALONG SAID NORTHEASTERLY LINE OF SAID BLOCK "D", 265 FEET TO THE POINT OF BEGINNING.
APN: 0171-211-20 AND 0171-211-21

SURVEYOR'S NOTES

THE BASIS OF BEARINGS IS THE CENTERLINE OF BROOKSIDE AVENUE AS SHOWN ON TRACT 1994, PARKWOOD ADDITION, MB 29/4, BEING N56°20'00"E

BENCHMARK

CITY OF REDLANDS BENCH MARK R-59, BRASS DISK IN TOP OF CURB AT THE WEST SIDE OF FLAG POLE ISLAND AT THE INTERSECTION OF CAJON STREET AND VINE STREET, IN FRONT OF OLD CITY HALL. ELEVATION = 1358.504

UTILITY NOTE

UNDERGROUND UTILITY LOCATIONS SHOWN WERE LOCATED BY PAINTED MARKINGS FURNISHED BY OTHERS. THE EXISTENCE AND APPROXIMATE LOCATIONS OF ANY UNDERGROUND UTILITIES OR STRUCTURES SHOWN ON THESE PLANS ARE OBTAINED BY A SEARCH OF THE AVAILABLE RECORDS. HICKS & HARTWICK, INC. ASSUMES NO LIABILITY AS TO THE EXACT LOCATION OF SAID LINES NOR FOR THE UTILITY OR IRRIGATION LINES WHOSE LOCATIONS ARE NOT SHOWN.

LEGEND

▭	ASPHALT PAVEMENT
▨	BUILDING
▭	LANDSCAPING
▭	CONCRETE
▬ ▭ ▬	PROPOSED SCREEN WALL
▬▭▬▭▬	PROPOSED RETAINING WALL
——(1210)——	EXISTING CONTOUR
----1210----	PROPOSED CONTOUR
——	PROPOSED SEWER SERVICE
——SD——	PROPOSED STORM DRAIN
=========	EXISTING STORM DRAIN
▭■■■■■■	EXISTING WATER SERVICE
■■■■■■■■	EXISTING SEWER LATERAL
■■■■■■■■	EXISTING WATER MAIN (SIZE AS SHOWN)
■■■○■■■	EXISTING SEWER MAIN (SIZE AS SHOWN) AND MANHOLE
----G-----	EXISTING GAS LINE (SIZE AS SHOWN)
----OH----	EXISTING OVERHEAD COMMUNICATION/POWER LINES
----GTE----	EXISTING GENERAL TELEPHONE
----SCE----	PROPOSED SOUTHERN CALIFORNIA EDISON
----GB-----	PROPOSED GRADE BREAK
○——⊗	FIRE HYDRANT ASSEMBLY
—▷—▷—	SWALE FLOW LINE
—▷∘—▷∘—	PIPE BELOW SWALE

ABBREVIATIONS

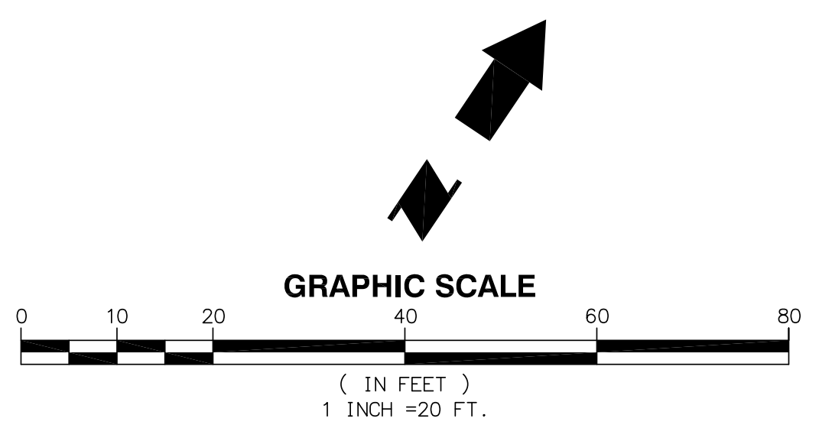
AC	ASPHALT PAVEMENT	LF	LINEAR FEET
APN	ASSESSOR'S PARCEL NUMBER	LS	LANDSCAPE
BLDG	BUILDING	MAX	MAXIMUM
℄	CENTERLINE	MIN	MINIMUM
CF	CURB FACE	PIV	POST INDICATOR VALVE
CLF	CHAIN LINK FENCE	PL	PROPERTY LINE
CONC.	CONCRETE	PP	POWER POLE
COR	CORNER	PROP	PROPOSED
DDC	DOUBLE DETECTOR CHECK	GB	GRADE BREAK
DIA	DIAMETER	GP	GUARD POST
EX.	EXISTING	GTE	GENERAL TELEPHONE
EG	EXISTING GRADE	GW	GUY-WIRE
FDC	FIRE DEPARTMENT CONNECTION	R/W	RIGHT OF WAY
FF	FINISHED FLOOR	SMH	SEWER
FG	FINISHED GRADE	SW	SIDEWALK
FH	FIRE HYDRANT	TC	TOP OF CURB
FL	FLOW LINE	TG	TOP OF GRATE
FS	FINISHED SURFACE	WTR	WATER
INV	INVERT	WV	WATER VALVE
LAT	LATERAL	WM	WATER METER
		XING	CROSSING

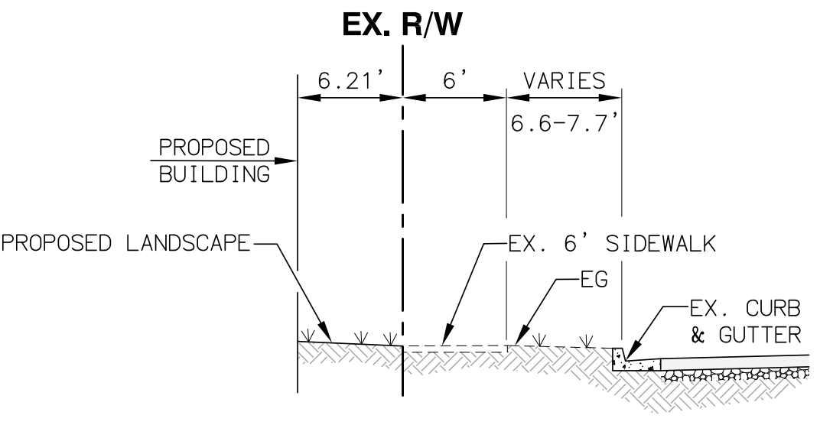
CURVE DATA TABLE

CURVE	DELTA	RADIUS	TANGENT	LENGTH
C1	89°56'09"	12.00'	11.99'	18.84'
C2	12°39'09"	220.00'	24.39'	48.58'
C3	33°55'57"	180.00'	54.92'	106.60'

LINE DATA TABLE

LINE	BEARING	DISTANCE
L1	N56°16'54"E	25.00'
L2	N89°44'54"E	9.80'
L3	N33°36'09"W	27.23'
L4	N89°54'38"W	3.26'





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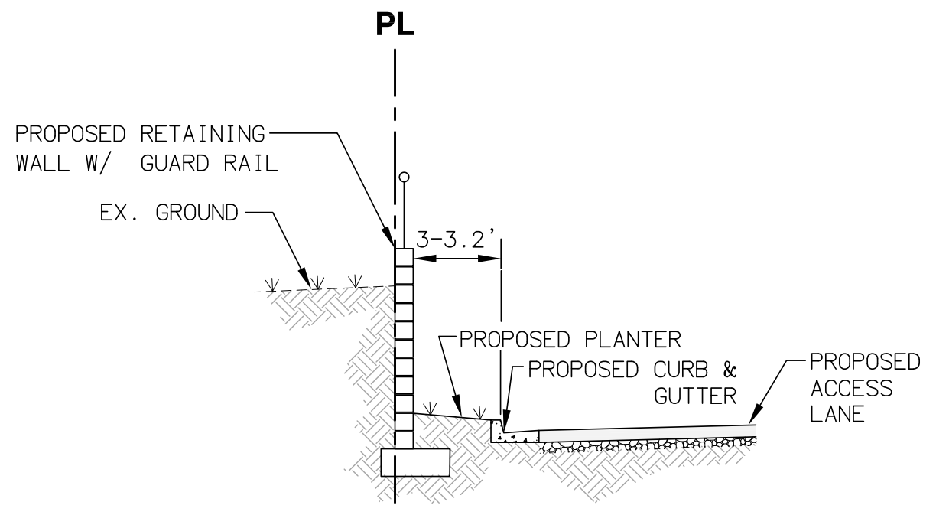

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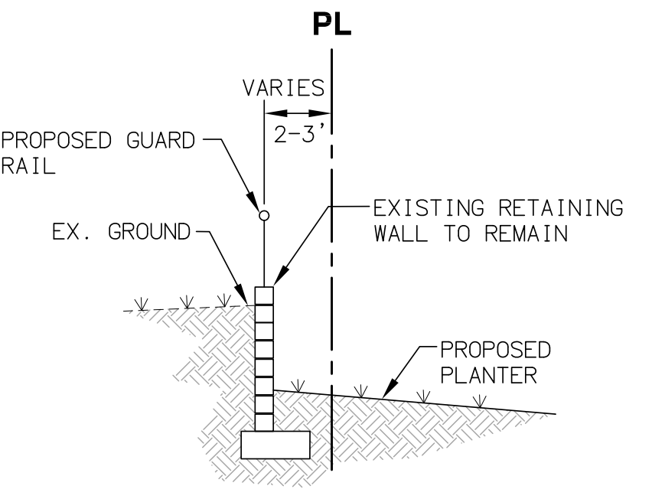

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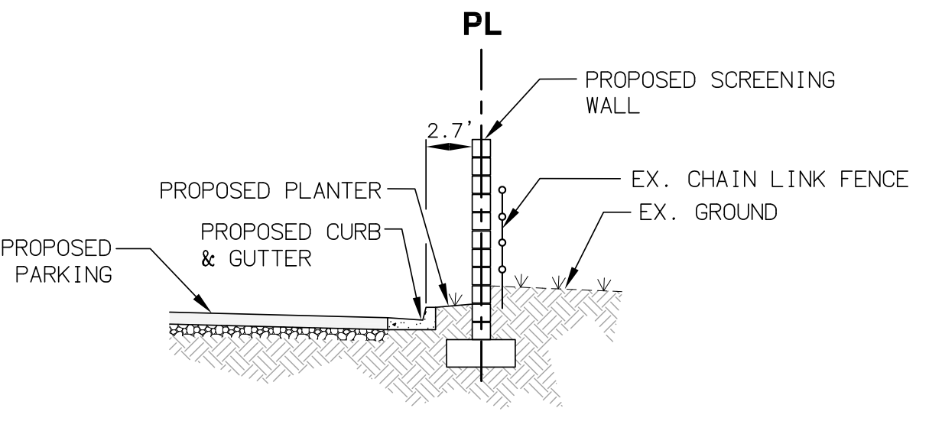

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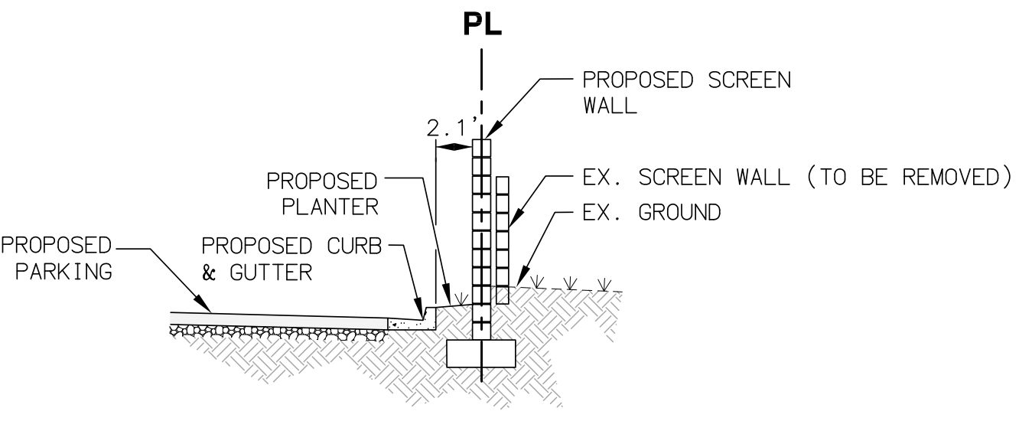

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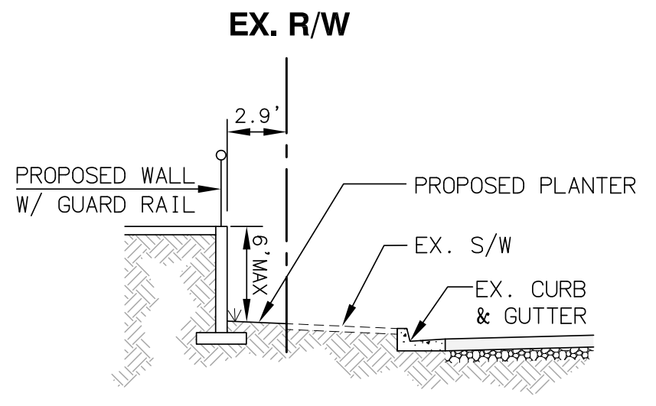

SECTION F-F
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Hall (City Center)\h_GRADING\ 10160_GP01.dwg 3:41pm - Sep 18, 2019

PRELIMINARY WATER QUALITY MANAGEMENT PLAN
REDLANDS CITY CENTER - 212 & 213 BROOKSIDE AVENUE
APN 0171-211-11 THROUGH -21, -25 & 0171-101-01 THROUGH -05

OWNER / APPLICANT

VANTAGEONE REAL ESTATE INVESTMENTS, LLC
THOMAS N. ROBINSON
4 CORPORATE PLAZA, SUITE 210
NEWPORT BEACH, CA 92660

CIVIL ENGINEER

HICKS & HARTWICK, INC.
37 EAST OLIVE AVENUE, SUITE C
REDLANDS, CA 92373
PH: (909) 793-2257

TENTATIVE MAP PREPARED BY:

Hicks & Hartwick, Inc.
37 East Olive Ave. Ste C
Redlands, CA. 92373
909.793.2257

MATTHEW C. HICKS
No. 63494
CIVIL

GENERAL NOTES

1. TOTAL WQMP PROJECT AREA: 130,627 SF (3.00 AC)
2. DATE PREPARED: 7-17-2019

SITE IMPLEMENTED BMP's

NOTE: ALL BMPs LISTED ARE PER CALIFORNIA STORMWATER QUALITY ASSOCIATION BEST MANAGEMENT PRACTICE HANDBOOK, (CONSTRUCTION, JULY 2012)

SOURCE CONTROL BMP's
ROUTINE STRUCTURAL

①	LANDSCAPE PLANNING	SD-10
②	ROOF RUNOFF CONTROLS	SD-11
③	EFFICIENT IRRIGATION	SD-12
④	PROTECT SLOPES AND CHANNELS	-
⑤	STORM DRAIN SIGNAGE	SD-13
⑥	INLET TRASH RACKS	-
⑦	ENERGY DISSIPATERS	-
⑧	TRASH STORAGE AREAS	SD-32

ALTERNATIVE MATERIAL

⑨	PERVIOUS PAVEMENT (DECOMPOSED GRANITE, ETC.)	SD-20
⑩	ALTERNATIVE BUILDING MATERIALS	SD-21

DESIGN BASIS OF TREATMENT CONTROL BMP's
TREATMENT CONTROL BMP

⑩	SUBSURFACE INFILTRATION	VOLUME BASED	-
⑪	CATCH BASIN INSERTS (KRISTAR FLOGARD OR EQUIV.)		MP-52
⑫	VORTEX SEPARATOR	FLOW BASED	MP-51

WQMP STUDY AREA SUMMARY

TOTAL WQMP STUDY AREA: 130,627 SF (3.00 AC)

DA-1 DMA A	103,792 SF	2.38 AC
BUILDING	44,636 SF	
ASPHALT CONCRETE PAVEMENT	41,016 SF	
CONC. SIDEWALK, CONC. CURB/GUTTER, TRASH ENCLOSURE ETC.	8,443 SF	
TOTAL IMPERVIOUS	94,095 SF	2.16 AC
LANDSCAPING (TURF, PLANTERS, SLOPES & DECOMPOSED GRANITE)	9,697 SF	
TOTAL PERVIOUS	9,697 SF	0.22 AC

DA-2 DMA A	26,835 SF	0.62 AC
BUILDING	10,550 SF	
ASPHALT CONCRETE PAVEMENT	5,373 SF	
CONC. SIDEWALK, CONC. CURB/GUTTER, TRASH ENCLOSURE ETC.	9,038 SF	
TOTAL IMPERVIOUS	24,961 SF	0.57 AC
LANDSCAPING (TURF, PLANTERS, SLOPES & DECOMPOSED GRANITE)	1,874 SF	
TOTAL PERVIOUS	1,874 SF	0.04 AC

TREATMENT FLOW SUMMARY

			TREATMENT VOLUME REQUIRED		*TREATMENT VOLUME PROVIDED*	
DA-1	103,792 SF	2.38 AC	DCV	8,631 c.f.	**DCV**	**8,746 c.f.**
IMPERVIOUS AREA	94,095 SF					
DA-2	26,835 SF	0.62 AC	DCV	2,339 c.f.	**DCV**	**2,343 c.f.**
IMPERVIOUS AREA	24,961 SF					

TREATMENT FLOW TOTAL

			TREATMENT VOLUME REQUIRED		*TREATMENT VOLUME PROVIDED*	
DA-1 & DA-2	130,627 SF	3.00 AC	DCV	10,970 c.f.	**DCV**	**11,089 c.f.**
IMPERVIOUS AREA	119,056 SF					

LEGEND

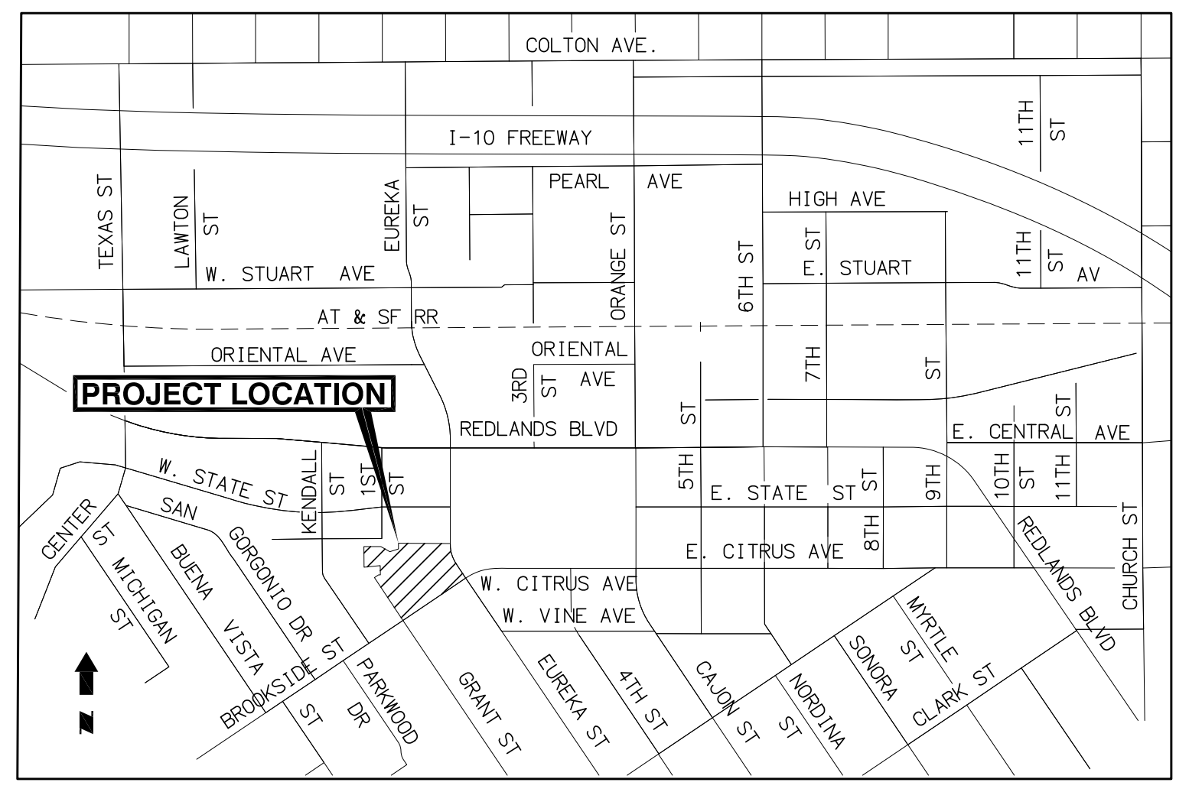
EXISTING 5' CONTOUR
EXISTING 1' CONTOUR
PROPOSED 5' CONTOUR
PROPOSED 1' CONTOUR
TOTAL WQMP PROJECT AREA BOUNDARY
DRAINAGE AREAS PER HYDRO STUDY
EXISTING STORM DRAIN PIPE
PROPOSED STORM DRAIN PIPE
OPEN SPACE & LANDSCAPING
2: 1 SLOPE OR LESS
AC PAVEMENT
CONCRETE
BUILDING
FLOW ARROW
SWALE FLOW LINE
PIPE BELOW SWALE

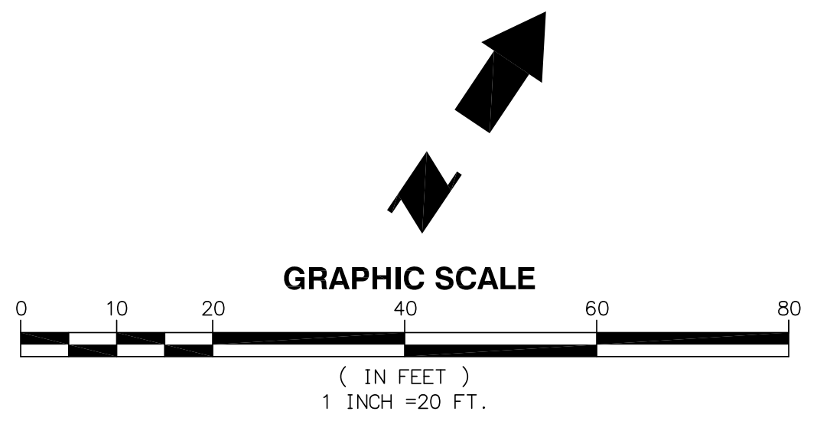
ABBREVIATIONS

AC	ASPHALT CONCRETE/ACRES
AVE	AVENUE
BLDG.	BUILDING
℄	CENTERLINE
CF	CUBIC FEET
CFS	CUBIC FEET PER SECOND
ELEV	ELEVATION
EX.	EXISTING
L=	LENGTH
MAX.	MAXIMUM
MB	MAP BOOK
MIN.	MINIMUM
PROP.	PROPOSED
R=	RADIUS
SD	STORM DRAIN
SF	SQUARE FEET
TYP	TYPICAL

VICINITY MAP

NOT TO SCALE





\\T1\acaddata_10000_\10160 Redlands Safety Hall (City Center)\k_HYDRO\03 WQMP\PWQMP\DWG Files\ 10160_WQMP_01.dwg 9:48am - Sep 18, 2019

RECORDING REQUESTED BY
AND WHEN RECORDED MAIL TO:

CITY CLERK
CITY OF REDLANDS
P.O. BOX 3005
REDLANDS, CA 92373

SPACE ABOVE THIS LINE FOR RECORDER'S USE

STORMWATER TREATMENT DEVICE AND CONTROL MEASURE ACCESS AND MAINTENANCE AGREEMENT

Assessor's Parcel Number(s)
APN 0171-211-11 through -21, -25 & 0171-101-01 through -05

THIS AGREEMENT is made and entered into this _____ day of ______________, 20__, by and between Vantage One Real Estate Investments, LLC ("Owner"), and the City of Redlands, a municipal corporation ("City"). The Owner and the City are sometimes each individually referred to herein as a "Party" and, collectively, as the "Parties."

RECITALS

WHEREAS, the Owner owns real property ("Property") in the City specifically described in Exhibits "A" and "B" which are attached hereto and incorporated herein by this reference; and

WHEREAS, at the time of approval of the Owner's development project commonly known as "Redlands City Center" (the "Project"), the City required the Project to employ on-site control measures to minimize pollutants in urban stormwater runoff; and

WHEREAS, the Owner has chosen to install underground infiltration systems, hydrodynamic separators and catch basin inserts (the "Devices") to minimize pollutants in urban stormwater runoff; specifically described in Exhibit "C" and shown in Exhibit "D" both of which are attached hereto and incorporated herein by this reference; and

WHEREAS, the Devices have been installed in accordance with plans and specifications approved by the City; and

WHEREAS, the Devices being installed on private property and draining only private property, is a private facility with all maintenance or replacement therefor being the sole responsibility of the Owner; and

WHEREAS, the Owner is aware that periodic and continuous maintenance including, but not necessarily limited to, filter material replacement and sediment removal is required to assure proper performance of the Devices and that such maintenance activity will require compliance with all Federal, State and local laws and regulations, including those pertaining to confined space and waste disposal methods in effect at the time such maintenance occurs;

NOW, THEREFORE, in consideration of the City's approval of the Project and the mutual promises contained herein, the City of Redlands and Vantage One Real Estate Investments, LLC agree as follows:

AGREEMENT

1. The Owner hereby provides the City and its designees with full right of access to the Devices and the Owner's Property in the immediate vicinity of the Devices (a) at any time, upon reasonable notice; or (b) in the event of emergency, as determined by the City Engineer with no advance notice; for the purpose of inspecting, sampling and testing of the Devices, and in cases of emergency, to undertake all necessary repairs or other preventative measures at the Owner's expense as provided for in Section 3, below. The City shall make every effort at all times to minimize or avoid interference with the Owner's use of the Property when undertaking such inspections and repairs.

2. The Owner shall diligently maintain the Devices in a manner consistent with the manufacturers' recommended maintenance schedule to ensure efficient performance. All reasonable precautions shall be exercised by the Owner and the Owner's representatives in the removal and extraction of materials from the Devices, and the ultimate disposal of the materials in a manner consistent with all applicable laws. As may be requested from time to time by the City, the Owner shall provide the City with documentation identifying the materials removed, the quantity and the location of disposal destinations, as appropriate.

3. In the event the Owner fails to perform the necessary maintenance required by this Agreement within thirty (30) days of being given written notice by the City to do so, setting forth with specificity the action to be taken, the City is authorized to cause any maintenance necessary to be done and charge the entire cost and expense to the Owner, including administrative costs, attorneys' fees and interest thereon at the maximum rate authorized by law, twenty (20) days after the Owner's receipt of the notice of expense until paid in full.

4. This Agreement affects County of San Bernardino Assessor's Parcel No.'s 0171-211-11 through -21, -25 & 0171-101-01 through -05, and shall be recorded in the Official Records of the County of San Bernardino at the expense of the Owner and shall constitute notice to all successors and assigns to the title to the Property of the obligations herein set forth. This Agreement shall also constitute a lien against the Property in such amount as will fully reimburse the City, including interest as herein above set forth, subject to foreclosure in event of default in payment.

5. In event any action is commenced to enforce or interpret any of the terms or conditions of this Agreement the prevailing Party shall, in addition to any costs and other relief, be entitled to the recovery of its reasonable attorneys' fees, including fees for the use of in-house counsel by a Party.

6. It is the intent of the Parties that the burdens and benefits herein undertaken shall constitute equitable servitudes that run with the Property and shall be binding upon future owners of all or any portion of the Property. Any owner's liability hereunder shall terminate at the time it ceases to be an owner of the encumbered Property, except for obligations which accrue prior to the date of transfer by such owner, which shall remain the personal obligation of such owner.

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

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

CITY
City Engineer
City of Redlands
P.O. Box 3005
Redlands, CA 92373

OWNER
Tom Robinson
VantageOne Real Estate Investments, LLC
4 Corporate Plaza, Suite 210
Newport Beach, CA 92660

9. This Agreement shall be governed by and construed in accordance with the laws of the State of California.

10. Any amendment to this Agreement shall be in writing and approved by the City Council of City and signed by the City and the Owner.

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

CITY OF REDLANDS:

____
Paul W. Foster, Mayor

OWNER:

____
Tom Robinson, Managing Partner

Attest:

____
Sam Irwin, City Clerk

Replace this page with a fully executed Notary Acknowledgment page.

Housekeeping Practices SC-60

Description

Promote efficient and safe housekeeping practices (storage, use, and cleanup) when handling potentially harmful materials such as fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals. Related information is provided in BMP fact sheets SC-11 Spill Prevention, Control & Cleanup and SC-34 Waste Handling & Disposal.

Approach

Pollution Prevention

- Purchase only the amount of material that will be needed for foreseeable use. In most cases this will result in cost savings in both purchasing and disposal. See SC-61 Safer Alternative Products for additional information.

- Be aware of new products that may do the same job with less environmental risk and for less or the equivalent cost. Total cost must be used here; this includes purchase price, transportation costs, storage costs, use related costs, clean up costs and disposal costs.

Suggested Protocols

General

- Keep work sites clean and orderly. Remove debris in a timely fashion. Sweep the area.

- Dispose of wash water, sweepings, and sediments, properly.

- Recycle or dispose of fluids properly.

- Establish a daily checklist of office, yard and plant areas to confirm cleanliness and adherence to proper storage and security. Specific employees should be assigned specific inspection responsibilities and given the authority to remedy any problems found.

- Post waste disposal charts in appropriate locations detailing for each waste its hazardous nature (poison, corrosive, flammable), prohibitions on its disposal (dumpster, drain, sewer) and the recommended disposal method (recycle, sewer, burn, storage, landfill).

- Summarize the chosen BMPs applicable to your operation and post them in appropriate conspicuous places.

Objectives

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

Targeted Constituents

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

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

- Require a signed checklist from every user of any hazardous material detailing amount taken, amount used, amount returned and disposal of spent material.
- Do a before audit of your site to establish baseline conditions and regular subsequent audits to note any changes and whether conditions are improving or deteriorating.
- Keep records of water, air and solid waste quantities and quality tests and their disposition.
- Maintain a mass balance of incoming, outgoing and on hand materials so you know when there are unknown losses that need to be tracked down and accounted for.
- Use and reward employee suggestions related to BMPs, hazards, pollution reduction, work place safety, cost reduction, alternative materials and procedures, recycling and disposal.
- Have, and review regularly, a contingency plan for spills, leaks, weather extremes etc. Make sure all employees know about it and what their role is so that it comes into force automatically.

Training

- Train all employees, management, office, yard, manufacturing, field and clerical in BMPs and pollution prevention and make them accountable.
- Train municipal employees who handle potentially harmful materials in good housekeeping practices.
- Train personnel who use pesticides in the proper use of the pesticides. The California Department of Pesticide Regulation license pesticide dealers, certify pesticide applicators and conduct onsite inspections.
- Train employees and contractors in proper techniques for spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.
- Keep your Spill Prevention Control and Countermeasure (SPCC) plant up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- There are no major limitations to this best management practice.
- There are no regulatory requirements to this BMP. Existing regulations already require municipalities to properly store, use, and dispose of hazardous materials

Requirements

Costs

- Minimal cost associated with this BMP. Implementation of good housekeeping practices may result in cost savings as these procedures may reduce the need for more costly BMPs.

Maintenance

- Ongoing maintenance required to keep a clean site. Level of effort is a function of site size and type of activities.

Supplemental Information

Further Detail of the BMP

- The California Integrated Waste Management Board's Recycling Hotline, 1-800-553-2962, provides information on household hazardous waste collection programs and facilities.

Examples

There are a number of communities with effective programs. The most pro-active include Santa Clara County and the City of Palo Alto, the City and County of San Francisco, and the Municipality of Metropolitan Seattle (Metro).

References and Resources

British Columbia Lake Stewardship Society. Best Management Practices to Protect Water Quality from Non-Point Source Pollution. March 2000.
http://www.nalms.org/bclss/bmphome.html#bmp

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

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities, Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July, 1998, Revised by California Coastal Commission, February 2002.

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

San Mateo STOPPP - (http://stoppp.tripod.com/bmp.html)

Drainage System Maintenance SC-74

Photo Credit: Geoff Brosseau

Objectives

- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

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

Description

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

Approach

Suggested Protocols

Catch Basins/Inlet Structures

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

- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Clean and repair as needed.

- Keep accurate logs of the number of catch basins cleaned.

- Record the amount of waste collected.

- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.

- Dewater the wastes with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed of. Do not dewater near a storm drain or stream.

- Except for small communities with relatively few catch basins that may be cleaned manually, most municipalities will require mechanical cleaners such as eductors, vacuums, or bucket loaders.

Storm Drain Conveyance System

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.

- Collect flushed effluent and pump to the sanitary sewer for treatment.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.

- Do not allow discharge from cleaning a storm drain pump station or other facility to reach the storm drain system.

- Conduct quarterly routine maintenance at each pump station.

- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.

- Sample collected sediments to determine if landfill disposal is possible, or illegal discharges in the watershed are occurring.

Open Channel

- Consider modification of storm channel characteristics to improve channel hydraulics, to increase pollutant removals, and to enhance channel/creek aesthetic and habitat value.

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

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

Illicit Connections and Discharges

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

Illegal Dumping

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

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

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

Training

- Train crews in proper maintenance activities, including record keeping and disposal.

- Only properly trained individuals are allowed to handle hazardous materials/wastes.

- Train municipal employees from all departments (public works, utilities, street cleaning, parks and recreation, industrial waste inspection, hazardous waste inspection, sewer maintenance) to recognize and report illegal dumping.

- Train municipal employees and educate businesses, contractors, and the general public in proper and consistent methods for disposal.

- Train municipal staff regarding non-stormwater discharges (See SC-10 Non-Stormwater Discharges).

Spill Response and Prevention

- Refer to SC-11, Prevention, Control & Cleanup

- Have spill cleanup materials readily available and in a known location.

- Cleanup spills immediately and use dry methods if possible.

- Properly dispose of spill cleanup material.

Other Considerations

- Cleanup activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.

- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, liquid/sediment disposal, and disposal of flushed effluent to sanitary sewer may be prohibited in some areas.

- Regulations may include adoption of substantial penalties for illegal dumping and disposal.

- Municipal codes should include sections prohibiting the discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.

- Private property access rights may be needed to track illegal discharges up gradient.

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

Requirements

Costs

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

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

Maintenance

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

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

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

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

Supplemental Information

Further Detail of the BMP

Storm Drain flushing

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

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, releasing the backed up water and resulting in the cleaning of the storm drain segment.

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

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

Flow Management

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

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

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

Stream Corridor Planning

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

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

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

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

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

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

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

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

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

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

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

Examples

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

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

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

References and Resources

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

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

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP) Municipal Activities Model Program Guidance. 2001. Project Clean Water. November.

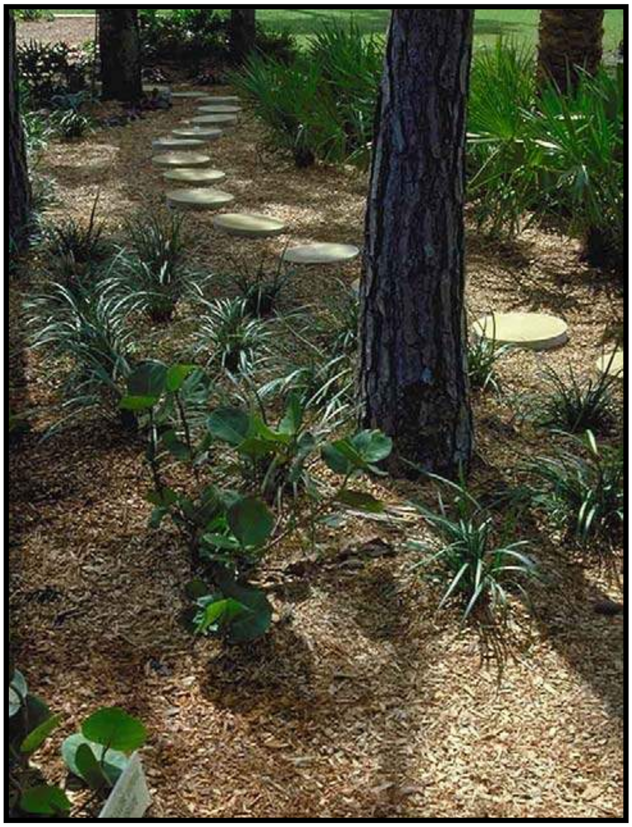
United States Environmental Protection Agency (USEPA). 1999. Stormwater Management Fact Sheet Non-stormwater Discharges to Storm Sewers. EPA 832-F-99-022. Office of Water, Washington, D.C. September.

United States Environmental Protection Agency (USEPA). 1999. Stormwater O&M Fact Sheet Catch Basin Cleaning. EPA 832-F-99-011. Office of Water, Washington, D.C. September.

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Illegal Dumping Control. On line: http://www.epa.gov/npdes/menuofbmps/poll_7.htm

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Storm Drain System Cleaning. On line: http://www.epa.gov/npdes/menuofbmps/poll_16.htm

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.

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

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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Association

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.

Pervious Pavements SD-20

Design Objectives

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

Description

Pervious paving is used for light vehicle loading in parking areas. The term describes a system comprising a load-bearing, durable surface together with an underlying layered structure that temporarily stores water prior to infiltration or drainage to a controlled outlet. The surface can itself be porous such that water infiltrates across the entire surface of the material (e.g., grass and gravel surfaces, porous concrete and porous asphalt), or can be built up of impermeable blocks separated by spaces and joints, through which the water can drain. This latter system is termed ‘permeable’ paving. Advantages of pervious pavements is that they reduce runoff volume while providing treatment, and are unobtrusive resulting in a high level of acceptability.

Approach

Attenuation of flow is provided by the storage within the underlying structure or sub base, together with appropriate flow controls. An underlying geotextile may permit groundwater recharge, thus contributing to the restoration of the natural water cycle. Alternatively, where infiltration is inappropriate (e.g., if the groundwater vulnerability is high, or the soil type is unsuitable), the surface can be constructed above an impermeable membrane. The system offers a valuable solution for drainage of spatially constrained urban areas.

Significant attenuation and improvement in water quality can be achieved by permeable pavements, whichever method is used. The surface and subsurface infrastructure can remove both the soluble and fine particulate pollutants that occur within urban runoff. Roof water can be piped into the storage area directly, adding areas from which the flow can be attenuated. Also, within lined systems, there is the opportunity for stored runoff to be piped out for reuse.

Suitable Applications

Residential, commercial and industrial applications are possible. The use of permeable pavement may be restricted in cold regions, arid regions or regions with high wind erosion. There are some specific disadvantages associated with permeable pavement, which are as follows:

- Permeable pavement can become clogged if improperly installed or maintained. However, this is countered by the ease with which small areas of paving can be cleaned or replaced when blocked or damaged.

- Their application should be limited to highways with low traffic volumes, axle loads and speeds (less than 30 mph limit), car parking areas and other lightly trafficked or non-trafficked areas. Permeable surfaces are currently not considered suitable for adoptable roads due to the risks associated with failure on high speed roads, the safety implications of ponding, and disruption arising from reconstruction.

- When using un-lined, infiltration systems, there is some risk of contaminating groundwater, depending on soil conditions and aquifer susceptibility. However, this risk is likely to be small because the areas drained tend to have inherently low pollutant loadings.

- The use of permeable pavement is restricted to gentle slopes.

- Porous block paving has a higher risk of abrasion and damage than solid blocks.

Design Considerations

Designing New Installations

If the grades, subsoils, drainage characteristics, and groundwater conditions are suitable, permeable paving may be substituted for conventional pavement on parking areas, cul de sacs and other areas with light traffic. Slopes should be flat or very gentle. Scottish experience has shown that permeable paving systems can be installed in a wide range of ground conditions, and the flow attenuation performance is excellent even when the systems are lined.

The suitability of a pervious system at a particular pavement site will, however, depend on the loading criteria required of the pavement.

Where the system is to be used for infiltrating drainage waters into the ground, the vulnerability of local groundwater sources to pollution from the site should be low, and the seasonal high water table should be at least 4 feet below the surface.

Ideally, the pervious surface should be horizontal in order to intercept local rainfall at source. On sloping sites, pervious surfaces may be terraced to accommodate differences in levels.

Design Guidelines

The design of each layer of the pavement must be determined by the likely traffic loadings and their required operational life. To provide satisfactory performance, the following criteria should be considered:

- The subgrade should be able to sustain traffic loading without excessive deformation.

- The granular capping and sub-base layers should give sufficient load-bearing to provide an adequate construction platform and base for the overlying pavement layers.

- The pavement materials should not crack of suffer excessive rutting under the influence of traffic. This is controlled by the horizontal tensile stress at the base of these layers.

There is no current structural design method specifically for pervious pavements. Allowances should be considered the following factors in the design and specification of materials:

- Pervious pavements use materials with high permeability and void space. All the current UK pavement design methods are based on the use of conventional materials that are dense and relatively impermeable. The stiffness of the materials must therefore be assessed.

- Water is present within the construction and can soften and weaken materials, and this must be allowed for.

- Existing design methods assume full friction between layers. Any geotextiles or geomembranes must be carefully specified to minimize loss of friction between layers.

- Porous asphalt loses adhesion and becomes brittle as air passes through the voids. Its durability is therefore lower than conventional materials.

The single sized grading of materials used means that care should be taken to ensure that loss of finer particles between unbound layers does not occur.

Positioning a geotextile near the surface of the pervious construction should enable pollutants to be trapped and retained close to the surface of the construction. This has both advantages and disadvantages. The main disadvantage is that the filtering of sediments and their associated pollutants at this level may hamper percolation of waters and can eventually lead to surface ponding. One advantage is that even if eventual maintenance is required to reinstate infiltration, only a limited amount of the construction needs to be disturbed, since the sub-base below the geotextile is protected. In addition, the pollutant concentration at a high level in the structure allows for its release over time. It is slowly transported in the stormwater to lower levels where chemical and biological processes may be operating to retain or degrade pollutants.

The design should ensure that sufficient void space exists for the storage of sediments to limit the period between remedial works.

- Pervious pavements require a single size grading to give open voids. The choice of materials is therefore a compromise between stiffness, permeability and storage capacity.

- Because the sub-base and capping will be in contact with water for a large part of the time, the strength and durability of the aggregate particles when saturated and subjected to wetting and drying should be assessed.

- A uniformly graded single size material cannot be compacted and is liable to move when construction traffic passes over it. This effect can be reduced by the use of angular crushed rock material with a high surface friction.

In pollution control terms, these layers represent the site of long term chemical and biological pollutant retention and degradation processes. The construction materials should be selected, in addition to their structural strength properties, for their ability to sustain such processes. In general, this means that materials should create neutral or slightly alkaline conditions and they should provide favorable sites for colonization by microbial populations.

Construction/Inspection Considerations

- Permeable surfaces can be laid without cross-falls or longitudinal gradients.

- The blocks should be lain level

- They should not be used for storage of site materials, unless the surface is well protected from deposition of silt and other spillages.
- The pavement should be constructed in a single operation, as one of the last items to be built, on a development site. Landscape development should be completed before pavement construction to avoid contamination by silt or soil from this source.
- Surfaces draining to the pavement should be stabilized before construction of the pavement.
- Inappropriate construction equipment should be kept away from the pavement to prevent damage to the surface, sub-base or sub-grade.

Maintenance Requirements

The maintenance requirements of a pervious surface should be reviewed at the time of design and should be clearly specified. Maintenance is required to prevent clogging of the pervious surface. The factors to be considered when defining maintenance requirements must include:

- Type of use
- Ownership
- Level of trafficking
- The local environment and any contributing catchments

Studies in the UK have shown satisfactory operation of porous pavement systems without maintenance for over 10 years and recent work by Imbe et al. at 9th ICUD, Portland, 2002 describes systems operating for over 20 years without maintenance. However, performance under such regimes could not be guaranteed, Table 1 shows typical recommended maintenance regimes:

Table 1 Typical Recommended Maintenance Regimes	
Activity	**Schedule**
■ Minimize use of salt or grit for de-icing ■ Keep landscaped areas well maintained ■ Prevent soil being washed onto pavement	Ongoing
■ Vacuum clean surface using commercially available sweeping machines at the following times: - End of winter (April) - Mid-summer (July / August) - After Autumn leaf-fall (November)	2/3 x per year
■ Inspect outlets	Annual
■ If routine cleaning does not restore infiltration rates, then reconstruction of part of the whole of a pervious surface may be required. ■ The surface area affected by hydraulic failure should be lifted for inspection of the internal materials to identify the location and extent of the blockage. ■ Surface materials should be lifted and replaced after brush cleaning. Geotextiles may need complete replacement. ■ Sub-surface layers may need cleaning and replacing. ■ Removed silts may need to be disposed of as controlled waste.	As needed (infrequent) Maximum 15-20 years

Permeable pavements are up to 25 % cheaper (or at least no more expensive than the traditional forms of pavement construction), when all construction and drainage costs are taken into account. (Accepting that the porous asphalt itself is a more expensive surfacing, the extra cost of which is offset by the savings in underground pipework etc.) (Niemczynowicz, et al., 1987)

Table 1 gives US cost estimates for capital and maintenance costs of porous pavements (Landphair et al., 2000)

Redeveloping Existing Installations

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

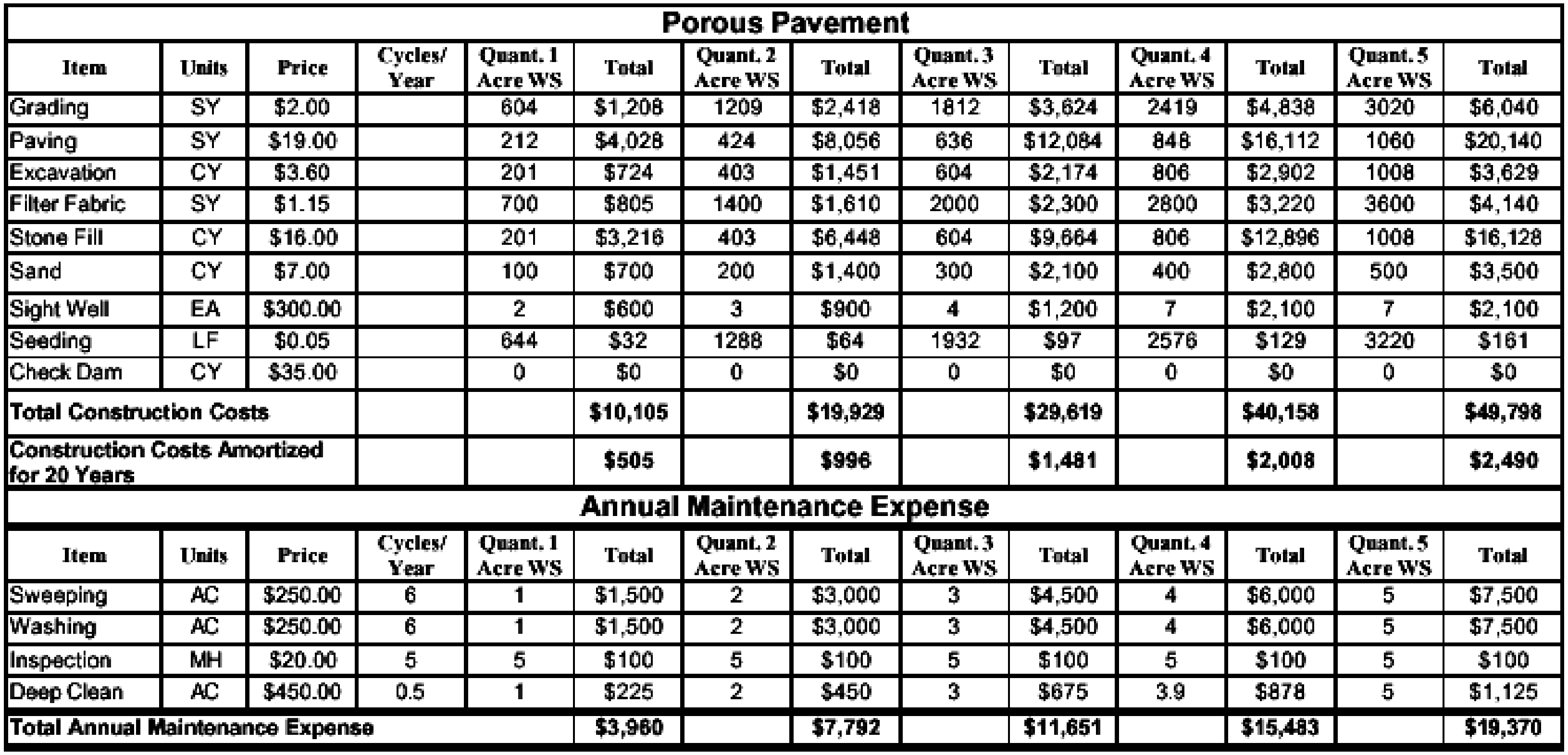
Additional Information

Cost Considerations

Permeable pavements are up to 25 % cheaper (or at least no more expensive than the traditional forms of pavement construction), when all construction and drainage costs are taken into account. (Accepting that the porous asphalt itself is a more expensive surfacing, the extra cost of which is offset by the savings in underground pipework etc.) (Niemczynowicz, et al., 1987)

Table 2 gives US cost estimates for capital and maintenance costs of porous pavements (Landphair et al., 2000)

Table 2 Engineer's Estimate for Porous Pavement



Porous Pavement

Item	Units	Price	Cycles/ Year	Quant. 1 Acre WS	Total	Quant. 2 Acre WS	Total	Quant. 3 Acre WS	Total	Quant. 4 Acre WS	Total	Quant. 5 Acre WS	Total
Grading	SY	$2.00		604	$1,208	1209	$2,418	1812	$3,624	2419	$4,838	3020	$6,040
Paving	SY	$19.00		212	$4,028	424	$8,056	636	$12,084	848	$16,112	1060	$20,140
Excavation	CY	$3.60		201	$724	403	$1,451	604	$2,174	806	$2,902	1008	$3,629
Filter Fabric	SY	$1.15		700	$805	1400	$1,610	2000	$2,300	2800	$3,220	3600	$4,140
Stone Fill	CY	$16.00		201	$3,216	403	$6,448	604	$9,664	806	$12,896	1008	$16,128
Sand	CY	$7.00		100	$700	200	$1,400	300	$2,100	400	$2,800	500	$3,500
Sight Well	EA	$300.00		2	$600	3	$900	4	$1,200	7	$2,100	7	$2,100
Seeding	LF	$0.05		644	$32	1288	$64	1932	$97	2576	$129	3220	$161
Check Dam	CY	$35.00		0	$0	0	$0	0	$0	0	$0	0	$0
Total Construction Costs					**$10,105**		**$19,929**		**$29,619**		**$40,158**		**$49,798**
Construction Costs Amortized for 20 Years					**$505**		**$996**		**$1,481**		**$2,008**		**$2,490**

Annual Maintenance Expense

Item	Units	Price	Cycles/ Year	Quant. 1 Acre WS	Total	Quant. 2 Acre WS	Total	Quant. 3 Acre WS	Total	Quant. 4 Acre WS	Total	Quant. 5 Acre WS	Total
Sweeping	AC	$250.00	6	1	$1,500	2	$3,000	3	$4,500	4	$6,000	5	$7,500
Washing	AC	$250.00	6	1	$1,500	2	$3,000	3	$4,500	4	$6,000	5	$7,500
Inspection	MH	$20.00	5	5	$100	5	$100	5	$100	5	$100	5	$100
Deep Clean	AC	$450.00	0.5	1	$225	2	$450	3	$675	3.9	$878	5	$1,125
Total Annual Maintenance Expense					**$3,960**		**$7,792**		**$11,651**		**$15,483**		**$19,370**

Supplemental Information

-

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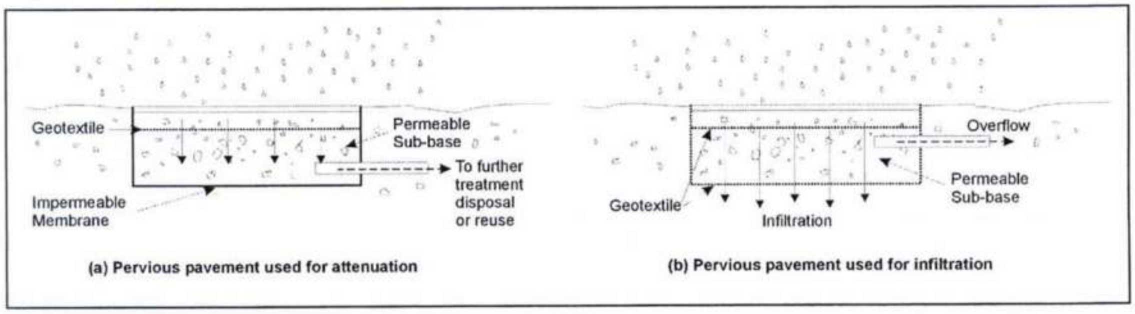

Schematics of a Pervious Pavement System

Alternative Building Materials SD-21

Design Objectives

- ✓ Maximize Infiltration
- ✓ Provide Retention
- ✓ Source Control
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutant
- Collect and Convey

Description

Alternative building materials are selected instead of conventional materials for new construction and renovation. These materials reduce potential sources of pollutants in stormwater runoff by eliminating compounds that can leach into runoff, reducing the need for pesticide application, reducing the need for painting and other maintenance, or by reducing the volume of runoff.

Approach

Alternative building materials are available for use as lumber for decking, roofing materials, home siding, and paving for driveways, decks, and sidewalks.

Suitable Applications

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

Design Considerations

Designing New Installations

Decking

One of the most common materials for construction of decks and other outdoor construction has traditionally been pressure treated wood, which is now being phased out. The standard treatment is called CCA, for chromated copper arsenate. The key ingredients are arsenic (which kills termites, carpenter ants and other insects), copper (which kills the fungi that cause wood to rot) and chromium (which reacts with the other ingredients to bind them to the wood). The amount of arsenic is far from trivial. A deck just 8 feet x 10 feet contains more than 1 1/3 pounds of this highly potent poison. Replacement materials include a new type of pressure treated wood, plastic and composite lumber.

There are currently over 20 products in the market consisting of plastic or plastic-wood composites. Plastic lumber is made from 100% recycled plastic, # 2 HDPE and polyethylene plastic milk jugs

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and soap bottles. Plastic-wood composites are a combination of plastic and wood fibers or sawdust. These materials are a long lasting exterior weather, insect, and chemical resistant wood lumber replacement for non structural applications. Use it for decks, docks, raised garden beds and planter boxes, pallets, hand railings, outdoor furniture, animal pens, boat decks, etc.

New pressure treated wood uses a much safer recipe, ACQ, which stands for ammoniacal copper quartenary. It contains no arsenic and no chromium. Yet the American Wood Preservers Association has found it to be just as effective as the standard formula. ACQ is common in Japan and Europe.

Roofing

Several studies have indicated that metal used as roofing material, flashing, or gutters can leach metals into the environment. The leaching occurs because rainfall is slightly acidic and slowly dissolved the exposed metals. Common traditional applications include copper sheathing and galvanized (zinc) gutters.

Coated metal products are available for both roofing and gutter applications. These products eliminate contact of bare metal with rainfall, eliminating one source of metals in runoff. There are also roofing materials made of recycled rubber and plastic that resemble traditional materials.

A less traditional approach is the use of green roofs. These roofs are not just green, they're alive. Planted with grasses and succulents, low- profile green roofs reduce the urban heat island effect, stormwater runoff, and cooling costs, while providing wildlife habitat and a connection to nature for building occupants. These roofs are widely used on industrial facilities in Europe and have been established as experimental installations in several locations in the US, including Portland, Oregon. Their feasibility is questionable in areas of California with prolonged, dry, hot weather.

Paved Areas

Traditionally, concrete is used for construction of patios, sidewalks, and driveways. Although it is non-toxic, these paved areas reduce stormwater infiltration and increase the volume and rate of runoff. This increase in the amount of runoff is the leading cause of stream channel degradation in urban areas.

There are a number of alternative materials that can be used in these applications, including porous concrete and asphalt, modular blocks, and crushed granite. These materials, especially modular paving blocks, are widely available and a well established method to reduce stormwater runoff.

Building Siding

Wood siding is commonly used on the exterior of residential construction. This material weathers fairly rapidly and requires repeated painting to prevent rotting. Alternative “new” products for this application include cement-fiber and vinyl. Cement-fiber siding is a masonry product made from Portland cement, sand, and cellulose and will not burn, cup, swell, or shrink.

Pesticide Reduction

A common use of powerful pesticides is for the control of termites. Chlordane was used for many years for this purpose and is now found in urban streams and lakes nationwide. There are a number of physical barriers that can be installed during construction to help reduce the use of pesticides.

Sand barriers for subterranean termites are a physical deterrent because the termites cannot tunnel through it. Sand barriers can be applied in crawl spaces under pier and beam foundations, under slab foundations, and between the foundation and concrete porches, terraces, patios and steps. Other possible locations include under fence posts, underground electrical cables, water and gas lines, telephone and electrical poles, inside hollow tile cells and against retaining walls.

Metal termite shields are physical barriers to termites which prevent them from building invisible tunnels. In reality, metal shields function as a helpful termite detection device, forcing them to build tunnels on the outside of the shields which are easily seen. Metal termite shields also help prevent dampness from wicking to adjoining wood members which can result in rot, thus making the material more attractive to termites and other pests. Metal flashing and metal plates can also be used as a barrier between piers and beams of structures such as decks, which are particularly vulnerable to termite attack.

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

There are no good, independent, comprehensive sources of information on alternative building materials for use in minimizing the impacts of stormwater runoff. Most websites or other references to "green" or "alternative" building materials focus on indoor applications, such as formaldehyde free plywood and low VOC paints, carpets, and pads. Some supplemental information on alternative materials is available from the manufacturers.

Fires are a source of concern in many areas of California. Information on the flammability of alternative decking materials is available from the University of California Forest Product Laboratory (UCFPL) website at: http://www.ucfpl.ucop.edu/WDDeckIntro.htm

Vortex Separator MP-51

Description

Vortex separators: (alternatively, swirl concentrators) are gravity separators, and in principle are essentially wet vaults. The difference from wet vaults, however, is that the vortex separator is round, rather than rectangular, and the water moves in a centrifugal fashion before exiting. By having the water move in a circular fashion, rather than a straight line as is the case with a standard wet vault, it is possible to obtain significant removal of suspended sediments and attached pollutants with less space. Vortex separators were originally developed for combined sewer overflows (CSOs), where it is used primarily to remove coarse inorganic solids. Vortex separation has been adapted to stormwater treatment by several manufacturers.

Design Considerations

- Service Area
- Settling Velocity
- Appropriate Sizing
- Inlet Pipe Diameter

California Experience

There are currently about 100 installations in California.

Targeted Constituents

✓	Sediment	▲
✓	Nutrients	●
✓	Trash	
✓	Metals	●
	Bacteria	
✓	Oil and Grease	
✓	Organics	

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

Advantages

- May provide the desired performance in less space and therefore less cost.
- May be more cost-effective pre-treatment devices than traditional wet or dry basins.
- Mosquito control may be less of an issue than with traditional wet basins.

Limitations

- As some of the systems have standing water that remains between storms, there is concern about mosquito breeding.
- It is likely that vortex separators are not as effective as wet vaults at removing fine sediments, on the order 50 to 100 microns in diameter and less.
- The area served is limited by the capacity of the largest models.
- As the products come in standard sizes, the facilities will be oversized in many cases relative to the design treatment storm, increasing the cost.
- The non-steady flows of stormwater decreases the efficiency of vortex separators from what may be estimated or determined from testing under constant flow.
- Do not remove dissolved pollutants.
- A loss of dissolved pollutants may occur as accumulated organic

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matter (e.g., leaves) decomposes in the units.

Design and Sizing Guidelines

The stormwater enters, typically below the effluent line, tangentially into the basin, thereby imparting a circular motion in the system. Due to centrifugal forces created by the circular motion, the suspended particles move to the center of the device where they settle to the bottom. There are two general types of vortex separation: free vortex and dampened (or impeded) vortex. Free vortex separation becomes dampened vortex separation by the placement of radial baffles on the weir-plate that impede the free vortex-flow pattern

It has been stated with respect to CSOs that the practical lower limit of vortex separation is a particle with a settling velocity of 12 to 16.5 feet per hour (0.10 to 0.14 cm/s). As such, the focus for vortex separation in CSOs has been with settleable solids generally 200 microns and larger, given the presence of the lighter organic solids. For inorganic sediment, the above settling velocity range represents a particle diameter of 50 to 100 microns. Head loss is a function of the size of the target particle. At 200 microns it is normally minor but increases significantly if the goal is to remove smaller particles.

The commercial separators applied to stormwater treatment vary considerably with respect to geometry, and the inclusion of radial baffles and internal circular chambers. At one extreme is the inclusion of a chamber within the round concentrator. Water flows initially around the perimeter between the inner and outer chambers, and then into the inner chamber, giving rise to a sudden change in velocity that purportedly enhances removal efficiency. The opposite extreme is to introduce the water tangentially into a round manhole with no internal parts of any kind except for an outlet hood. Whether the inclusion of chambers and baffles gives better performance is unknown. Some contend that free vortex, also identified as swirl concentration, creates less turbulence thereby increasing removal efficiency. One product is unique in that it includes a static separator screen.

- Sized is based on the peak flow of the design treatment event as specified by local government.
- If an in-line facility, the design peak flow is four times the peak of the design treatment event.
- If an off-line facility, the design peak flow is equal to the peak of the design treatment event.
- Headloss differs with the product and the model but is generally on the order of one foot or less in most cases.

Construction/Inspection Considerations

No special considerations.

Performance

Manufacturer’s differ with respect to performance claims, but a general statement is that the manufacturer’s design and rated capacity (cfs) for each model is based on and believed to achieve an aggregate reduction of 90% of all particles with a specific gravity of 2.65 (glacial sand) down to 150 microns, and to capture the floatables, and oil and grease. Laboratory tests of two products support this claim. The stated performance expectation therefore implies that a lesser removal efficiency is obtained with particles less than 150 microns, and the lighter, organic settleables. Laboratory tests of one of the products found about 60% removal of 50 micron sand at the expected average operating flow rate

Experience with the use of vortex separators for treating combined sewer overflows (CSOs), the original application of this technology, suggests that the lower practical limit for particle removal are particles with a settling velocity of 12 feet per hour (Sullivan, 1982), which represents a particle diameter of 100 to 200 microns, depending on the specific gravity of the particle. The CSO experience therefore seems consistent with the limited experience with treating stormwater, summarized above

Traditional treatment technologies such as wet ponds and extended detention basins are generally believed to be more effective at removing very small particles, down to the range of 10 to 20 microns. Hence, it is intuitively expected that vortex separators do not perform as well as the traditional wet and dry basins, and filters. Whether this matters depends on the particle size distribution of the sediments in stormwater. If the distribution leans towards small material, there should be a marked difference between vortex separators and, say, traditional wet vaults. There are little data to support this conjecture

In comparison to other treatment technologies, such as wet ponds and grass swales, there are few studies of vortex separators. Only two of manufactured products currently available have been field tested. Two field studies have been conducted. Both achieved in excess of 80% removal of TSS. However, the test was conducted in the Northeast (New York state and Maine) where it is possible the stormwater contained significant quantities of deicing sand. Consequently, the influent TSS concentrations and particle size are both likely considerably higher than is found in California stormwater. These data suggest that if the stormwater particles are for the most part fine (i.e., less than 50 microns), vortex separators will not be as efficient as traditional treatment BMPs such as wet ponds and swales, if the latter are sized according to the recommendations of this handbook.

There are no equations that provide a straightforward determination of efficiency as a function of unit configuration and size. Design specifications of commercial separators are derived from empirical equations that are unique and proprietary to each manufacturer. However, some general relationships between performance and the geometry of a separator have been developed. CSO studies have found that the primary determinants of performance of vortex separators are the diameters of the inlet pipe and chamber with all other geometry proportional to these two.

Sullivan et al. (1982) found that performance is related to the ratios of chamber to inlet diameters, D2/D1, and height between the inlet and outlet and the inlet diameter, H1/D1, shown in Figure 3. The relationships are: as D2/D1 approaches one, the efficiency decreases; and, as the H1/D1 ratio decreases, the efficiency decreases. These relationships may allow qualitative comparisons of the alternative designs of manufacturers. Engineers who wish to apply these concepts should review relevant publications presented in the References.

Siting Criteria

There are no particularly unique siting criteria. The size of the drainage area that can be served by vortex separators is directly related to the capacities of the largest models.

Additional Design Guidelines

Vortex separators have two capacities if positioned as in-line facilities, a treatment capacity and a hydraulic capacity. Failure to recognize the difference between the two may lead to significant under sizing; i.e., too small a model is selected. This observation is relevant to three of the five products. These three technologies all are designed to experience a unit flow rate of about 24 gallons/square foot of separator footprint at the peak of the design treatment event. This is the horizontal area of the separator zone within the container, not the total footprint of the unit. At this unit flow rate, laboratory tests by these manufacturers have established that the performance will meet the general claims previously described. However, the units are sized to handle 100 gallons/square foot at the peak of the hydraulic event. Hence, in selecting a particular model the design engineer must be certain to match the peak flow of the design event to the stated treatment capacity, not the hydraulic capacity. The former is one-fourth the latter. If the unit is positioned as an off-line facility, the model selected is based on the capacity equal to the peak of the design treatment event.

Maintenance

Maintenance consists of the removal of accumulated material with an eductor truck. It may be necessary to remove and dispose the floatables separately due to the presence of petroleum product.

Maintenance Requirements

Remove all accumulated sediment, and litter and other floatables, annually, unless experience indicates the need for more or less frequent maintenance.

Cost

Manufacturers provide costs for the units including delivery. Installation costs are generally on the order of 50 to 100 % of the manufacturer's cost. For most sites the units are cleaned annually.

Cost Considerations

The different geometry of the several manufactured separators suggests that when comparing the costs of these systems to each other, that local conditions (e.g., groundwater levels) may affect the relative cost-effectiveness.

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Drain Inserts MP-52

Design Considerations

- Use with other BMPs
- Fit and Seal Capacity within Inlet

Targeted Constituents

- ✓ Sediment
- ✓ Nutrients
- ✓ Trash
- ✓ Metals
- Bacteria
- ✓ Oil and Grease
- ✓ Organics

Removal Effectiveness

See New Development and Redevelopment Handbook-Section 5.

Description

Drain inserts are manufactured filters or fabric placed in a drop inlet to remove sediment and debris. There are a multitude of inserts of various shapes and configurations, typically falling into one of three different groups: socks, boxes, and trays. The sock consists of a fabric, usually constructed of polypropylene. The fabric may be attached to a frame or the grate of the inlet holds the sock. Socks are meant for vertical (drop) inlets. Boxes are constructed of plastic or wire mesh. Typically a polypropylene "bag" is placed in the wire mesh box. The bag takes the form of the box. Most box products are one box; that is, the setting area and filtration through media occur in the same box. Some products consist of one or more trays or mesh grates. The trays may hold different types of media. Filtration media vary by manufacturer. Types include polypropylene, porous polymer, treated cellulose, and activated carbon.

California Experience

The number of installations is unknown but likely exceeds a thousand. Some users have reported that these systems require considerable maintenance to prevent plugging and bypass.

Advantages

- Does not require additional space as inserts as the drain inlets are already a component of the standard drainage systems.
- Easy access for inspection and maintenance.
- As there is no standing water, there is little concern for mosquito breeding.
- A relatively inexpensive retrofit option.

Limitations

Performance is likely significantly less than treatment systems that are located at the end of the drainage system such as ponds and vaults. Usually not suitable for large areas or areas with trash or leaves than can plug the insert.

Design and Sizing Guidelines

Refer to manufacturer's guidelines. Drain inserts come any many configurations but can be placed into three general groups: socks, boxes, and trays. The sock consists of a fabric, usually constructed of polypropylene. The fabric may be attached to a frame or the grate of the inlet holds the sock. Socks are meant for vertical (drop) inlets. Boxes are constructed of plastic or wire mesh. Typically a polypropylene "bag" is placed in the wire mesh box. The bag takes the form of the box. Most box products are one box; that is, the setting area and filtration through media occurs in the same box. One manufacturer has a double-box. Stormwater enters the first box where setting occurs. The stormwater flows into the second box where the filter media is located. Some products consist of one or more trays or mesh grates. The trays can hold different types of media. Filtration media vary with the manufacturer: types include polypropylene, porous polymer, treated cellulose, and activated carbon.

Construction/Inspection Considerations

Be certain that installation is done in a manner that makes certain that the stormwater enters the unit and does not leak around the perimeter. Leakage between the frame of the insert and the frame of the drain inlet can easily occur with vertical (drop) inlets.

Performance

Few products have performance data collected under field conditions.

Siting Criteria

It is recommended that inserts be used only for retrofit situations or as pretreatment where other treatment BMPs presented in this section area used.

Additional Design Guidelines

Follow guidelines provided by individual manufacturers.

Maintenance

Likely require frequent maintenance, on the order of several times per year.

Cost

- The initial cost of individual inserts ranges from less than $100 to about $2,000. The cost of using multiple units in curb inlet drains varies with the size of the inlet.
- The low cost of inserts may tend to favor the use of these systems over other, more effective treatment BMPs. However, the low cost of each unit may be offset by the number of units that are required, more frequent maintenance, and the shorter structural life (and therefore replacement).

References and Sources of Additional Information

Hrachovec, R., and G. Minton, 2001, Field testing of a sock-type catch basin insert, Planet CPR, Seattle, Washington

Interagency Catch Basin Insert Committee, Evaluation of Commercially-Available Catch Basin Inserts for the Treatment of Stormwater Runoff from Developed Sites, 1995

Larry Walker Associates, June 1998, NDMP Inlet/In-Line Control Measure Study Report

Manufacturers literature

Santa Monica (City), Santa Monica Bay Municipal Stormwater/Urban Runoff Project - Evaluation of Potential Catch basin Retrofits, Woodward Clyde, September 24, 1998

Woodward Clyde, June 11, 1996, Parking Lot Monitoring Report, Santa Clara Valley Nonpoint Source Pollution Control Program.

Oldcastle Precast®

FLOGARD+PLUS®
CATCH BASIN INSERT FILTER

Inspection and Maintenance Guide

DRAINAGE PROTECTION SYSTEMS
DPS

A division of
Oldcastle Precast

Stormwater

SCOPE:

Federal, State and Local Clean Water Act regulations and those of insurance carriers require that stormwater filtration systems be maintained and serviced on a recurring basis. The intent of the regulations is to ensure that the systems, on a continuing basis, efficiently remove pollutants from stormwater runoff thereby preventing pollution of the nation's water resources. These specifications apply to the FloGard+Plus® Catch Basin Insert Filter.

RECOMMENDED FREQUENCY OF SERVICE:

Drainage Protection Systems (DPS) recommends that installed FloGard+Plus Catch Basin Insert Filters be serviced on a recurring basis. Ultimately, the frequency depends on the amount of runoff, pollutant loading and interference from debris (leaves, vegetation, cans, paper, etc.); however, it is recommended that each installation be serviced a minimum of three times per year, with a change of filter medium once per year. DPS technicians are available to do an onsite evaluation, upon request.

RECOMMENDED TIMING OF SERVICE:

DPS guidelines for the timing of service are as follows:

1. For areas with a definite rainy season: Prior to, during and following the rainy season.
2. For areas subject to year-round rainfall: On a recurring basis (at least three times per year).
3. For areas with winter snow and summer rain: Prior to and just after the snow season and during the summer rain season.
4. For installed devices not subject to the elements (washracks, parking garages, etc.): On a recurring basis (no less than three times per year).

SERVICE PROCEDURES:

1. The catch basin grate shall be removed and set to one side. The catch basin shall be visually inspected for defects and possible illegal dumping. If illegal dumping has occurred, the proper authorities and property owner representative shall be notified as soon as practicable.
2. Using an industrial vacuum, the collected materials shall be removed from the liner. (Note: DPS uses a truck-mounted vacuum for servicing FloGard+Plus catch basin inserts.)
3. When all of the collected materials have been removed, the filter medium pouches shall be removed by unsnapping the tether from the D-ring and set to one side. The filter liner, gaskets, stainless steel frame and mounting brackets, etc., shall be inspected for continued serviceability. Minor damage or defects found shall be corrected on-the-spot and a notation made on the Maintenance Record. More extensive deficiencies that affect the efficiency of the filter (torn liner, etc.), if approved by the customer representative, will be corrected and an invoice submitted to the representative along with the Maintenance Record.
4. The filter medium pouches shall be inspected for defects and continued serviceability and replaced as necessary and the pouch tethers re-attached to the liner's D-ring. See below.
5. The grate shall be replaced.

REPLACEMENT AND DISPOSAL OF EXPOSED FILTER MEDIUM AND COLLECTED DEBRIS

The frequency of filter medium exchange will be in accordance with the existing DPS-Customer Maintenance Contract. DPS recommends that the medium be changed at least once per year. During the appropriate service, or if so determined by the service technician during a non-scheduled service, the filter medium will be replaced with new material. Once the exposed pouches and debris have been removed, DPS has possession and must dispose of it in accordance with local, state and federal agency requirements.

DPS also has the capability of servicing all manner of storm drain filters, catch basin inserts and catch basins without inserts, underground oil/water separators, stormwater interceptors and other such devices. All DPS personnel are highly qualified technicians and are confined space trained and certified. Call us at (888) 950-8826 for further information and assistance.

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CATCH BASIN INSERT FILTER

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CDS® Inspection and Maintenance Guide

CDS TECHNOLOGIES

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	yd3	m3
CDS2015-4	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Support

- Drawings and specifications are available at www.contechstormwater.com.
- Site-specific design support is available from our engineers.

Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, stormwater, earth stabilization and wastewater treament products. For information, visit www.ContechES.com or call 800.338.1122

The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; 7,517,450 related foreign patents or other patents pending.

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CDS Inspection & Maintenance Log

CDS Model: ______________________________ Location: ______________________________

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

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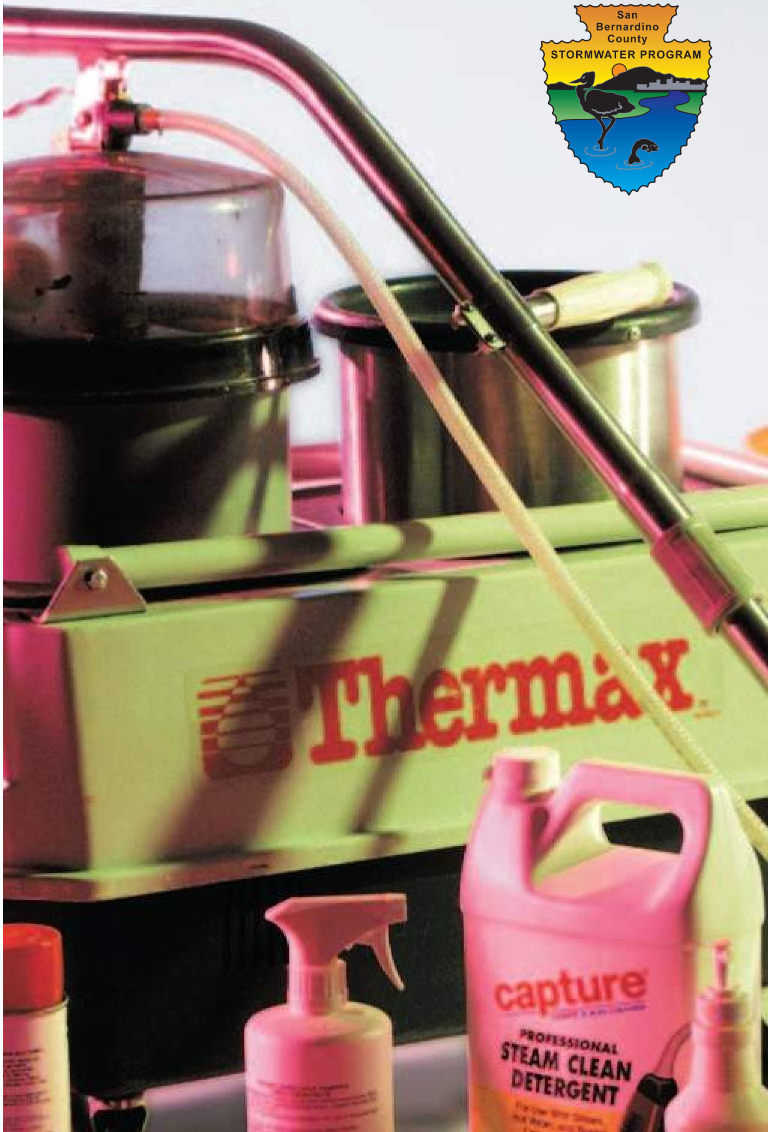
STORMWATER Pollution Prevention

CARPET CLEANING ACTIVITIES

San Bernardino County
STORMWATER PROGRAM



STORMWATER Pollution Prevention

Stormwater Management Practices for Carpet Cleaning Activities

Toxic chemicals and discharged waste water from carpet, drapery, furniture and window cleaning often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates local waterways, making them unsafe for people and wildlife. Following these best management practices will prevent pollution, comply with regulations and protect public health.

These guidelines apply even if the cleaning products are labeled "nontoxic" or "biodegradable". Although these products may be less harmful to the environment, they can still have harmful effects if they enter the storm drain untreated.

Dispose of Wastewater Properly

Wastewater from cleaning equipment must be discharged into a sink, toilet, or other drain connected to the sanitary sewer system within sanitary sewer discharge limits, hauled off and disposed of properly, or may be discharged to a pervious area, for example, a lawn area, as long as it does not overflow into the street, gutter, parking lot or storm drain. Wastewater should never be discharged into a street, gutter, parking lot or storm drain.

Filter Wastewater

Carpet cleaning wastewater should be filtered before discharging it to the sanitary sewer since fibers and other debris in the wastewater can clog pipes. The filtered material can be disposed of in the garbage, provided that the waste is not contaminated with hazardous pollutants.

To report illegal dumping call
(877) WASTE18
or visit our website:
sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

WASH YOUR CAR THE ECO-FRIENDLY WAY!

When possible, wash in a professional car wash.

1. **Locate** the nearest storm drain and ensure that wash water does not flow into it.
2. **Wash** in a contained area or on grass*, gravel or other permeable surface. Dispose of excess soapy water into the sanitary sewer *(ie. sink or toilet)* or onto grass.
3. **Use** eco-friendly cleaning products (*non-toxic, phosphate free or biodegradable*). Use as little soap as possible and wipe brake dust off tires with a rag before washing.
4. **Conserve** water by using a high pressure hose and turn off the water when not in use.

**Some local ordinances may not allow a car to be parked on the front lawn. Check with your City's Building and Code department if you are unsure.*

How Does Eco Car Washing Help Local Waterways?

When excess wash water travels through the street it has the potential to pick up oil, grease and other chemicals along the way before it ends up in the curb, gutter and the storm drain system. **This contaminated water then travels to our creeks and the Santa Ana River making it unsafe for people and wildlife**.

To report illegal dumping, call **(877) WASTE18** or
visit **sbcountystormwater.org**
To find a Hazardous Waste Facility, call **(800) OILY CAT**

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¡LAVE SU AUTO DE MANERA ECOLÓGICA!

Cuando sea posible, lávelo en un lavadero profesional de autos.

1 **Ubique** el desagüe pluvial más cercano y asegúrese de que nada pueda entrar en él o que pueda descargarse allí.

2 **Lave** su auto sobre el cesped, grava u otras superficies permeables. Elimine el exceso de agua jabonosa en un drenaje sanitario *(por ejemplo, lavamanos o inodoro)* o en el césped.

3 **Use** productos de limpieza ecológicos *(no tóxicos, sin fosfato o biodegradables)*. Use la menor cantidad de jabón posible y limpie el polvo de frenos de los neumáticos con un trapo antes de lavar.

4 **Conserve** agua usando una manguera de alta presión y cierre el agua cuando no la use.

** Es posible que algunas ordenanzas locales no permitan estacionar sobre el césped en el frente de la casa. Consulte con el departamento de Código Urbano y Edificación de su ciudad si no está seguro.*

¿De qué Manera el Lavado de Autos Ecológico Ayuda a Proteger los Canales Fluviales Locales?

Cuando el exceso de agua de lavado viaja por la calle, es posible que recoja aceite, grasa y otros elementos químicos en el camino antes de que llegue en el desagüe pluvial y el sistema de la boca de tormenta. **Esa agua contaminada luego viaja hacia nuestros arroyos y al Río Santa Ana, haciendo que sea inseguro para la gente y los animales.**

Para reportar actividades ilegales, llame a **(877) WASTE18** o visite **sbcountystormwater.org**. Para encontrar un establecimiento de Desechos Peligrosos, llame al **(800) OILY CAT**

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Pool Discharge Tips

Maintain your pool properly and help protect the environment

DID YOU KNOW?

Routine swimming pool maintenance generates a variety of wastes such as cleaning wastewater, filter back-wash residues, biocides and acid washes that can contribute to stormwater pollution. Chlorine and other pool chemicals can harm our waterways when they are discharged improperly.

Share these good housekeeping practices with your pool service personnel to keep pollutants out of our waterways:

HOLD IT BEFORE YOU DRAIN IT.

- De-chlorinate the water before draining the pool to the storm drain.
- Consult with your pool contractor before de-chlorinating the pool to learn about your options.

IMPORTANT:

- Dispose of filter backwash solids in the trash or landscape area.
- Neutralize acid washes before discharging to the sewer. Do not discharge to the storm drain.

SHUT: **Shut off the chlorination system or stop adding chlorine.**

HOLD: **Hold the water in the pool for at least 5 days or add a de-chlorinating agent.**

TEST: **Use a pool testing kit to ensure the level of chlorine is at 0.1ppm before discharging the water.**

- Make sure all debris is removed and chemicals are dissipated.
- pH of pool water should be between 6.5 and 8.5 before discharging.
- Make sure the water is free of any discoloration, mosquitoes, dirt or algae.

DRAIN: **Check with your city for local requirements before discharging your pool to the storm drain or sewer.**

- **Alternative 1:** Sanitary Sewer — Some cities allow pools to be drained to the sanitary sewer during non-peak hours.
- **Alternative 2:** Lawn or Garden — Discharge the pool water through the lawn or garden. The flow should be controlled to prevent erosion problems or the water entering a neighbor's property.
- **For Saltwater Pools:** Saltwater pools should only be drained to the sewer or hauled away.

To report illegal dumping, call (877) WASTE18 or visit sbcountystormwater.org

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Consejos para Vaciar su Piscina

Conserve su piscina en buen estado y ayude a proteger el medio ambiente

¿Sabía que...?

El mantenimiento de la piscina genera desechos, como las aguas residuales de limpieza, los residuos del agua estancada de los filtros y los lavados al ácido y otros químicos, que pueden contribuir a la contaminación de las aguas en las alcantarillas. El cloro y otros productos químicos para piscinas pueden dañar el medio ambiente cuando se desechan de manera inadecuada.

Comparta estas buenas prácticas de limpieza con su personal de servicio de piscinas para mantener las alcantarillas libres de contaminantes:

ESPERE ANTES DE VACIAR.

- **Debe eliminar el cloro del agua antes de vaciar la piscina en las alcantarillas.**
- **Consulte con su contratista de piscina para obtener más información sobre sus opciones.**

IMPORTANTE:

- **Deseche los sólidos del agua estancada de los filtros en la basura o en el jardín.**
- **Neutralice los lavados al ácido antes de vaciarlos en la alcantarilla. No deseche nada contaminante en las alcantarillas.**

CORTAR:	**Corte el sistema de cloración o deje de agregar cloro.**
CONSERVAR:	**Conserve el agua en la piscina 5 días o agregue un agente de descloración.**
PROBAR:	**Utilice un equipo de pruebas para piscinas con el fin de asegurar que el nivel de cloro esté en 0.1ppm antes de vaciar el agua.** ● Asegúrese de retirar todos los desechos y disipar los químicos. ● El pH del agua de la piscina debe estar entre 6.5 y 8.5 antes del vaciado. ● Asegúrese de que el agua no contenga contaminacion, zancudos, suciedad o algas.
VACIAR:	**Verifique los requisitos locales de su ciudad antes de vaciar su piscina en el desagüe de las alcantarillas.** ● **Alternativa 1:** Drenaje Sanitario — Algunas ciudades permiten que las piscinas se vacíen en el drenaje sanitario. ● **Alternativa 2:** Césped o Jardín — Vacíe el agua de la piscina en el césped o jardín. Se debe controlar la corriente de agua para evitar problemas de erosión o que el agua entre en la propiedad del vecino. ● **Para las Piscinas de Agua Salada:** Estas piscinas solo se deben ser vaciados en la alcantarilla o se debe transportar el agua y los residuos a algún lugar adecuado.

Para reportar desechos ilegales, comuníquese al (877) WASTE18 o visite sbcountystormwater.org

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WISHFUL THINKING...

UNTIL THIS IS A REALITY,

PLEASE PICK UP AFTER YOUR PET.

San Bernardino County
STORMWATER PROGRAM

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MOBILE VEHICLE CLEANING & MAINTENANCE

DISCHARGE INTO THE STORM DRAIN, **ACCIDENTAL OR NOT,** CAN LEAD TO ENFORCEMENT ACTIONS, WHICH CAN INCLUDE FINES.

These best management practices will help you **prevent polluted water and other materials from flowing into the street, gutter and storm drain**.

WASH WATER DISPOSAL

✓ Wash in contained area that has been bermed up to contain the wash water.

- ✓ When washing items contaminated by hazardous materials, wash water should be collected and hauled off-site for proper disposal.
- ✓ Wash in customers wash bay or pump wastewater to the wash bays' pretreatment system.

! Engine cleaning must be performed at a facility that has the equipment to properly process the contaminated wash water runoff.

HAZARDOUS WASTE SPILL CLEAN-UP & DISPOSAL

✓ Stop the source of the spill immediately. Locate the nearest storm drain and ensure nothing can enter or be discharged into it.

✓ Use tarps and drip pans to prevent spills.

- ✓ If a spill occurs, use an absorbent material such as kitty litter or absorbent pads.
- ✓ Clean up the excess. Properly dispose of absorbent material used to clean up spills - contact an approved hauler for assistance/disposal. Sweep work area thoroughly after cleaning.
- ✓ Keep toxics out of the trash by disposing of them properly, this includes absorbent materials used to clean up toxic waste spills. Toxic materials may include used motor oil and oil filters, antifreeze, batteries and gasoline. Make sure to maintain hauling records for all hazardous waste.

To report illegal dumping, call (877) WASTE18 or visit sbcountystormwater.org
To report toxic spills call (800) 33 TOXIC
To dispose of hazardous waste, call the CUPA Program (909) 386-8401

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SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION

Regulatory information

The Federal Water Pollution Control Act prohibits the discharge of any pollutant to navigable waters from a point source unless the discharge is authorized by a National Pollutant Discharge Elimination System (NPDES) permit. The 1987 passage of the Water Quality Act established NPDES permit requirements for discharges of storm water. The NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

Industrial facilities and construction sites are regulated by the Regional Water Quality Control Board and State Water Resources Control Board, through general storm water permits. Most industrial, manufacturing or transportation businesses that store materials, products or equipment outdoors, or conduct vehicle washing or process operations outdoors are required to obtain coverage under the State Water Resources Control Board's General Industrial Activities Stormwater Permit. For more information about this permit, visit www.swrcb.ca.gov/stormwtr/industrial.html or contact your local storm water coordinator.

If your business conducts construction activities, including clearing, grading, stockpiling or excavation that results in soil disturbances of at least one acre, you are subject to the State Water Resources Control Board's General Construction Activities Stormwater Permit. To find out more about this storm water permit for construction, visit: www.swrcb.ca.gov/stormwtr/construction.html.

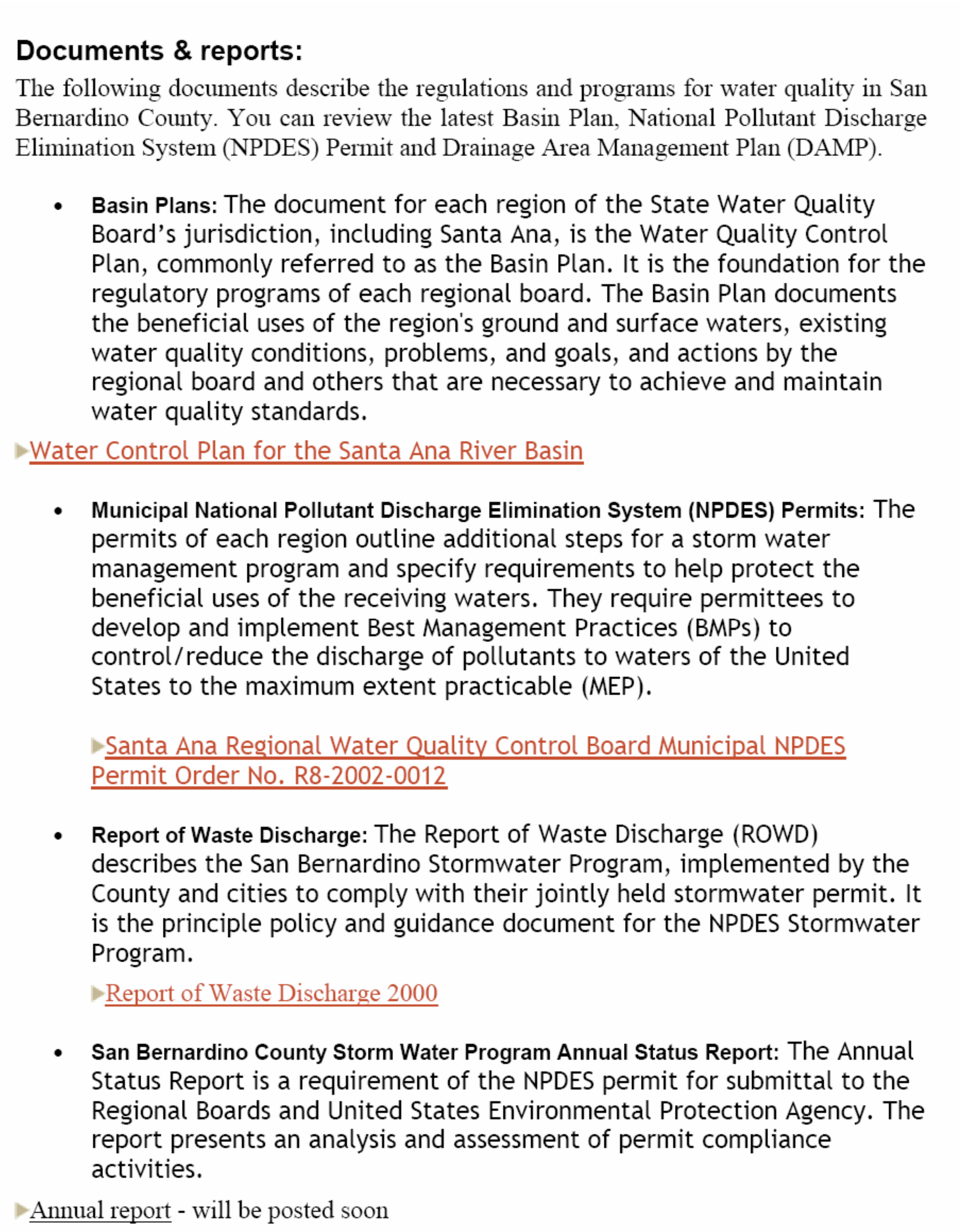
Cities and counties are regulated through permits issued by the Regional Boards. Since 1990, operators of large storm drain systems such as San Bernardino County's have been required to:

- Develop a storm water management program designed to prevent harmful pollutants from being dumped or washed by storm water runoff, into the storm water system, then discharged into local water bodies; and
- Obtain a National Pollutant Discharge Elimination System (NPDES) permit.

The NPDES permit programs in California are administered by the State Water Resources Control Board and by nine regional boards that issue NPDES permits and enforce regulations within their respective region.

San Bernardino County lies within the jurisdiction of the Santa Ana Region. This regional board issues a permit to the San Bernardino County Permittees, which includes the County of San Bernardino, San Bernardino County Flood Control District and incorporated cities of San Bernardino County. Since the program's inception, the County of San Bernardino has served as the principal permittee.

SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION



Documents & reports:

The following documents describe the regulations and programs for water quality in San Bernardino County. You can review the latest Basin Plan, National Pollutant Discharge Elimination System (NPDES) Permit and Drainage Area Management Plan (DAMP).

- **Basin Plans:** The document for each region of the State Water Quality Board's jurisdiction, including Santa Ana, is the Water Quality Control Plan, commonly referred to as the Basin Plan. It is the foundation for the regulatory programs of each regional board. The Basin Plan documents the beneficial uses of the region's ground and surface waters, existing water quality conditions, problems, and goals, and actions by the regional board and others that are necessary to achieve and maintain water quality standards.

▸Water Control Plan for the Santa Ana River Basin

- **Municipal National Pollutant Discharge Elimination System (NPDES) Permits:** The permits of each region outline additional steps for a storm water management program and specify requirements to help protect the beneficial uses of the receiving waters. They require permittees to develop and implement Best Management Practices (BMPs) to control/reduce the discharge of pollutants to waters of the United States to the maximum extent practicable (MEP).

  ▸Santa Ana Regional Water Quality Control Board Municipal NPDES Permit Order No. R8-2002-0012

- **Report of Waste Discharge:** The Report of Waste Discharge (ROWD) describes the San Bernardino Stormwater Program, implemented by the County and cities to comply with their jointly held stormwater permit. It is the principle policy and guidance document for the NPDES Stormwater Program.

  ▸Report of Waste Discharge 2000

- **San Bernardino County Storm Water Program Annual Status Report:** The Annual Status Report is a requirement of the NPDES permit for submittal to the Regional Boards and United States Environmental Protection Agency. The report presents an analysis and assessment of permit compliance activities.

▸Annual report - will be posted soon

For more information about how you can prevent stormwater pollution:

www.sbcountystormwater.org

IT'S A WIN WIN
FOR A FREE RAIN BARREL

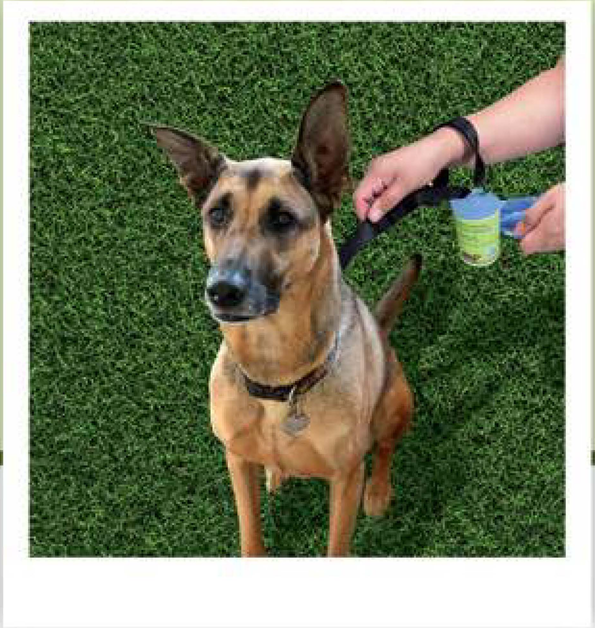
Be part of the solution
and join the great giveaway!

Sign up for San Bernardino County Stormwater's e-newsletter for a chance to win this FREE rain barrel (estimated value: $125 dollars).

Note: we will not share, sell or otherwise distribute email addresses to other organizations or companies.

EVERY DROP COUNTS!

Safely capture rainwater on your property and then reuse it for your home's irrigation. Join others in saving on water expenses and preserving our local waterways.



For more information about
current campaigns visit
sbcountystormwater.org/dog

facebook.com/sbcountystormwater

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Montclair • Ontario • Rancho Cucamonga • Redlands • Rialto • San Bernardino •
San Bernardino County • San Bernardino County Flood Control District • Upland • Yucaipa

PICK UP
After Your Pet!

**Protect the health of
your pet and the environment**

San Bernardino County Stormwater Program

WHY IT MATTERS

PROTECT
YOUR FAMILY AND YOUR PET

- Dog waste can infect children and adults with disease-causing bacteria and parasites.
- Your dog can get infected from the waste of other dogs.

PROTECT
OUR ENVIRONMENT

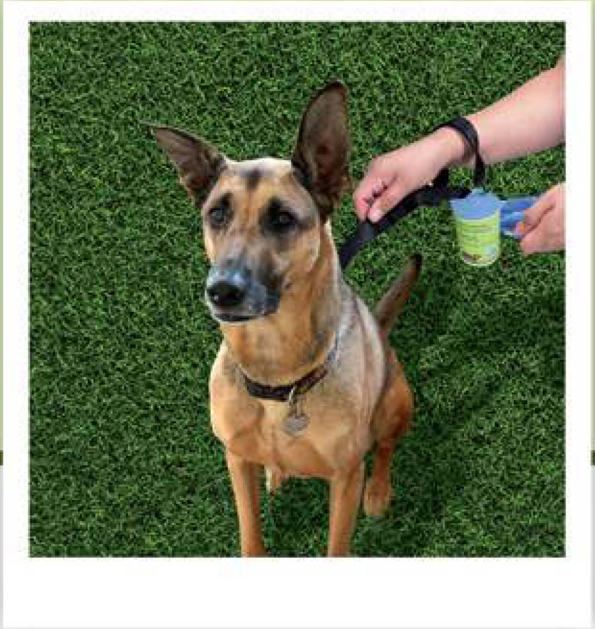
Leaving dog waste on the streets or on your property can have a negative impact on water quality. Pet waste that's not disposed of properly flows untreated through the storm drain system and directly into our local water bodies. Pet waste is a pollutant that contains nutrients, parasites and bacteria that can affect the quality of our rivers and the ocean and make the water unsafe for swimming, drinking or fishing.

BAG IT AND TRASH IT

It's that simple to protect our health and the environment!

- Keep a supply of bags near your dog leash or tie them to the leash
- Use a poop scooper
- Bring several plastic bags with you
- Reuse plastic grocery bags or purchase special doggie waste bags at pet supplies stores
- Make sure your pet's waste gets into a trash can

Encourage your neighbors and other pet owners to do the right thing and pick up after their pets.



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¡RECOJA los desechos de sus mascotas!

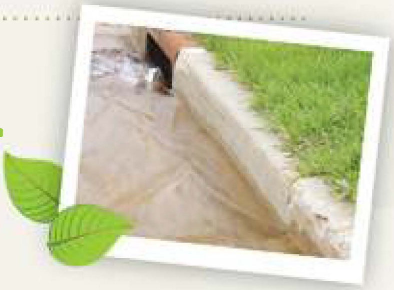
Proteja la salud de su mascota y el medio ambiente

San Bernardino County Stormwater Program

POR QUÉ ES IMPORTANTE

PROTEJA A SU FAMILIA Y A SU MASCOTA

- Los desechos de los perros pueden infectar a niños y adultos con enfermedades causadas por bacterias y parásitos.
- Su perro puede contraer una infección de los desechos de otros perros.



PROTEJA EL MEDIO AMBIENTE

Dejar desechos de perros en la calle o en su propiedad puede tener un impacto negativo en la calidad del agua. Los desechos de mascotas que no se eliminan de la propiedad fluyen sin tratamiento por el sistema de drenaje de tormentas y llegan directamente a las masas de agua locales. Los desechos de mascotas son agentes contaminantes que contienen nutrientes, parásitos y bacterias que pueden afectar la calidad de nuestros ríos y océanos, y hacer que el agua no sea segura para nadar, beber o pescar.

COLÓQUELA EN UNA BOLSA Y TÍRELA EN LA BASURA

Así de simple es proteger nuestra salud y el medio ambiente.

- Guarde algunas bolsas cerca de la correa de su perro o átelas a la correa;
- Use una cuchara para recojer el desecho;
- Lleve varias bolsas plásticas;
- Reutilice bolsas plásticas de comestibles o compre bolsas especiales para desechos de perros en las tiendas para mascotas;
- Asegúrese de tirar los desechos de su perro en un cesto de basura.

Aliente a sus vecinos y otros dueños de mascotas a hacer lo correcto y levantar los desechos de sus mascotas.

WE DID IT OURSELVES AND WE DID IT RIGHT

When painting your home, protect your family and community.

- **PAINTS** that are water-based are less toxic and should be used whenever possible.
- **BRUSHES** with water-based paint should be washed in the sink. Those with oil-based paint should be cleaned with paint thinner.
- **SAFELY** dispose of unwanted paint. The County of San Bernardino offers 9 HHW Centers that accept paint and other toxic waste FREE of charge.

To report illegal dumping, call
(877) WASTE18 or visit
sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

Artwork Courtesy of the City of Los Angeles Stormwater Program. Printed on recycled paper.

LO HICIMOS NOSOTROS MISMOS
Y LO HICIMOS BIEN

Cuando pinte su casa, proteja a su familia y a su comunidad.

- **PINTURAS** a base de agua son menos tóxicas y debe de utilizarlas cuando sea posible.
- **BROCHAS** a base de agua deben ser lavadas en el lavabo. Esas con pintura a base de aceite deben ser limpiadas con disolvente.
- **SANAMENTE** deshágase de la pintura que no necesita. El Condado de San Bernardino ofrece 9 centros de recolección que aceptan pintura y otros desechos tóxicos GRATUITAMENTE.

Para reportar actividades ilegales llamar al
(877) WASTE18 **o visite**
sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

Arte Cortesía del Programa de Agua Pluvial de la Ciudad de Los Angeles. Impreso en papel reciclado.

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Paint SAFELY

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AND WE DID IT RIGHT

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STORMWATER PROGRAM

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Pinte De Manera SANA

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San Bernardino County
STORMWATER PROGRAM

Arte Cortesía del Programa de Agua Pluvial de la Ciudad de Los Angeles. Impreso en papel reciclado.

■ Mobile vehicle maintenance

Wash in a designated area that has been bermed up to contain the wash water.

Common water control devices are: recycling systems; pretreatment or sewer discharge systems; limited recycling systems; wash pits(portable vinyl wash pads), vacuum sludge filtering systems; wet-dry vacuums, sump pumps; drain covers; portable dams; vacu-brooms; oil absorbent pads, booms, pillows, and tubes; plastic sheeting; filter tubs; buckets; pans; and squeegees.

When cleaning engines using chemical additives like soaps, solvents or degreasers, the cleaning must be performed at a facility that has the equipment to properly process the contaminated wastewater runoff, or using a leak-proof ground cover device that will catch and contain all contaminated wastewater runoff for later disposal in a manner that complies with city, county, state and federal codes.

Wastewater from cleaning equipment must be discharged into a sink, toilet, or other drain connected to the sanitary sewer

LANDSCAPE MAINTENANCE

DISCHARGE TO THE STORM DRAIN, **ACCIDENTAL OR NOT**, COULD LEAD TO ENFORCEMENT ACTIONS, WHICH COULD INCLUDE FINES.

Follow the best practices below to **prevent water pollution from landscaping activities.**

RECYCLE YARD WASTE

- ✓ Recycle leaves, grass clippings and other yard waste.
- ✓ Do not blow, sweep, rake or hose yard waste into the street or catch basin.
- ✓ **Try grasscycling:** the natural recycling of grass by leaving clippings on the lawn when mowing.

For more information, please visit: **www.calrecycle.ca.gov/organics/grasscycling**

USE FERTILIZERS, HERBICIDES AND PESTICIDES SAFELY

- ✓ Fertilizers, herbicides and pesticides are often carried into the storm drain system by sprinkler runoff. Use natural and non-toxic alternatives as often as possible.
- ✓ If you must use chemical fertilizers, herbicides or pesticides:
  - Spot apply, rather than blanketing entire areas.
  - Avoid applying near curbs and driveways, and **never** before a rain.
  - Apply fertilizers as needed: when plants could best use it and when the potential runoff would be low.
  - Follow the manufacturer's instructions carefully—this will not only give the best results, but will save money.

USE WATER WISELY

- ✓ Control the amount of water and direction of sprinklers. Sprinklers should only be on long enough to allow water to soak into the ground, but not so long as to cause runoff.
- ✓ Periodically inspect, fix leaks and realign sprinkler heads.
- ✓ Plant native vegetation to reduce the need of water, fertilizers, herbicides and pesticides.

HOMEOWNERS

KEEP THESE TIPS IN MIND WHEN HIRING PROFESSIONAL LANDSCAPERS AND REMIND AS NECESSARY.

Leftover pesticides, fertilizers, and herbicides contaminate landfills and should be disposed of through a Hazardous Waste Facility.

For more information on proper disposal call,

(909) 382-5401 or 1-800-OILY CAT.

*FREE for San Bernardino County residents only. Businesses can call for cost inquiries and to schedule an appointment.

To report illegal dumping, call (877) WASTE18 or visit sbcountystormwater.org
To report toxic spills, call 1(800) 33 TOXIC
To dispose of hazardous waste, call 1(800) OILY CAT

sbcountystormwater.org

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MANTENIMIENTO DE JARDINERÍA

LAS DESCARGAS A LOS DESAGUES PLUVIALES, DE MANERA ACCIDENTAL O NO, PUEDEN INDUCIR A LA APLICACIÓN DE MULTAS Y OTRAS MEDIDAS.

Siga las mejores prácticas descritas debajo para evitar la contaminación del agua por actividades de jardinería.

RECICLAJE DE LOS DESECHOS DE JARDÍN

- ✓ Reciclar las hojas, recortes de césped y otros desechos de jardín.
- ✓ No soplar, barrer, o usar la manguera para empujar los desechos de jardín a la calle.
- ✓ **Poner a prueba el reciclaje de césped (grasscycling): la manera natural de reciclar el césped dejando los recortes sobre el césped cuando son cortados. Para más información, visite la página web: www.calrecycle.ca.gov/organics/grasscycling**

USAR FERTILIZANTES, HERBICIDAS Y PESTICIDAS DE MANERA SEGURA

- ✓ Los fertilizantes, herbicidas y pesticidas son arrastrados con frecuencia hacia el sistema de desagüe pluvial mediante el escurrimiento de los rociadores. Use alternativas naturales no tóxicas siempre que sea posible.
- ✓ Si tiene que usar fertilizantes, herbicidas o pesticidas químicos:
  Aplicar solo en el sitio necesario, en lugar de cubrir todas las áreas.
  Evitar aplicar cerca de los bordillos y las calzadas, y nunca antes de que llueva.
  Aplicar los fertilizantes cuando sea necesario: esto es, cuando las plantas mejor podrían usarlo y el posible escurrimiento sea bajo.
  Seguir las instrucciones del fabricante cuidadosamente – esto no solo le proporcionará los mejores resultados, pero le permitirá ahorrar dinero.

USAR EL AGUA DE MANERA PRUDENTE

- ✓ Controlar la cantidad de agua y la orientación de los rociadores. Los rociadores deben ser **solo lo suficientemente largos como para** permitir que el agua remoje el suelo, pero no tan largos que causen un escurrimiento.
- ✓ Inspeccione, repare los escapes y alinee los aspersores periódicamente.
- ✓ Siembre plantas nativas para reducir el uso de agua, fertilizantes, herbicidas y pesticidas.

! PROPIETARIOS DE HOGARES

Tengan en cuenta estos consejos cuando contraten a paisajistas profesionales y recuérdenselos según sea necesario.

Los sobrantes de pesticidas, fertilizantes y herbicidas contaminan los vertederos y deben ser desechados a través de Plantas de Tratamiento para Residuos Peligrosos.

Para más información sobre el manejo adecuado de residuos peligrosos, llame a **(909) 382-5401 o 1-800-OILY CAT.**

*GRATIS únicamente para los residentes del Condado de San Bernardino. Las empresas pueden llamar para indagar sobre los costos y concertar una cita

Para denunciar el vertido ilegal de basura, llame al (877) WASTE18 o visite sbcountystormwater.org
Para denunciar derrames tóxicos, llame al 1(800) 33 TOXIC
Para desechar residuos peligrosos, llame al 1(800) OILY CAT

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FOR MORE INFORMATION ON PREVENTING STORMWATER POLLUTION

CALL 1(800) CLEANUP OR VISIT WWW.SBCOUNTY.GOV/STORMWATER

The San Bernardino County Stormwater Program is a cooperative effort including the Flood Control District, the County of San Bernardino,and the cities of Big Bear Lake, Chino, Chino Hills, Colton, Fontana, Grand Terrace, Highland, Loma Linda, Montclair, Ontario, Rancho Cucamonga, Redlands, Rialto, San Bernardino, Upland, and Yucaipa.

Stormwater Pollution Prevention

Best Management Practices for Homeowner's Associations, Property Managers and Property Owners

San
Bernardino
County
STORMWATER PROGRAM

Your Guide To Maintaining Water Friendly Standards In Your Community

sbcountystormwater.org

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Redlands · Rialto · San Bernardino · San Bernardino County · San Bernardino County Flood Control District · Upland · Yucaipa

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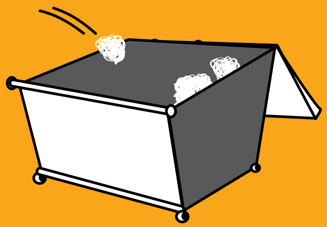
COMMERCIAL TRASH ENCLOSURES

FOLLOW THESE **REQUIREMENTS** TO **KEEP OUR WATERWAYS CLEAN**

Trash enclosures, such as those found in commercial and apartment complexes, typically contain materials that are intended to find their way to a landfill or a recycling facility. **These materials are NOT meant to go into our local lakes and rivers.**

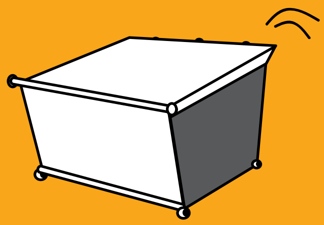
PROTECT WATER QUALITY BY FOLLOWING THESE SIMPLE STEPS

PUT TRASH INSIDE



Place trash inside the bin (preferably in sealed bags)

CLOSE THE LID



Prevent rain from entering the bin in order to avoid leakage of polluted water runoff

KEEP TOXICS OUT

- Paint
- Grease, fats and used oils
- Batteries, electronics and fluorescent lights

SOME ADDITIONAL GUIDELINES, INCLUDE

✓ SWEEP FREQUENTLY

Sweep trash enclosure areas frequently, instead of hosing them down, to prevent polluted water from flowing into the streets and storm drains.

✓ FIX LEAKS

Address trash bin leaks immediately by using dry clean up methods and report to your waste hauler to receive a replacement.

✓ CONSTRUCT ROOF

Construct a solid cover roof over the existing trash enclosure structure to prevent rainwater from coming into contact with trash and garbage. Check with your local City/County for Building Codes.

In San Bernardino County, stormwater pollution is caused by food waste, landscape waste, chemicals and other debris that are washed into storm drains and end up in our waterways - untreated! You can be part of the solution by maintaining a water-friendly trash enclosure.

THANK YOU FOR HELPING TO KEEP SAN BERNARDINO COUNTY CLEAN AND HEALTHY!

San Bernardino County STORMWATER PROGRAM

In the event of a spill or discharge to a storm drain or waterway, contact San Bernadino County Stormwater immediately: (877) WASTE18 | sbcountystormwater.org/report

sbcountystormwater.org

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CESQG PROGRAM

Conditionally Exempt Small Quantity Generator

WHAT IS A CESQG?

Businesses that generate 27 gallons or 220 lbs. of hazardous waste, or 2.2 lbs. of extremely hazardous waste per month are called "Conditionally Exempt Small Quantity Generators," or CESQGs. San Bernardino County Household Hazardous Program provides waste management services to CESQG businesses. The most common CESQGs in San Bernardino County are painters, print shops, auto shops, builders, agricultural operators and property managers, but there are many others. When you call, be ready to describe the types and amounts of waste your business generates in a typical month. If you generate hazardous waste on a regular basis, you must:

- Register with San Bernardino County Fire Department (909) 386-8401 as a hazardous waste generator.
- To obtain an EPA ID# and application form from the State visit www.dtsc.ca.gov.
- Manage hazardous waste in accordance with all applicable local, state and federal laws and regulations.

HOW DO I GET SERVICE?

To arrange an appointment for the CESQG Program, call 1-800-OILY CAT or 909-382-5401. Be ready to describe the type and amount of hazardous waste your business is ready to dispose of, and the types and size(s) of containers that the waste is in.

Waste Type and Cost

There is a small handling fee involved in the collection of hazardous waste from your business. Disposal costs depend on the type of waste.

Aerosols	$1.29/lb.
Automobile motor oil	$.73/gal.
Anti-freeze	$1.57/gal.
Contaminated oil	$4.48/gal.
Car batteries	$.62/ea.
Corrosive liquids, solids	$2.80/lb.
Flammable solids, liquids	$1.57/lb.
Latex Paint	$.73/lb.
Mercury	$10.08/lb.
NiCad/Alkaline Batteries	$2.13/lb.
Oil Base Paints	$1.00/lb.
Oil Filters	$.56/ea.
Oxidizers	$9.63/lb.
PCB Ballasts	$5.94/lb.
Pesticides (most)	$2.91/lb.
Photofixer, developer	$4.31/gal.
Television & Monitors	$11.20/ea.
Additional Handling	$138.00/hr.

Rates subject to change without notice

WE CANNOT ACCEPT

- Radioactives
- Water reactives
- Explosives
- Compressed gas cylinders
- Medical or biohazardous waste
- Asbestos
- Remediation wastes

HAZARDOUS WASTE

WHY IS THE FIRE DEPARTMENT COLLECTING HAZARDOUS WASTE?

Small Quantity Generators often have difficulty disposing of small quantities of hazardous waste. Hazardous waste companies usually have a minimum amount of waste that they will pick up, or charge a minimum fee for service. Typically, the minimum fee exceeds the cost of disposal for the hazardous waste. This leaves the small quantity generator in a difficult situation. Some respond by storing hazardous waste until it becomes economical for the hazardous waste transporter to pick it up, putting the business out of compliance by exceeding regulatory accumulation time limits. Other businesses simply store their hazardous wastes indefinitely, creating an unsafe work environment and exceeding accumulation time limits. Yet other businesses attempt to illegally dispose of their waste at household hazardous waste collection facilities. These facilities are not legally permitted to accept commercial wastes, nor are prepared to provide legal documentation for commercial hazardous waste disposal. In answer to the problems identified above, the San Bernardino County Fire Department Household Hazardous Program instituted the Conditionally Exempt Small Quantity Generator Program.

PAYMENT FOR SERVICES

The CESQG Program will prepare an invoice for your business at the time of service. You can pay at the time of service with cash or a check, or you can mail your payment to the Fire Department within 30 days. Please note that we do not accept credit card payments. The preferred method of payment is to handle payment at time of service. Additional charges may apply for accounts not paid within 30 days.

ARE THERE ANY OTHER WAYS THAT I CAN SAVE MONEY ON HAZARDOUS WASTE DISPOSAL?

Yes! First, start by reducing the amount of waste that you produce by changing processes or process chemicals, at your business. Next, examine if there is a way that you can recycle your waste back into your processes. Network with similar businesses or trade associations for waste minimization and pollution prevention solutions.

WHAT IF YOUR BUSINESS DOES NOT QUALIFY?

Call the San Bernardino County Fire Department Field Services Division for assistance with hazardous waste management at 909-386-8401. If you reduce the amount of waste you generate each month to 27 gallons or less, you may qualify in the future.

WHAT HAPPENS TO YOUR HAZARDOUS WASTE?

Hazardous waste collected by the CESQG Program is transported to a state permitted processing facility in San Bernardino. The waste is further processed at this point and packaged for off-site recycling (oil filters, oil, latex paint, antifreeze, and batteries) or destructive incineration (pesticides, corrosives, flammables, oil based paint).

San Bernardino County Fire Department
CESQG Program
2824 East "W" Street
San Bernardino, CA 92415-0799
Phone: 909-382-5401
Fax: 909-382-5413
www.sbcfire.org/hazmat/hhw.asp
Email: jschwab@sbcfire.org

WORKING OUTDOORS & HANDLING SPILLS

WHEN WORKING OUTDOORS USE THE 3Cs

CUANDO TRABAJE AL AIRE LIBRE UTILICE LAS 3Cs

CONTROL | CONTROL

Locate the nearest storm drain and ensure nothing can enter or be discharged into it.

Ubique el desagüe de aguas pluviales más cercano y asegúrese de que nada pueda ingresar a éste ni descargarse en él.

CONTAIN | CONTENER

Isolate your area to prevent material from potentially flowing or being blown away.

Aísle su área para evitar que el material pueda discurrirse o ser llevado por el viento.

CAPTURE | CAPTURAR

Sweep up debris and place it in the trash. Clean up spills with an absorbent material (e.g. kitty litter) or vacuum with a Wet-Vac and dispose of properly.

Recoja los restos y colóquelos en la basura. Limpie los derrames con un material absorbente (como la arena para gatos) o aspírelos con una Wet-Vac (aspiradora de humedad) y deséchelos correctamente.

COMMERCIAL LANDSCAPE

DISCHARGE TO THE STORM DRAIN, **ACCIDENTAL OR NOT**, COULD LEAD TO ENFORCEMENT ACTIONS, WHICH COULD INCLUDE FINES.

Follow the best practices below to **prevent water pollution from landscaping activities**.

RECYCLE YARD WASTE

✓ Recycle leaves, grass clippings and other yard waste.

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For more information, please visit: **www.calrecycle.ca.gov/organics/grasscycling**

USE FERTILIZERS, HERBICIDES AND PESTICIDES SAFELY

✓ Fertilizers, herbicides and pesticides are often carried into the storm drain system by sprinkler runoff. Use natural and non-toxic alternatives as often as possible.

✓ If you must use chemical fertilizers, herbicides or pesticides:

- Spot apply, rather than blanketing entire areas.
- Avoid applying near curbs and driveways, and **never** before a rain.
- Apply fertilizers as needed: when plants could best use it and when the potential runoff would be low.
- Follow the manufacturer's instructions carefully—this will not only give the best results, but will save money.

USE WATER WISELY

✓ Control the amount of water and direction of sprinklers. Sprinklers should only be on long enough to allow water to soak into the ground, but not so long as to cause runoff.

✓ Periodically inspect, fix leaks and realign sprinkler heads.

✓ Plant native vegetation to reduce the need of water, fertilizers, herbicides and pesticides.

HOMEOWNERS

KEEP THESE TIPS IN MIND WHEN HIRING PROFESSIONAL LANDSCAPERS AND REMIND AS NECESSARY.

Leftover pesticides, fertilizers, and herbicides contaminate landfills and should be disposed of through a Hazardous Waste Facility.

For more information on proper disposal call,

(909) 382-5401 or 1-800-OILY CAT.

*FREE for San Bernardino County residents only. Businesses can call for cost inquiries and to schedule an appointment.

SIDEWALK, PLAZA, ENTRY MONUMENT & FOUNTAIN MAINTENANCE

Pollutants on sidewalks and other pedestrian traffic areas and plazas are typically due to littering and vehicle use. Fountain water containing chlorine and copperbased algaecides is toxic to aquatic life. Proper inspection, cleaning, and repair of pedestrian areas and HOA owned surfaces and structures can reduce pollutant runoff from these areas. Maintaining these areas may involve one or more of the following activities:

1. **Surface Cleaning**
2. **Graffiti Cleaning**
3. **Sidewalk Repair**
4. **Controlling Litter**
5. **Fountain Maintenance**

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 sidewalk, plaza, and fountain maintenance and cleaning include:

- 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).
- Once per year, educate HOA staff and tenants on pollution prevention measures.

MODEL PROCEDURES:

1. Surface Cleaning

Discharges of wash water to the storm water drainage system from cleaning or hosing of impervious surfaces is prohibited.

Sidewalks, Plazas

✓ Use dry methods (e.g. sweeping, backpack blowers, vacuuming) whenever practical to clean sidewalks and plazas rather than hosing, pressure washing, or steam cleaning. DO NOT sweep or blow material into curb; use devices that contain the materials.

✓ If water must be used, block storm drain inlets and contain runoff. Discharge wash water to landscaping or contain and dispose of properly.

SIDEWALK, PLAZA, ENTRY MONUMENT & FOUNTAIN MAINTENANCE

Parking Areas, Driveways, Drive-thru

- ✓ Parking facilities should be swept/vacuumed on a regular basis. Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- ✓ If water must be used, block storm drain inlets and contain runoff. Discharge wash water to landscaping or contain and dispose of properly.
- ✓ Sweep all parking lots at least once before the onset of the wet season.
- ✓ Use absorbents to pick up oil; then dry sweep.
- ✓ Appropriately dispose of spilled materials and absorbents.

OPTIONAL:

- Consider increasing sweeping frequency based on factors such as traffic volume, land use, field observations of sediment and trash accumulation, proximity to water courses, etc.

Building Surfaces, Decks, etc., without loose paint

- ✓ Use high-pressure water, no soap.
- ✓ If water must be used, block storm drain inlets and contain runoff. Discharge wash water to landscaping or contain and dispose of properly.

Unpainted Building Surfaces, Wood Decks, etc.

- ✓ If water must be used, block storm drain inlets and contain runoff. Discharge wash water to landscaping or contain and dispose of properly.
- ✓ Use biodegradable cleaning agents to remove deposits.
- ✓ Make sure pH is between 6.5 and 8.5 THEN discharge to landscaping (if cold water without a cleaning agent) otherwise dispose of properly.

2. Graffiti Cleaning

Graffiti Removal

- ✓ Avoid graffiti abatement activities during rain events.
- ✓ When graffiti is removed by painting over, implement the procedures under Painting and Paint Removal in the Roads, Streets, and Highway Operation and Maintenance procedure sheet.
- ✓ Protect nearby storm drain inlets prior to removing graffiti from walls, signs, sidewalks, or other structures needing graffiti abatement. Clean up afterwards by sweeping or vacuuming thoroughly, and/or by using absorbent and properly disposing of the absorbent.

✓ Note that care should be taken when disposing of waste since it may need to be disposed of as hazardous waste.

OPTIONAL:

- Consider using a waterless and non-toxic chemical cleaning method for graffiti removal (e.g. gels or spray compounds).

3. Sidewalk Repair

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 material.

✓ Designate an area for clean up and proper disposal of excess materials.

✓ Remove and recycle as much of the broken pavement as possible.

✓ When making saw cuts in pavement, use as little water as possible. Cover each storm drain inlet 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 shovel or vacuum the slurry, remove from site and dispose of properly.

✓ 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. Discharge wash water to landscaping, pump to the sanitary sewer if permitted to do so or contain and dispose of properly.

Concrete Installation and Repair

✓ Avoid mixing excess amounts of fresh concrete or cement mortar on-site. Only mix what is needed for the job.

✓ Wash concrete trucks off-site or in designated areas on-site, such that there is no discharge of concrete wash water into storm drain inlets, open ditches, streets, or other storm water conveyance structures. (See Concrete Waste Management BMP WM – 8)

SIDEWALK, PLAZA, ENTRY MONUMENT & FOUNTAIN MAINTENANCE

✓ Store dry and wet concrete materials under cover, protected from rainfall and runoff and away from drainage areas. After job is complete remove temporary stockpiles (asphalt materials, sand, etc.) and other materials as soon as possible.

✓ Return leftover materials to the transit mixer. Dispose of small amounts of excess concrete, grout, and mortar in the trash.

✓ When washing concrete to remove fine particles and expose the aggregate, contain the wash water for proper disposal.

✓ Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stock pile, or dispose in the trash.

✓ Protect applications of fresh concrete from rainfall and runoff until the material has hardened.

4. Litter Control

✓ 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.

OPTIONAL:

- Post “No Littering” signs.

5. Fountain Maintenance

✓ Do not use copper-based algaecides. Control algae with chlorine or other alternatives, such as sodium bromide.

✓ Allow chlorine to dissipate for a few days and then recycle/reuse water by draining it gradually onto a landscaped area. Water must be tested prior to discharge to ensure that chlorine is not present (concentration must be less than 0.1 ppm).

✓ Contact local agency for approval to drain into sewer or storm drain.

✓ Avoid mixing excess amounts of fresh concrete or cement mortar on-site. Only mix what is needed for the job.

EQUIPMENT MAINTENANCE & REPAIR

Vehicle or equipment maintenance has the potential to be a significant source of stormwater pollution. Engine repair and service (parts cleaning, spilled fuel, oil, etc.), replacement of fluids, and outdoor equipment storage and parking (dripping engines) can all contaminate stormwater. Conducting the following activities in a controlled manner will reduce the potential for stormwater contamination:

1. **General Maintenance and Repair**
2. **Vehicle and Machine Repair**
3. **Waste Handling/Disposal**

Related vehicle maintenance activities are covered under the following program headings in this manual: "Vehicle and Equipment Cleaning", "Vehicle and Equipment Storage", and "Vehicle Fueling".

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 equipment maintenance and repair include:

- Review maintenance activities to verify that they minimize the amount of pollutants discharged to receiving waters. Keep accurate maintenance logs to evaluate materials removed and improvements made.

- Switch to non-toxic chemicals for maintenance when possible.

- Choose cleaning agents that can be recycled.

- Minimize use of solvents. Clean parts without using solvents whenever possible. Recycle used motor oil, diesel oil, and other vehicle fluids and parts whenever possible.

- Once per year, educate HOA staff and tenants on pollution prevention measures.

EQUIPMENT MAINTENANCE & REPAIR

MODEL PROCEDURES:

1. General Maintenance and Repair

General Guidelines

> ➔ *Note: Permission must be obtained for any discharge of wash water to the sanitary sewer from the local sewering agency.*

✓ Review maintenance activities to verify that they minimize the amount of pollutants discharged to receiving waters. Keep accurate maintenance logs to evaluate materials removed and improvements made.

✓ Regularly inspect vehicles and equipment for leaks.

✓ Move activity indoors or cover repair area with a permanent roof if feasible.

✓ Minimize contact of stormwater with outside operations through berming the local sewering and drainage routing.

✓ Place curbs around the immediate boundaries of the process equipment.

✓ Clean yard storm drain inlets regularly and stencil them.

Good Housekeeping

✓ Avoid hosing down work areas. If work areas are washed and if discharge to the sanitary sewer is allowed, treat water with an appropriate treatment device (e.g. clarifier) before discharging. If discharge to the sanitary sewer is not permitted, pump water to a tank and dispose of properly.

✓ Collect leaking or dripping fluids in drip pans or container. Fluids are easier to recycle or dispose of properly if kept separate.

✓ Keep a drip pan under the vehicle while you unclip hoses, unscrew filters, any discharge of or remove other parts. Place a drip pan under any vehicle that might leak while you work on it to keep splatters or drips off the shop floor.

✓ Educate employees on proper handling and disposal of engine fluids.

✓ Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.

✓ Do not pour liquid waste to floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections.

✓ Post signs at sinks and stencil outdoor storm drain inlets.

2. Vehicle Repair

General Guidelines

✓ Perform vehicle fluid removal or changing inside of a building or in a contained covered area, where feasible, to prevent the run-on of stormwater and the runoff of spills.

✓ Regularly inspect vehicles and equipment for leaks, and repair as needed.

✓ Use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.

✓ Immediately drain all fluids from wrecked vehicles. Ensure that the drain pan or drip pan is large enough to contain drained fluids (e.g. larger pans are needed to contain antifreeze, which may gush from some vehicles).

✓ Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.

✓ Recycle used motor oil, diesel oil, and other vehicle fluids and parts whenever possible.

✓ Oil filters disposed of in trash cans or dumpsters can leak oil. 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 your oil supplier or recycler about recycling oil filters.

✓ Store cracked batteries in a non-leaking secondary container and dispose of properly at recycling facilities or at County hazardous waste disposal site.

Vehicle Leak and Spill Control

✓ Use absorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.

✓ Place a stockpile of spill cleanup materials where it will be readily accessible.

✓ Sweep floor using dry absorbent material.

3. Machine Repair

✓ Keep equipment clean; don't allow excessive build-up of oil or grease.

✓ Minimize use of solvents.

✓ Use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.

✓ Perform major equipment repairs at the corporation yard, when practical.

✓ Following good housekeeping measures in Vehicle Repair section.

4. Waste Handling/Disposal

Waste Reduction

✓ Prevent spills and drips of solvents and cleansers to the shop floor.

✓ Do liquid cleaning at a centralized station so the solvents and residues stay in one area. Recycle liquid cleaners when feasible.

✓ Locate drip pans, drain boards, and drying racks to direct drips back into a solvent sink or fluid holding tank for reuse.

OPTIONAL:

- If possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous material:

    -Use non-caustic detergents instead of caustic cleaning for parts cleaning.

    -Use a water-based cleaning service and have tank cleaned. Use detergent-based or water-based cleaning systems in place of organic solvent degreasers.

    -Replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check list of active ingredients to see whether it contains chlorinated solvents.

    -Choose cleaning agents that can be recycled.

Recycling

OPTIONAL:

- Separate wastes for easier recycling. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents separate from non-chlorinated solvents.
- Label and track the recycling of waste material (e.g. used oil, spent solvents, batteries).
- Purchase recycled products to support the market for recycled materials.

LIMITATIONS:

Space and time limitations may preclude all work being conducted indoors. It may not be possible to contain and clean up spills from vehicles/equipment brought on-site after working hours. Dry floor cleaning methods may not be sufficient for some spills – see spill prevention and control procedures sheet. Identification of engine leaks may require some use of solvents.

POOL MAINTENANCE

Pool chemicals and filter solids, when discharged to the City streets, gutters or storm drans, DO NOT GET TREATED before reaching the Santa Ana River. Chlorine, acid cleaning chemicals and metal-based algaecides used in pools can kill beneficial organisms in the food chain and pollute our drinking water.

When emptying your swimming pool, spa or fountain, please use one of the following best management practices to prevent water pollution:

- Reuse the water as landscape irrigation
- Empty the water into the sewer between midnight and 6:00 am
- Remove solids and floating debris and dispose of in the trash, de-chlorinate the water to a chlorine residual = 0, wait 24 hours, then discharge the water to the street or storm drain
- Try not to use metal-based algaecides (i.e. copper sulfate) in your pool or spa. If you have, empty your pool or spa into the sewer. *Prior to discharging pool water into the sanitary sewer system, contact your local agency.*
- If the pool contains algae and mosquito larvae, discharge the water to the sewer

When acid cleaning or other chemical cleaning:

- Neutralize the pool water to pH of 6.5 to 8.5, then discharge to the sewer

For swimming pool and spa filter backwash:

- Dispose of solids into trash bag, then wash filter into a landscape area
- Settle, dispose of solids in trash and discharge water to the sewer, never to the storm drain

» For Residents

*The following is a preview of the information we have available to residents. For more fact sheets, visit **sbcountystormwater.org***

Household Hazardous Waste Center Locations

TOO TOXIC TO TRASH

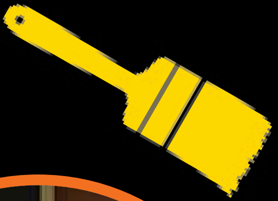
Dispose of your **HOUSEHOLD HAZARDOUS WASTE** (HHW) at a **FREE** HHW Center near you. Examples of items collected: pesticides, fertilizers, paints, cleaners, antifreeze, batteries, motor oil, oil filters, and electronic waste.

SERVICE AREA	LOCATION	DAYS OPEN	HOURS
Big Bear Lake (does not accept E-waste)	42040 Garstin Dr. (cross: Big Bear Blvd.)	Saturdays	9 a.m. - 2 p.m.
Chino	5050 Schaefer Ave. (cross: 4th St.)	2nd & 4th Sat.	8 a.m. - 1 p.m.
Fontana (Fontana residents only)	16454 Orange Way (cross: Cypress Ave.) Note: Provide a trash bill and a driver's license as proof of residency.	Saturdays	8 a.m. - 12 p.m.
Ontario	1430 S. Cucamonga Ave. (cross: Belmont St.)	Fri. & Sat.	9 a.m. - 2 p.m.
Rancho Cucamonga	8794 Lion Street. (Off 9th St, between Vineyard and Hellman)	Saturdays	8 a.m. - 12 p.m.
Redlands	500 Kansas St. (cross: Park Ave.)	Saturdays	9:30 a.m. - 12:30 p.m.
Rialto (does not accept E-waste)	246 Willow Ave. (cross: Rialto Ave.)	2nd & 4th Fri. & Sat.	8 a.m. - 12 p.m.
San Bernardino	2824 East 'W' St., 302 (cross: Victoria Ave.)	Mon. – Fri.	9 a.m. - 4 p.m.
Upland	1370 N. Benson Ave. (cross: 14th St.)	Saturdays	9 a.m. - 2 p.m.

To report illegal dumping, call (877) WASTE18
or visit sbcountystormwater.org

Artwork Courtesy of the City of Los Angeles Stormwater Program. Printed on recycled paper.

TAKE ONE



WE DID IT OURSELVES
AND WE DID IT RIGHT

When painting your home,
protect your family and community.

- **PAINTS** that are water-based are less toxic and should be used whenever possible.
- **BRUSHES** with water-based paint should be washed in the sink. Those with oil-based paint should be cleaned with paint thinner.
- **SAFELY** dispose of unwanted paint and paint thinner. The County of San Bernardino offers 9 HHW Centers that accept paint and other household hazardous waste from residents FREE of charge. For a list of acceptable materials, location information, and hours of operation call 1-800-OILY CAT.

VEHICLE MAINTENANCE

Oil, grease, anti-freeze and other toxic automotive fluids often make their way into the San Bernardino County storm drain system, and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

Cleaning Auto Parts

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

Storing Hazardous Waste

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

Preventing Leaks and Spills

Conduct all vehicle maintenance inside of a garage. Place drip pans underneath vehicle to capture fluids. Use absorbent materials instead of water to clean work areas.

Cleaning Spills

Use dry methods for spill cleanup (sweeping, absorbent materials). To report accidental spills into the street or storm drain call (877) WASTE18 or 911.

Proper Disposal of Hazardous Waste

Dispose of household hazardous waste by taking it to your nearest household hazardous waste center. For more information, call 1-800-OILY CAT or check out sbcountystormwater.org/Disposal.html

FREE

DOGGIE WASTE BAGS

Remember to pick up after your pet every time to keep San Bernardino County clean and healthy!

To RECEIVE your

FREE CONTAINER

visit us online at sbcountystormwater.org/dog

In the event of a spill or discharge to a storm drain or waterway, contact San Bernadino County Stormwater immediately: (877) WASTE18 | sbcountystormwater.org/report

sbcountystormwater.org

Big Bear • Chino • Chino Hills • Colton • Fontana • Grand Terrace • Highland • Loma Linda • Montclair • Ontario • Rancho Cucamonga Redlands • Rialto • San Bernadino • San Bernadino County • San Bernadino County Flood Control District • Upland • Yucaipa

» Get In Touch With Us Online!

» Website
sbcountystormwater.org

» eUpdates
sbcountystormwater.org/newsletter

» Facebook
facebook.com/sbcountystormwater

» YouTube
youtube.com/sbcountystormwater

» Report Pollution Violations
sbcountystormwater.org/report

» Email
info@sbcountystormwater.org

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Dispose of your **HOUSEHOLD HAZARDOUS WASTE** (HHW) at a **FREE** HHW Center near you. Examples of items collected: pesticides, fertilizers, paints, cleaners, antifreeze, batteries, motor oil, oil filters, and electronic waste.

SERVICE AREA	LOCATION	DAYS OPEN	HOURS
Big Bear Lake (does not accept E-waste)	42040 Garstin Dr. (cross: Big Bear Blvd.)	Saturdays	9 a.m. - 2 p.m.
Chino	5050 Schaefer Ave. (cross: 4th St.)	2nd & 4th Sat.	8 a.m. - 1 p.m.
Fontana (Fontana residents only)	16454 Orange Way (cross: Cypress Ave.) Note: Provide a trash bill and a driver's license as proof of residency.	Saturdays	8 a.m. - 12 p.m.
Ontario	1430 S. Cucamonga Ave. (cross: Belmont St.)	Fri. & Sat.	9 a.m. - 2 p.m.
Rancho Cucamonga	8794 Lion Street. (Off 9th St, between Vineyard and Hellman)	Saturdays	8 a.m. - 12 p.m.
Redlands	500 Kansas St. (cross: Park Ave.)	Saturdays	9:30 a.m. - 12:30 p.m.
Rialto (does not accept E-waste)	246 Willow Ave. (cross: Rialto Ave.)	2nd & 4th Fri. & Sat.	8 a.m. - 12 p.m.
San Bernardino	2824 East 'W' St., 302 (cross: Victoria Ave.)	Mon. – Fri.	9 a.m. - 4 p.m.
Upland	1370 N. Benson Ave. (cross: 14th St.)	Saturdays	9 a.m. - 2 p.m.

San Bernardino County
STORMWATER PROGRAM

To report illegal dumping, call (877) WASTE18
or visit sbcountystormwater.org

Artwork Courtesy of the City of Los Angeles Stormwater Program. Printed on recycled paper.

TAKE ONE

MUY TÓXICO PARA LA BASURA

Deshágase de sus **DESECHOS PELIGROSOS** gratuitamente en un centro de recolección cerca de usted. Ejemplos de artículos que se aceptan: pesticidas, fertilizantes, pinturas, limpiadores, anticongelante, baterías, aceite de motores y filtros, y aparatos electrónicos.

ÁREA DE SERVICIO	UBICACIÓN	ABIERTO	HORARIO
Big Bear Lake (no se acepta materiales electronicas)	42040 Garstin Dr. (Big Bear Blvd.)	Sábado	9 a.m. - 2 p.m.
Chino	5050 Schaefer Ave. (4th St.)	2nd & 4th Sábado	8 a.m. - 1 p.m.
Fontana (residentes de Fontana solamente)	16454 Orange Way (Cypress Ave.) Nota: Presentar un recibo de basura y licencia de conducir como prueba de residencia.	Sábado	8 a.m. - 12 p.m.
Ontario	1430 S. Cucamonga Ave. (Belmont St.)	Viernes & Sábado	9 a.m. - 2 p.m.
Rancho Cucamonga	8794 Lion Street (Off 9th St, between Vineyard & Hellman)	Sábado	8 a.m. - 12 p.m.
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San Bernardino	2824 East ‘W’ St., 302 (Victoria Ave.)	Lunes – Viernes	9 a.m. - 4 p.m.
Upland	1370 N. Benson Ave. (14th St.)	Sábado	9 a.m. - 2 p.m.

San Bernardino County
STORMWATER PROGRAM

Para reportar actividades ilegales llamar al (877) WASTE18
o visite sbcountystormwater.org

Arte Cortesía del Programa de Agua Pluvial de la Ciudad de Los Angeles. Impreso en papel reciclado.

TOME UNO

A SAFE GARDEN:
A LOT DEPENDS ON IT.

Protect your family and community when using pesticides and fertilizers.

- **STRATEGICALLY** apply products on your lawn when rain is not expected. Rain can wash toxic chemicals from your lawn into local waterways.
- **SPOT-APPLY** products directly on the problem instead of the whole area. Use less chemicals, and conserve the supply of your product.
- **SAFELY** dispose of unwanted products. The County of San Bernardino offers 9 HHW Centers that accept pesticides, fertilizers and other toxic waste FREE of charge.

To report illegal dumping, call
(877) WASTE18 or visit
sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

Artwork Courtesy of the City of Los Angeles Stormwater Program. Printed on recycled paper.

UN JARDÍN SANO:
MUCHO DEPENDE DE ÉL.

Proteja a su familia y a su comunidad cuando utilice pesticidas y fertilizantes.

- **ESTRATÉGICAMENTE** aplique productos en su césped solamente cuando no se espera lluvia. La lluvia puede llevarse químicos tóxicos de su césped hacia los canales pluviales en su área.
- **ESCASAMENTE** aplique los productos directamente en el área en donde exista el problema en lugar de distribuirlo en todo el jardín. Así, utilizará menos productos químicos y le rendirá más.
- **ELIMINE** productos tóxicos sanamente. El Condado de San Bernardino ofrece 9 centros de recolección que aceptan pesticidas, fertilizantes y otros desechos tóxicos GRATUITAMENTE.

Para reportar actividades ilegales llamar al
(877) WASTE18 **o visite**
sbcountystormwater.org

San Bernardino County
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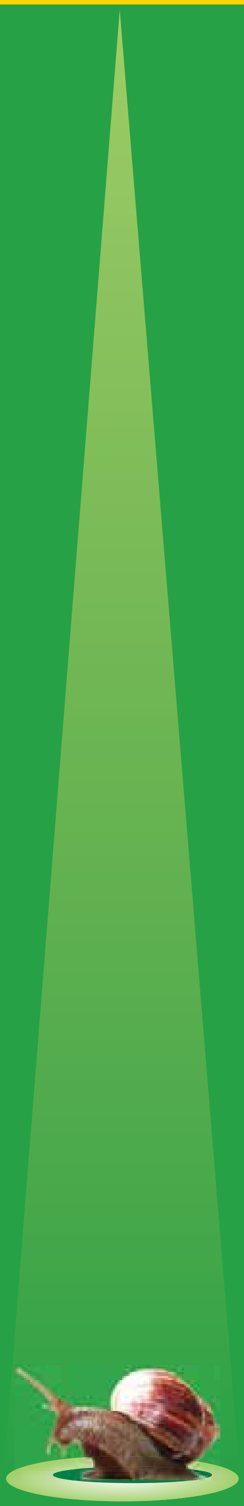
San
Bernardino
County
STORMWATER PROGRAM

Arte Cortesía del Programa de Agua Pluvial de la Ciudad de Los Angeles. Impreso en papel reciclado.

SPOT-APPLY

pesticides directly on the problem rather than blanketing the whole area.



sbcountystormwater.org

A SAFE GARDEN:
A LOT DEPENDS ON IT.

San Bernardino County
STORMWATER PROGRAM

(877) WASTE18

Artwork Courtesy of the City of Los Angeles Stormwater Program. Printed on recycled paper.

ESCASAMENTE

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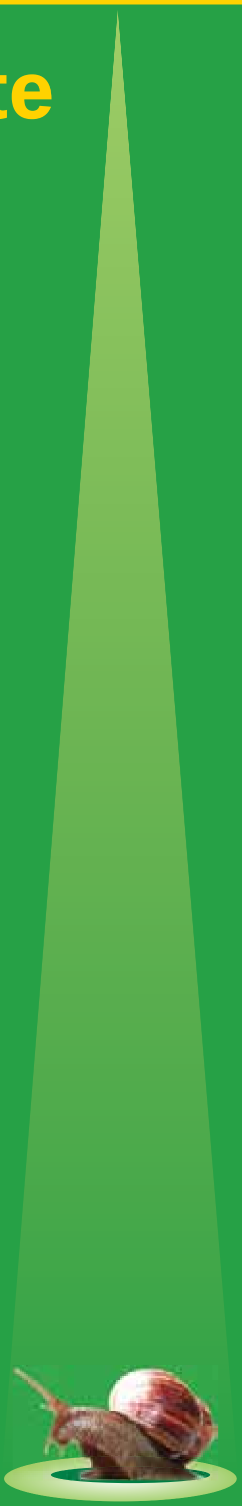

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UN JARDÍN SANO:

MUCHO DEPENDE DE EL.

San Bernardino County STORMWATER PROGRAM

(877) WASTE18

Arte Cortesía del Programa de Agua Pluvial de la Ciudad de Los Angeles. Impreso en papel reciclado.

GARDEN SMART:
Use Pesticides and Fertilizers Sparingly

sbcounty.gov/stormwater

Artwork Courtesy of the City of Los Angeles Stormwater Program

Managing
FATS, OIL and GREASE
"It's Easier than YOU Think!"

THE
WRONG WAY
La Forma Incorrecta

1

Do not pour cooking residue directly into the drain.

No vierta residuos de cocinar directamente en el desague.

2

Do not dispose of food waste into the garbage disposal.

No ponga desperdicios de comida en el triturador de comida.

3

Do not pour waste oil directly into the drain.

No ponga desperdicio de aceite directamente en el desague.

4

Do not wash floor mats where water will run off directly into the storm drain.

No lave tapetes de piso en un lugar donde el agua corra hacia el desague.

THE
RIGHT WAY
La Forma Correcta

1

Wipe pots, pans, and work areas prior to washing.

Limpie con una toallita las ollas, cazuelas, y areas de trabajo antes de lavarlos.

2

Dispose of food waste directly into the trash.

Deseche los desperdicios de comida en el bote de basura.

3

Collect waste oil and store for recycling.

Junte el desperdicio de aceite y guardelo para que sea reciclado.

4

Clean mats inside over a utility sink.

Limpie los tapetes de piso detro de un lavabo o fregador.

San Bernardino County Stormwater Program

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STORMWATER

Pollution Prevention

ROADWORK AND PAVING

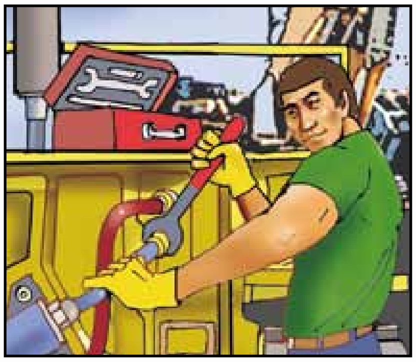
Asphalt, saw-cut slurry and excavated materials from road paving, surfacing and pavement removal often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

Preventing Erosion

Schedule excavation and grading work during dry weather. Develop and implement erosion and sediment control plans for excavated embankments. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.

During Construction

Cover catch basins and maintenance holes when applying seal coat, slurry seal or fog seal. Use check dams, ditches or berms around excavations, and avoid over applying water for dust control. Never wash excess materials from exposed aggregate or concrete into the street, gutter or a storm drain.



Maintaining Vehicles & Equipment

Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutter and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks, and prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids.

Asphalt & Concrete Removal

Barricade storm drain openings during saw-cutting, and recycle broken up pavement at a crushing company. For recycling information, call (909) 386-8401.

Cleaning & Preventing Spills

Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. Sweep up dry spills, instead of hosing. Prevent spills from paver machines by using drip pans, or by placing absorbent materials like cloths or rags under the machines when not in use. To report serious spills, call 911.

To report illegal dumping call

(877) WASTE18

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San Bernardino County
STORMWATER PROGRAM

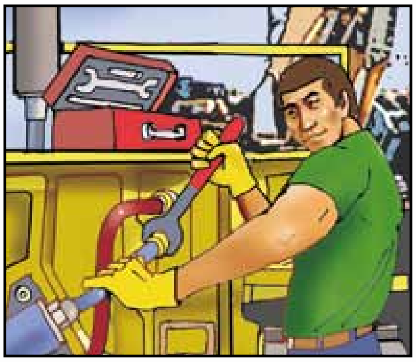
Prevención de Contaminación del Desagüe

TRABAJO DE CARRETERAS & PAVIMENTO

Asfalto, mezcla y materiales de excavaciones del pavimento acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

Previniendo Erosiones
Planea las excavaciones trabajo de jardineria durante el clima seco. Desarrolla e implementa planes de embancamientos de control de sedimento y excavaciones. Cubre montones de tierra, grava y otros materiales con un plastico para protejerlos de la llvia, aire y desagüe.

Durante Construcción
Cubre los lavados y da mantenimiento a los hoyos al aplicar selladura o mezcla. Revisa las areas de excavaciones, y evita pasarte de agua para preveenir polvadura. Nunca laves los materiales llenos de concreto en la calle, drenajes o en el desagüe.



Mantenimiento de Vehiculos & Herramientas
Has el mantenimiento y carga de vehiculos en el mismo lugar, lejos de la calle, las alcantarillas y los drenajes. Inspecciona los vehiculos y el equipo de cualquier goteadura y evita goteaduras de autos que no se usan vasiandoles la gasolina, aceite de transmision, frenos y liquidos del radiador.

Removiendo Asfalto & Concreto
Bloquea alrededor de los drenajes cuando estes usando las maquinas de sierra, tambien recicla todo el pavimento roto en la compañia demolidora. Para más información llama al (909) 386-8401.

Limpiando & Previniendo Derrames
Mantente siempre preparado para cualquier derrame, usa siempre las herramientas de seguridad al igual que materiales como, tierra para desechos de gato o aserrin Barre los derrames en ves de lavarlos con la manguera. Previene los derrames de las maquinas usando enbudos o colocanto garras para absorver cualquier liquido. Para reportar derrames llama al 911.

Para reportar actividades
ilegales llamar al:

(877) WASTE18
sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

STORMWATER Pollution Prevention

HOME & GARDEN

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

Recycle Household Hazardous Waste

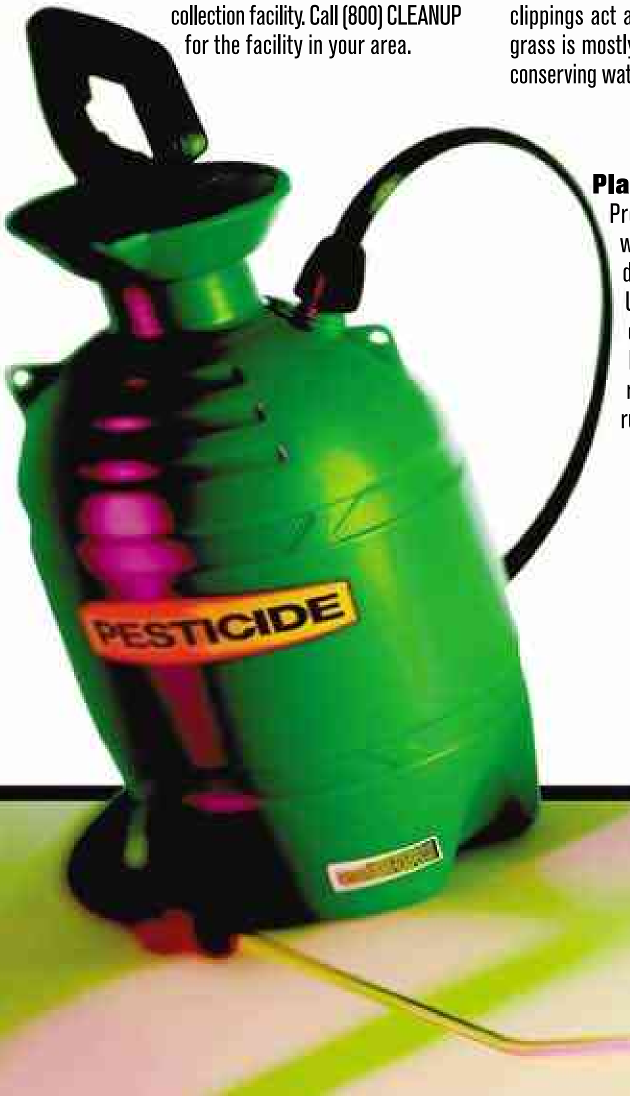
Household products like paint, pesticides, solvents and cleaners are too dangerous to dump and too toxic to trash. Take them to be recycled at a convenient household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.

Disposing of Yard Waste

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

Use Fertilizers & Pesticides Safely

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



Planting in the Yard

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

Use Water Wisely

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

To report illegal dumping call

(877) WASTE18

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San Bernardino County
STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

JARDIN

Basura del jardín y otros toxicos caseros como pintura, pesticidas y otros mas acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

Disponiendo Desechos del Jardin

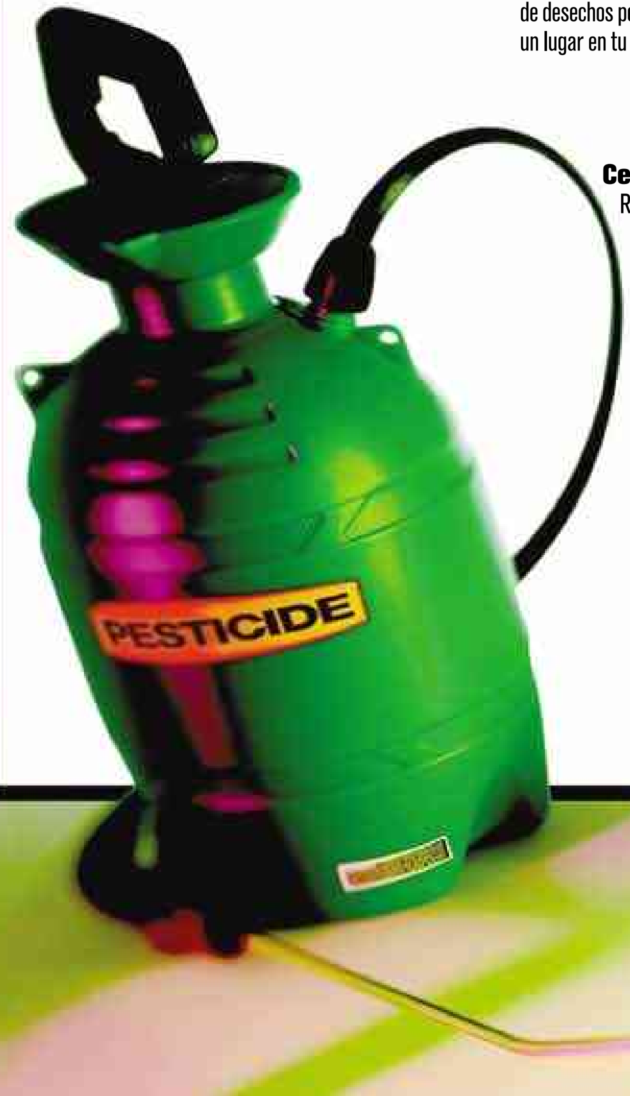
Recicla hojas, pasto y otras basuras del jardín en ves de soplarlas, barrerlas hacia la calle. El pasto sirve como fertilizante, y como el pasta es la mayoria agua tambien riega tu jardín, ahorrandote agua.

Reciclando Materiales del Hogar Peligrosos

Limpiadores del hogar como pintura, pesticidas, solventes y limpiadores son demasiado toxicos para tirarlos en la basura. Desechalos en unlugar de colección de desechos peligrosos. Llama al (800) CLEANUP para un lugar en tu area.

Usando Fertilizantes & Pesticidas Adecuadamente

Fertilizantes y pesticidas muchas veces terminan en los drenajes. Usa alternativas que no sean toxicas. Si tu usas fertilizantes y pesticidas con quimicos, no los uses cerca de las banquetas y cocheras y nunca los uses en tiempos de lluvia.



Cembrando en el Jardin

Reduce la basura del jardín y ahorra agua plantando arboles y plantas de bajo mantenimiento. Riega moderadamente con mangueras u otros metodos para las flores o vegetacion asi reduciras tu pago del mes y prevenes el desagüe.

Usando el Agua Adecuadamente

Reduce el pago del agua y previene el desagüe controlando la cantidad y direccion de tus regaderas para el jardin. Solo necesitas regar de 10 a 20 minutos a la semana. Durante la primavera y otoño es la mitad. Las regaderas del jardin deverian estar ajustadas a que rieguen lo suficinete y evitar el desagüe.

Para reportar actividades
ilegales llamar al:

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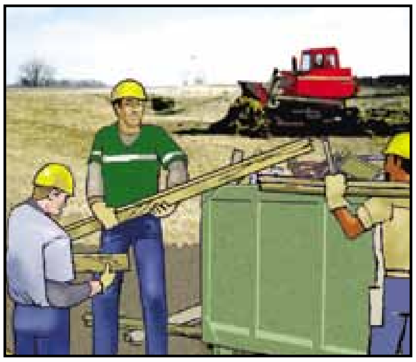
Pollution Prevention

EXCAVATION AND GRADING

Sediment, cement wash, asphalt and vehicle fluids from soil excavation and grading often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



Recycling Waste

Recycle broken asphalt, concrete, wood, and cleared vegetation whenever possible. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. For recycling and disposal information, call (909) 386-8401.

Maintaining Vehicles & Equipment

Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutters and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks. Use gravel approaches where truck traffic is heavy to reduce soil compaction and limit the tracking of sediment into the street.

Cleaning & Preventing Spills

Use a drip pan and funnel when draining or pouring fluids. Sweep up dry spills, instead of hosing. Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. Prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids. To report serious spills, call 911.

Storing Materials

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

Preventing Erosion

Avoid excavation or grading during wet weather. Plant temporary vegetation on slopes where construction is not immediately planned, and permanent vegetation once excavation and grading are complete. Construct diversion dikes to channel runoff. Channels can be lined with grass or roughened pavement to reduce runoff velocity.

To report illegal dumping call

(877) WASTE18

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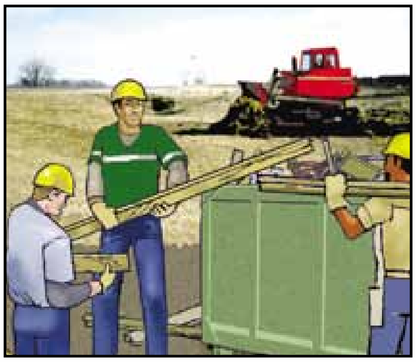
San Bernardino County
STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

EXCAVACIONES

Sedimento, cemento, asfalto y liquidos de auto, tierra y residuos peligrosos de lugares de construcción acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.



Reciclando Desechos

Recicla el aspfalto, concreto, madera y la vegetacion cuando sea posible. Materiales no reciclados se deverian llevar a lugares de desechos peligrosos. Para màs informacion llama al (909) 386-8401.

Manteniendo Vehiculos & Herramientas

Has el mantenimiento y carga de vehiculos en el mismo lugar, lejos de la calle, las alcantarillas y los drenajes. Inspecciona los vehiculos y el equipo de cualquier goteadura. Usa grava donde mayormente se consentra el trafico de camiones para y reducir el sedimento en las calles.

Limpiando & Previniendo Derrames

Usa siempre un enbudo al vaciar liquidos. Barre los derrames en ves de lavarlos con la manguera. Mantente siempre preparado para cualquier derrame, usa siempre las herramientas de seguridad al igual que materiales como, tierra para desechos de gato o aserrin. Preveen goteaduras de autos que no se usan vasiandoles la gasolina, aceite de transmision, frenos y liquidos del radiador. Para reportar derrames llama al 911.

Almacenando Materiales

Manten materiales de construccion y residuos lejos de las calles, coladeras y desagües. Manten tapados los bultos de arena, grava y erramientas para excavar cuviertos con algun plastico para protejerlos de la lluvia, el aire y el desagüe.

Previniendo Erosiones

Evita las excavaciones durante lluvia. Planta vegetacion temporal en colinas donde aun no hay planes de construcción y planta vegetacion permanente al terminar las excavaciones. Construye algunos canales para el desagüe. Estos pueden ser creados con pasto y cemento para reducir la velocidad del desagüe.

Para reportar actividades
ilegales llamar al:

(877) WASTE18

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STORMWATER PROGRAM

STORMWATER

Pollution Prevention

CONSTRUCTION

Cement wash, sediment, vehicle fluids, dust and hazardous debris from construction sites often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

Store Materials Safely

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

Ordering Materials & Recycling Waste

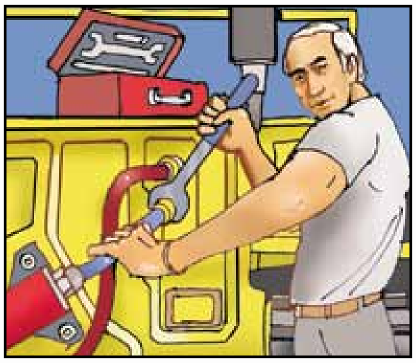
Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. You can recycle broken asphalt, concrete, wood, and cleared vegetation. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. For recycling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

Preventing Erosion

Avoid excavation or grading during wet weather. Plant temporary vegetation or add hydromulch on slopes where construction is not immediately planned, and permanent vegetation once excavation and grading are complete. Construct diversion dikes to channel runoff to a detention basin and around the construction site. Channels can be lined with grass or roughened pavement to reduce runoff velocity.

Cleaning & Preventing Spills

Use a drip pan and funnel when draining or pouring fluids. Sweep up dry spills, instead of hosing. Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. To report serious spills, call 911.



Maintaining Vehicles & Equipment

Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutter and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks, and prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids.

To report illegal dumping call

(877) WASTE18

sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

CONSTRUCCIÓN

Cemento, sedimentos, liquidos de auto, polvos y residuos peligrosos acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

Almacenando Materiales Cuidadosamente

Manten materiales de construcción y residuos lejos de las calles, coladeras y desagües. Manten tapados los bultos de arena, grava y herramientas para excavar cuviertos con algun plastico para protejerlos de la lluvia, el aire y el desagüe.

Ordenando Materiales & Reciclando Desechos

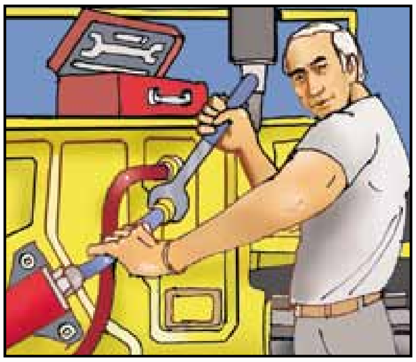
Reduce la cantidad al ordenar el material, solo ordena lo necesario. Usa materiales que se puedan reciclar cuando sea posible. Se puede reciclar el aspfalto, concreto, madera y la vegetacion. Materiales no reciclados se deven llevar a lugares de desechos peligrosos. Para mas información llama al (909) 386-8401.

Limpiando & Previniendo Derrames

Usa siempre un enbudo al vaciar liquidos. Barre los derrames en ves de lavarlos con la manguera. Mantente siempre preparado para cualquier derrame, usa siempre las herramientas de seguridad al igual que materiales como, tierra para desechos de gato o aserrin. Para reportar derrames llama al 911.

Previniendo Erosiones

Evita las excavaciones durante lluvia. Planta vegetacion temporal en colinas donde aun no hay planes de construccion y planta vegetacion permanente al terminar las excavaciones. Construye algunos canales para el desagüe. Estos pueden ser creados con pasto y cemento para reducir la velocidad del desagüe.



Mantenimiento de Vehiculos & Herramientas

Has el mantenimiento y carga de vehiculos en el mismo lugar, lejos de la calle, las alcantarillas y los drenajes. Inspecciona los vehiculos y el equipo de cualquier goteadura y preveen goteaduras de autos que no se usan vasiandoles la gasolina, aceite de transmision, frenos y liquidos del radiador.

Para reportar actividades ilegales llamar al:

(877) WASTE18

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San Bernardino County
STORMWATER PROGRAM

STORMWATER Pollution Prevention

FRESH CONCRETE & MORTAR APPLICATION

Cement wash, sediment, vehicle fluids, dust and hazardous debris from construction sites often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

Storing Materials

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

Ordering Materials & Recycling Waste

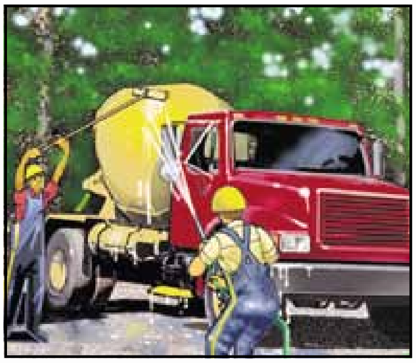
Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. When breaking up paving, recycle the pieces at a crushing company. You can also recycle broken asphalt, concrete, wood, and cleared vegetation. Non-recyclable materials should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

During Construction

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

Cleaning Up

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



To report illegal dumping call

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San Bernardino County STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

APLICANDO CONCRETO FRESCO

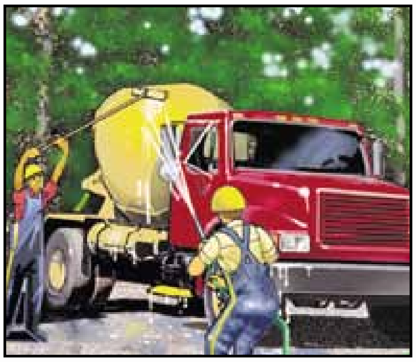
Cemento, grava, asfalto y liquidos de auto, tierra y residuos peligrosos de lugares de concreto fresco por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

Almacenando Materiales
Manten materiales de construcción y residuos lejos de las calles, coladeras y desagües. Manten tapados los bultos de arena, grava y herramientas para excavar cuviertos con algun plastico para protejerlos de la lluvia, el aire y el desagüe.

Ordenando Materiales & Reciclando
Reduce la cantidad al ordenar el material, solo ordena lo necesario. Usa materiales recicables cuando sea posible. Cuando estes rompiendo el pavimento, recicla los pedasos en la compañia demolidora. Se puede reciclar el aspfalto, concreto, madera y la vegetacion. Materiales no reciclados se deverian llevar a lugares de desechos peligrosos. llama al (909) 386-8401 para más información.

Durante Construcción
Planea las excavaciones durante clima seco. No dejes que el cemento o la cal lleguen hasta las calles o drenajes, evita esto con plantas temporales para detener el desagüe. Cubre las maquinas de mesclar con alguna garra para que se facilite la limpieza de residuos. Nunca entierres los desechos. Recicla todos los desechos peligrosos.

Limpiando
Lava la cal en un area designada, no la eches hacia la cochera o en la calle. Lava las mescladoras y las herramientas en un lugar especifico, donde el agua llegue a un contenedor. El agua de cemento se puede reciclar volviendola a usar en las mescladoras. Nunca dejes el agua de cemento que corra hacia las calles, alcantarillas o drenajes.



Para reportar actividades ilegales llamar al:

(877) WASTE18

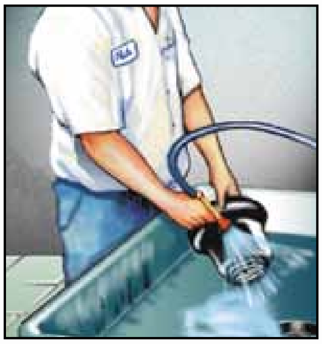
sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

STORMWATER Pollution Prevention

AUTO MAINTENANCE

Oil, grease, anti-freeze and other toxic automotive fluids often make their way into the San Bernardino County storm drain system, and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



Cleaning Auto Parts

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

Storing Hazardous Waste

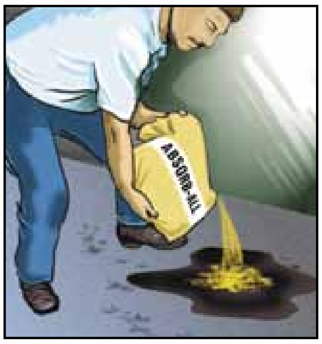
Keep your liquid waste segregated. Many fluids can be recycled via hazardous waste disposal companies if they are not mixed. Store all materials under cover with spill containment or inside to prevent contamination of rainwater runoff.

Metal Grinding and Polishing

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

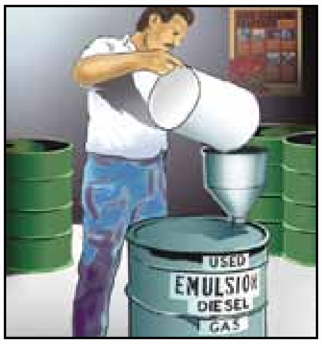
Preventing Leaks and Spills

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



Cleaning Spills

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



Proper Disposal of Hazardous Waste

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

To report illegal dumping call

(877) WASTE18

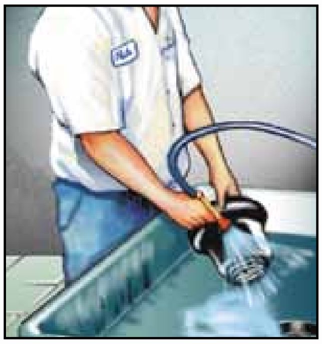
sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

MANTENIMIENTO DE AUTO

Aceite, grasa, anti-congelantes y otros liquidos toxicos para el auto acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

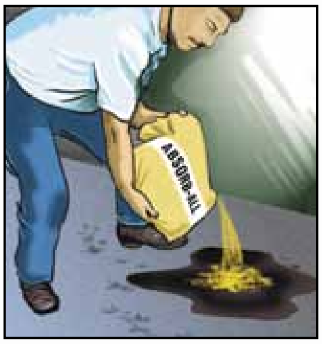


Limpiar Partes De Autos
Limpia las partes de auto con un cepillo de alambres o usa un limpiador de hornos en vez de usar limpiadores líquidos. Arregla las graseras, perchas para secar y tablas de escurrir para que los líquidos sean dirigidos al lavadero o recipientes para guardar líquidos. No laves las partes de auto o herramientas en el estacionamiento, la cochera o la calle.

Almacenando Desechos Peligrosos
Manten los desechos líquidos separados. Varios líquidos pueden ser reciclados por compañias que se especializan en desechos tóxicos si aun no estan mezclados. Guarda y cubre todos los materiales dentro de un lugar para prevenir la contaminación del desagüe.

Desechos de Metal & Pulidos
Manten un recipiente debajo de las maquinas de tornos o amoladoras para colectar desechos de metal. Manda los desechos de metal a un centro de reciclaje de metales. Guarda los desechos de metal en un recipiente cuvierto o dentro del local.

Prevenir Goteaduras & Derrames
Utilisa caserolas para el goteo de líquidos. Use limpiadores absorbentes en lugar de agua para limpiar el área de trabajo.



Limpiando Derrames
Sigue tu plan de como actuar sobre los materiales tóxicos, como esta indicado en el departamento de bomberos local u otras autoridades de materiales tóxicos. Asegurate que todos los empleados estén informados y capaz de aplicar cada fase del plan. Usa métodos secos para limpiar derramamientos (barriendo, materiales absorbentes, etc.).

Manera Correcta de Depositar los Desechos Peligrosos
Recicla el aceite de motor y filtros de aceite usados, anti-congelante, baterias, lubricantes, y desechos de metal y partes de auto pulidas. Llama a un colector de desechos tóxicos para disponer de absorbentes saturados. Mas iformación sobre reciclaje, llama al (909) 386-8401.

Para reportar actividades ilegales llamar al:

(877) WASTE18

sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION

Construction & development:

Soil, cement wash, asphalt, oil and other hazardous debris from construction sites often make their way into the San Bernardino County storm drain system, and flow untreated into local waterways. Follow these best management practices to prevent pollution, protect public health and avoid fines or legal action.

- **Store Materials Safely:** Keep construction materials and debris away from the street, gutter and storm drains. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.
- **Preventing Erosion:** Avoid excavation or grading during wet weather. Plant temporary vegetation or add hydro mulch on slopes where construction is not immediately planned, and permanent vegetation once excavation and grading are complete. Construct diversion dikes to channel runoff to a detention basin and around the construction site. Use gravel approaches where truck traffic is frequent to reduce soil compaction and limit the tracking of sediment into the streets. For more information on erosion control, call (909) 799-7407.

- **Cleaning & Preventing Spills:** Use a drip pan and funnel when draining or pouring fluids. Sweep up dry spills, instead of hosing. Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. To report serious spills, call 911.
- **Maintaining Vehicles & Equipment:** Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutter and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks, and prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, and brake and radiator fluids.
- **Ordering Materials & Recycling Waste:** Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. You can recycle broken asphalt, concrete, wood, and cleared vegetation. Dispose of hazardous materials through a hazardous waste hauler or other means in accordance with the construction permit. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. For recycling and disposal information, call (909) 386-8401.
- **Concrete and mortar application:** Never dispose of cement washout into driveways, streets, gutters or drainage ditches. Wash concrete mixers and equipment only in specified washout areas, where the water flows into lined containment ponds. Cement wash water can be recycled by pumping it back into cement mixers for reuse.

For more information about how you can prevent stormwater pollution:

www.sbcountystormwater.org

NOTICE

! DISCHARGE INTO OUR WATERWAYS, ACCIDENTAL OR NOT, CAN LEAD TO ENFORCEMENT ACTIONS, WHICH CAN INCLUDE FINES.

WHEN WORKING WITH CONCRETE

USE THE 3Cs

CONTROL

Locate the nearest storm drain and ensure nothing can enter or be discharged into it. Use plastic covers and sandbags when working within 50' of a storm drain or catch basin.

CONTAIN

Isolate area and secure bags of cement after they are open. Keep cement, sand and aggregate (wet/dry) and slurries from saw cutting, from flowing into the streets, gutter and storm drains or being blown away. Cover bags of cement in case of rain.

CAPTURE

Sweep dry residue or vacuum wet concrete residue and dispose of properly. Create a designated washout area for equipment and tools and place away from driveways and storm drains. Dispose of concrete/plaster waste and rinsewater by hauling off to an approved disposal site.

To report illegal dumping, call **(877) WASTE18** or visit **sbcountystormwater.org**

SAN BERNARDINO COUNTY STORMWATER POLLUTION PREVENTION

Big Bear • Chino • Chino Hills • Colton • Fontana • Grand Terrace • Highland • Loma Linda • Montclair • Ontario • Rancho Cucamonga
Redlands • Rialto • San Bernardino • San Bernardino County • San Bernardino County Flood Control District • Upland • Yucaipa

AVISO

! LA DESCARGA EN NUESTRAS VÍAS FLUVIALES, DE FORMA ACCIDENTAL O NO, PUEDE LLEVAR A TOMAR MEDIDAS PARA CUMPLIR CON LA LEY QUE PUEDEN INCLUIR MULTAS.

CUANDO TRABAJE CON CONCRETO
APLIQUE LAS 3 C

CONTROL

Ubique el desagüe pluvial más cercano y asegúrese de que nada pueda entrar en él o que pueda descargarse allí. Use cubiertas de plástico y bolsas de arena cuando trabaje a una distancia de 50' de un desagüe pluvial o sumidero.

CONTENCIÓN

Aísle el área y asegure las bolsas de cemento una vez que las haya abierto. Impida que el cemento, la arena y los componentes del concreto (secos y húmedos) y los residuos acuosos resultantes después de cortar con sierra, fluyan hacia la calle, la alcantarilla y los desagües o que se vuelen con el viento.
Cubra las bolsas de cemento en caso de lluvia.

CAPTURA

Barra los residuos secos o limpie con una aspiradora los residuos de concreto húmedo y elimínelos en forma apropiada. Cree un área específica para enjuagar equipos y herramientas, y colóquela lejos de las entradas de automóviles y de los desagües pluviales.
Desheche los residuos de concreto o yeso y el agua de enjuague, llevándolos a un sitio aprobado para su eliminación.

Para informar sobre el vaciado ilegal de residuos, llame al **(877) WASTE18** o visite el sitio: **sbcountystormwater.org**

PREVENCIÓN DE CONTAMINACIÓN DE AGUAS PLUVIALES EN EL CONDADO DE SAN BERNARDINO

Big Bear • Chino • Chino Hills • Colton • Fontana • Grand Terrace • Highland • Loma Linda • Montclair • Ontario • Rancho Cucamonga • Redlands
Rialto • San Bernardino • Condado de San Bernardino • Distrito de Control de Inundaciones del Condado de San Bernardino • Upland • Yucaipa

SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION

■ Commercial landscape maintenance:

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

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

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

For more information about how you can prevent stormwater pollution:

www.sbcountystormwater.org

SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION

Carpet cleaning:

Toxic chemicals and discharged waste water from carpet, drapery, furniture and window cleaning often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates local waterways, making them unsafe for people and wildlife. Following these best management practices will prevent pollution, comply with regulations and protect public health.

These guidelines apply even if the cleaning products are labeled “nontoxic” or “biodegradable”. Although these products may be less harmful to the environment, they can still have harmful effects if they enter the storm drain untreated.

- **Dispose of wastewater properly:** Wastewater from cleaning equipment must be discharged into a sink, toilet, or other drain connected to the sanitary sewer system within sanitary sewer discharge limits, or hauled off and disposed of properly. Wastewater should never be discharged into a street, gutter, parking lot or storm drain.
- **Filter wastewater:** Carpet cleaning wastewater should be filtered before discharging it to the sanitary sewer since fibers and other debris in the wastewater can clog pipes. The filtered material can be disposed of in the garbage, as long as the waste is not contaminated with hazardous pollutants.

For more information about how you can prevent stormwater pollution:

www.sbcountystormwater.org

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San Bernardino County STORMWATER PROGRAM

San Bernardino County Stormwater Program
825 East Third Street · Room 127
San Bernardino, CA 94215-0835

STORMWATER
Pollution Prevention

LANDSCAPE MAINTENANCE

San Bernardino County STORMWATER PROGRAM

STORMWATER Pollution Prevention

Stormwater Management Practices for Commercial Landscape Maintenance

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

Recycle Yard Waste

Recycle leaves, grass clippings and other yard waste. Do not blow, sweep, rake or hose yard waste into the street. Try grasscycling - the natural recycling of grass by leaving clippings on the lawn when mowing. Grass clippings will quickly decompose, returning valuable nutrients to the soil. Further information can be obtained at www.ciwmb.ca.gov/Organics.

Use Fertilizers, Herbicides and Pesticides Safely

Fertilizers, herbicides and pesticides are often carried into the storm drain system by sprinkler runoff. Use of natural, non-toxic alternatives to the traditional fertilizers, herbicides and pesticides is highly recommended. If you must use chemical fertilizers, herbicides, or pesticides:

- Spot apply pesticides and herbicides, rather than blanketing entire areas.
- Avoid applying near curbs and driveways, and never apply before a rain.
- Apply fertilizers as needed, when plants can best use it, and when the potential for it being carried away by runoff is low.

Recycle Hazardous Waste

Pesticides, fertilizers, herbicides and motor oil contaminate landfills and should be disposed of through a Hazardous Waste Facility, which accepts these types of materials. For information on proper disposal call, (909) 386-8401.

Use Water Wisely

Conserve water and prevent runoff by controlling the amount of water and direction of sprinklers. Sprinklers should be on long enough to allow water to soak into the ground but not so long as to cause runoff. Periodically inspect, fix leaks and realign sprinkler heads. Plant native vegetation to reduce the need of water, fertilizers, herbicides, and pesticides.

Prevent Erosion

Erosion washes sediments, debris and toxic runoff into the storm drain system, polluting waterways.

- Prevent erosion and sediment runoff by using ground cover, berms and vegetation down-slope to capture runoff.
- Avoid excavation or grading during wet weather.

Store Materials Safely

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

To report illegal dumping call

(877) WASTE18

or visit our website:

sbcountystormwater.org

San Bernardino County
STORMWATER PROGRAM

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

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25	1	.25
		Predominant soil texture	0.25	2	.50
		Site soil variability	0.25	1	.25
		Depth to groundwater / impervious layer	0.25	1	.25
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			1.25
B	Design	Tributary area size	0.25	2	.50
		Level of pretreatment/ expected sediment loads	0.25	1	.25
		Redundancy	0.25	3	.75
		Compaction during construction	0.25	2	.50
		Design Safety Factor, $S_B = \Sigma p$			2.00
Combined Safety Factor, $S_{TOT} = S_A \times S_B$					2.50
Measured Infiltration Rate, inch/hr, K_M (corrected for test-specific bias)					0.90
Design Infiltration Rate, in/hr, $K_{DESIGN} = S_{TOT} \times K_M$					0.36

Supporting Data

Briefly describe infiltration test and provide reference to test forms:

PLEASE SEE ATTACHED SOILS TESTING UNDER TAB 6.4E MISC. DATA.

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

DCV Analysis - DA-1
REDLANDS CITY CENTER

Design Capture Volume Calculation	Template Item	Value	Comment
Project Area (ft^2)	1	103,792	
Impervious Area (ft^2)		94,095	
Imperviousness (Imp %)	2	90.66%	Imperviousness after applying preventative site design practices
Runoff Coefficient (Rc)	3	0.74	$Rc=0.858(Imp\%)^3-0.78(Imp\%)^2+0.774(Imp\%)+0.04$
$P_{2yr-1hr}$(in)	4	0.464	Determine 1-hour rainfall depth for a 2-year return period from NOAA
C_1		1.4807	Climatic region Valley=1.4807, Mountain=1.909, Desert=1.2371
P_6(in)	5	0.69	Mean 6-hr precipitation = $P_{2yr-1hr}$(in)*C_1
C_2	6	1.963	24 hrs = 1.582, 48 hrs = 1.963 Drawdown Rate
DCV (ft^3)	7	**8,631**	Design Capture Volume
Water Quality Credits Volume Reduction (ft^3)			
Remaining DCV (ft^3)		**8,631**	Remaining Design Capture Volume after Water Qaulity Credits applied
Flow Based BMP Calculation (Qbmp)			
Regression Coefficeint for Intensity ($I R_{C)}$		0.2787	Valley=0.2787 Mountain=0.3614 Desert=0.3250
Qbmp(ft^3/sec)		**0.23**	Q=(Rc)(PxIRc)(Area(ac))

DCV Analysis - DA-2
REDLANDS CITY CENTER

Design Capture Volume Calculation	Template Item	Value	Comment
Project Area (ft^2)	1	26,835	
Impervious Area (ft^2)		24,961	
Imperviousness (Imp %)	2	93.02%	Imperviousness after applying preventative site design practices
Runoff Coefficient (Rc)	3	0.78	$Rc=0.858(Imp\%)^3-0.78(Imp\%)^2+0.774(Imp\%)+0.04$
$P_{2yr-1hr}$(in)	4	0.464	Determine 1-hour rainfall depth for a 2-year return period from NOAA
C_1		1.4807	Climatic region Valley=1.4807, Mountain=1.909, Desert=1.2371
P_6(in)	5	0.69	Mean 6-hr precipitation = $P_{2yr-1hr}(in)*C_1$
C_2	6	1.963	24 hrs = 1.582, 48 hrs = 1.963 Drawdown Rate
DCV (ft^3)	7	**2,339**	Design Capture Volume
Water Quality Credits Volume Reduction (ft^3)			
Remaining DCV (ft^3)		**2,339**	Remaining Design Capture Volume after Water Qaulity Credits applied
Flow Based BMP Calculation (Qbmp)			
Regression Coefficeint for Intensity ($I R_{C}$)		0.2787	Valley=0.2787 Mountain=0.3614 Desert=0.3250
Qbmp(ft^3/sec)		**0.06**	Q=(Rc)(PxIRc)(Area(ac))

PWQMP Underground Infiltration Sizing - DA-1
REDLANDS CITY CENTER

Infiltration			
Remaining DCV	1	8,631	ft^3
Infiltration Rate	2	0.9	in/hr
Safety Factor	3	2.5	
P_{design}	4	0.36	in/hr
Max Drawdown Time	5	72	hrs
Max Pond Depth to Drain in 72 hrs	6	2.16	ft
Max Pond Depth (Basin Max. Depth)	6	2.21	ft
Pond Depth	7	2.16	ft
Infiltrating Surface Area	8	0	ft^2
Amended Soil Depth d_{media}	9	0	ft
Amended Soil Porosity	10	0	
Gravel Depth d_{media}	11	0	ft
Gravel Porosity	12	0	
Storm Duration	13	3	hrs
V_{ret} =	14	0	ft^3
Manufacturer's Retention	15	8746	ft^3
Total Retention Volume	16	8,746	ft^3
Fraction of DCV Achieved	17	101.33%	
Full DCV Achieved	18	Yes	
Actual		72.00	hrs

PWQMP Underground Infiltration Sizing - DA-2

REDLANDS CITY CENTER

Infiltration			
Remaining DCV	1	2,339	ft^3
Infiltration Rate	2	0.9	in/hr
Safety Factor	3	2.5	
P_{design}	4	0.36	in/hr
Max Drawdown Time	5	72	hrs
Max Pond Depth to Drain in 72 hrs	6	2.16	ft
Max Pond Depth (Basin Max. Depth)	6	2.21	ft
Pond Depth	7	2.16	ft
Infiltrating Surface Area	8	0	ft^2
Amended Soil Depth d_{media}	9	0	ft
Amended Soil Porosity	10	0	
Gravel Depth d_{media}	11	0	ft
Gravel Porosity	12	0	
Storm Duration	13	3	hrs
V_{ret} =	14	0	ft^3
Manufacturer's Retention	15	2,343	ft^3
Total Retention Volume	16	2,343	ft^3
Fraction of DCV Achieved	17	100.17%	
Full DCV Achieved	18	Yes	
Actual		72.00	hrs

DA-1 UNDERGROUND INFILTRATION SYSTEM

CULTEC

CULTEC Stormwater Design Calculator

Date:	September 14, 2019

Project Number:	10160 (DA-1 Infiltration)

Project Information:

Redlands City Center
212 & 213 Brookside Avenue
Redlands
CA

Calculations Performed By:

Matt Hicks
Hicks & Hartwick, Inc.

RECHARGER 280HD

Recharger 280HD Chamber Specifications

Height	**26.5**	inches
Width	**47.0**	inches
Length	**8.00**	feet
Installed Length	**7.00**	feet
Bare Chamber Volume	**42.55**	cu. feet
Installed Chamber Volume	**77.57**	cu. feet

Breakdown of Storage Provided by Recharger 280HD Stormwater System

Within Chambers	**5,057.73**	cu. feet
Within Feed Connectors	**10.96**	cu. feet
Within Stone	**4,518.17**	cu. feet
Total Storage Provided	**9,586.9**	**cu. feet**
Total Storage Required	8800.00 cu. feet	

Materials List

Recharger 280HD

Total Number of Chambers Required	**117**	**pieces**
Starter Chambers	**13**	pieces
Intermediate Chambers	**91**	pieces
End Chambers	**13**	pieces
HVLV FC-24 Feed Connectors	**24**	pieces
CULTEC No. 410 Non-Woven Geotextile	**1226**	sq. yards
CULTEC No. 4800 Woven Geotextile	**118**	feet
Stone	**418**	cu. yards

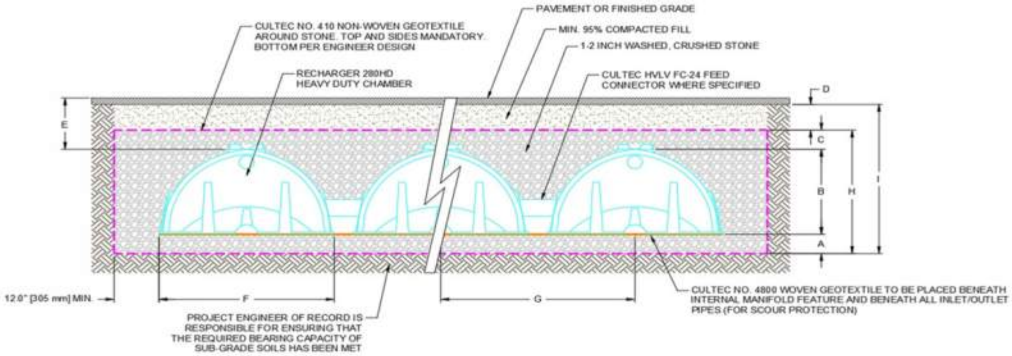
Based on 2 Internal Manifolds

Bed Detail

Bed detail for reference only. Not project specific. Not to scale.

Bed Layout Information

Number of Rows Wide	**13**	pieces
Number of Chambers Long	**9**	pieces
Chamber Row Width	**56.92**	feet
Chamber Row Length	**64.00**	feet
Bed Width	**58.92**	feet
Bed Length	**66.00**	feet
Bed Area Required	**3888.50**	sq. feet
Length of Separator Row	**N/A**	feet



Conceptual graphic only. Not job specific.

Cross Section Table Reference

A	Depth of Stone Base	**18.0**	inches
B	Chamber Height	**26.5**	inches
C	Depth of Stone Above Units	**6.0**	inches
D	Depth of 95% Compacted Fill	**10.0**	inches
E	Max. Depth Allowed Above the Chamber	**12.00**	feet
F	Chamber Width	**47.0**	inches
G	Center to Center Spacing	**4.42**	feet
H	Effective Depth	**4.21**	feet
I	Bed Depth	**5.04**	feet

CULTEC Stage-Storage Calculations

Date:	September 14, 2019

Project Information:

Redlands City Center
212 & 213 Brookside Avenue
Redlands
CA 92373

Project Number:

10160 (DA-1 Infiltration

STORAGE PROVIDED AT MAX. PONDING DEPTH

MAX. PONDING EL. = 3.66'
CHAMBER BOTTOM EL. = 1.50'
BED ELEVATION = 0.00'

Chamber Model -	**Recharger 280HD**	
Number of Rows-	13	units
Total Number of Chambers -	117	units
HVLV FC-24 Feed Connectors-	24	units
Stone Void -	40	%
Stone Base -	18	inches
Stone Above Units -	6	inches
Area -	3888.50	ft2
Base of Stone Elevation -	0.00	

Recharger 280HD Incremental Storage Volumes

Height of System		Chamber Volume		HVLV Feed Connector Volume		Stone Volume		Cumulative Storage Volume		Total Cumulative Storage Volume		Elevation		
in	mm	ft³	m³	ft3	m3	ft³	m³	ft³	m³	ft³	m³	ft	m	
50.5	1283	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	9588.58	271.52	4.210	1.28	Top of Stone Elevation
49.5	1257	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	9458.97	267.85	4.130	1.26	
48.5	1232	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	9329.35	264.18	4.040	1.23	
47.5	1207	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	9199.73	260.51	3.960	1.21	
46.5	1181	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	9070.12	256.84	3.880	1.18	
45.5	1156	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	8940.50	253.17	3.790	1.16	
44.5	1130	0.1	0.0	0.0	0.0	64.8	1.8	64.858	1.8	8810.88	249.50	3.710	1.13	Top of Chamber Elevation
44.0	1118	15.0	0.4	0.0	0.0	123.6	3.5	138.602	3.9	8746.03	247.66	3.670	1.12	
43.0	1092	39.1	1.1	0.0	0.0	114.0	3.2	153.079	4.3	8607.42	243.73	3.580	1.09	
42.0	1067	83.2	2.4	0.0	0.0	96.3	2.7	179.537	5.1	8454.34	239.40	3.500	1.07	
41.0	1041	111.5	3.2	0.0	0.0	85.0	2.4	196.509	5.6	8274.81	234.32	3.420	1.04	
40.0	1016	132.3	3.7	0.0	0.0	76.7	2.2	208.989	5.9	8078.30	228.75	3.330	1.02	
39.0	991	148.9	4.2	0.0	0.0	70.0	2.0	218.973	6.2	7869.31	222.83	3.250	0.99	
38.0	965	162.2	4.6	0.0	0.0	64.7	1.8	226.961	6.4	7650.34	216.63	3.170	0.97	
37.0	940	173.9	4.9	0.0	0.0	60.1	1.7	233.949	6.6	7423.37	210.21	3.080	0.94	
36.0	914	183.9	5.2	0.0	0.0	56.1	1.6	239.940	6.8	7189.43	203.58	3.000	0.91	
35.0	889	193.0	5.5	0.0	0.0	52.4	1.5	245.431	6.9	6949.49	196.79	2.920	0.89	
34.0	864	200.5	5.7	0.0	0.0	49.4	1.4	249.924	7.1	6704.05	189.84	2.830	0.86	
33.0	838	207.2	5.9	0.0	0.0	46.7	1.3	253.917	7.2	6454.13	182.76	2.750	0.84	
32.0	813	218.8	6.2	0.0	0.0	42.1	1.2	260.906	7.4	6200.21	175.57	2.670	0.81	
31.0	787	222.1	6.3	0.0	0.0	40.8	1.2	262.903	7.4	5939.31	168.18	2.580	0.79	
30.0	762	225.5	6.4	1.1	0.0	39.4	1.1	266.009	7.5	5676.40	160.74	2.500	0.76	
29.0	737	228.8	6.5	0.9	0.0	38.1	1.1	267.804	7.6	5410.39	153.21	2.420	0.74	
28.0	711	232.1	6.6	0.9	0.0	36.8	1.0	269.760	7.6	5142.59	145.62	2.330	0.71	
27.0	686	238.8	6.8	0.9	0.0	34.1	1.0	273.744	7.8	4872.83	137.98	2.250	0.69	
26.0	660	242.9	6.9	0.8	0.0	32.4	0.9	276.220	7.8	4599.09	130.23	2.170	0.66	
25.0	635	244.6	6.9	0.8	0.0	31.8	0.9	277.178	7.8	4322.87	122.41	2.080	0.64	
24.0	610	253.8	7.2	0.7	0.0	28.1	0.8	282.619	8.0	4045.69	114.56	2.000	0.61	
23.0	584	254.6	7.2	0.7	0.0	27.8	0.8	283.088	8.0	3763.07	106.56	1.920	0.58	
22.0	559	256.3	7.3	0.6	0.0	27.1	0.8	283.995	8.0	3479.98	98.54	1.830	0.56	
21.0	533	257.9	7.3	0.5	0.0	26.4	0.7	284.832	8.1	3195.99	90.50	1.750	0.53	
20.0	508	259.6	7.4	0.2	0.0	25.8	0.7	285.569	8.1	2911.16	82.43	1.670	0.51	
19.0	483	271.2	7.7	0.1	0.0	21.1	0.6	292.487	8.3	2625.59	74.35	1.580	0.48	
18.0	457	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	2333.10	66.07	1.500	0.46	Bottom of Chamber Elevation
17.0	432	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	2203.48	62.40	1.420	0.43	
16.0	406	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	2073.87	58.73	1.330	0.41	
15.0	381	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	1944.25	55.05	1.250	0.38	
14.0	356	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	1814.63	51.38	1.170	0.36	
13.0	330	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	1685.02	47.71	1.080	0.33	
12.0	305	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	1555.40	44.04	1.000	0.30	
11.0	279	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	1425.78	40.37	0.920	0.28	
10.0	254	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	1296.17	36.70	0.830	0.25	
9.0	229	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	1166.55	33.03	0.750	0.23	
8.0	203	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	1036.93	29.36	0.670	0.20	
7.0	178	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	907.32	25.69	0.580	0.18	
6.0	152	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	777.70	22.02	0.500	0.15	
5.0	127	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	648.08	18.35	0.420	0.13	
4.0	102	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	518.47	14.68	0.330	0.10	
3.0	76	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	388.85	11.01	0.250	0.08	
2.0	51	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	259.23	7.34	0.170	0.05	
1.0	25	0.0	0.0	0.0	0.0	129.6	3.7	129.617	3.7	129.62	3.67	0.080	0.03	
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	Bottom of Stone Elevation
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DA-2 UNDERGROUND INFILTRATION SYSTEM

CULTEC Stormwater Design Calculator

Date:	September 14, 2019

Project Number:	10160 (DA-2 Infiltration)

Project Information:

Redlands City Center
212 & 213 Brookside Avenue
Redlands
CA

Calculations Performed By:

Matt Hicks
Hicks & Hartwick, Inc.

RECHARGER 280HD

Recharger 280HD Chamber Specifications		
Height	**26.5**	inches
Width	**47.0**	inches
Length	**8.00**	feet
Installed Length	**7.00**	feet
Bare Chamber Volume	**42.55**	cu. feet
Installed Chamber Volume	**77.57**	cu. feet

Breakdown of Storage Provided by Recharger 280HD Stormwater System		
Within Chambers	**1,294.83**	cu. feet
Within Feed Connectors	**1.83**	cu. feet
Within Stone	**1,293.87**	cu. feet
Total Storage Provided	**2,590.5**	**cu. feet**
Total Storage Required	2500.00 cu. feet	

Materials List

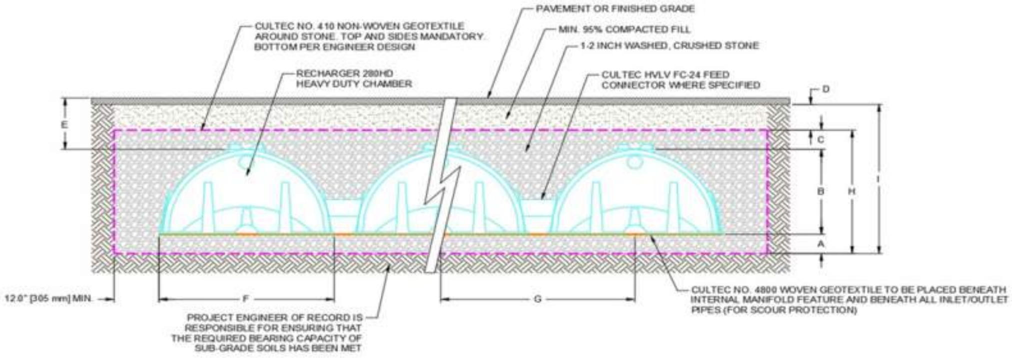
Recharger 280HD		
Total Number of Chambers Required	**30**	**pieces**
Starter Chambers	**3**	pieces
Intermediate Chambers	**24**	pieces
End Chambers	**3**	pieces
HVLV FC-24 Feed Connectors	**4**	pieces
CULTEC No. 410 Non-Woven Geotextile	**402**	sq. yards
CULTEC No. 4800 Woven Geotextile	**30**	feet
Stone	**120**	cu. yards

Based on 2 Internal Manifolds

Bed Detail

Bed Layout Information		
Number of Rows Wide	**3**	pieces
Number of Chambers Long	**10**	pieces
Chamber Row Width	**12.75**	feet
Chamber Row Length	**71.00**	feet
Bed Width	**14.75**	feet
Bed Length	**73.00**	feet
Bed Area Required	**1076.75**	sq. feet
Length of Separator Row	**N/A**	feet

Bed detail for reference only. Not project specific. Not to scale.



Conceptual graphic only. Not job specific.

Cross Section Table Reference			
A	Depth of Stone Base	**18.0**	inches
B	Chamber Height	**26.5**	inches
C	Depth of Stone Above Units	**6.0**	inches
D	Depth of 95% Compacted Fill	**10.0**	inches
E	Max. Depth Allowed Above the Chamber	**12.00**	feet
F	Chamber Width	**47.0**	inches
G	Center to Center Spacing	**4.42**	feet
H	Effective Depth	**4.21**	feet
I	Bed Depth	**5.04**	feet

CULTEC Stage-Storage Calculations

Date:	September 14, 2019

Project Information:

Redlands City Center
212 & 213 Brookside Avenue
Redlands
CA 92373

Project Number:

10160 (DA-2 Infiltration

Chamber Model -	**Recharger 280HD**	
Number of Rows-	3	units
Total Number of Chambers -	30	units
HVLV FC-24 Feed Connectors-	4	units
Stone Void -	40	%
Stone Base -	18	inches
Stone Above Units -	6	inches
Area -	1076.75	ft2
Base of Stone Elevation -	0.00	

STORAGE PROVIDED AT MAX. PONDING DEPTH

MAX. PONDING EL. = 3.66'
CHAMBER BOTTOM EL. = 1.50'
BED ELEVATION = 0.00'

Recharger 280HD Incremental Storage Volumes

Height of System		Chamber Volume		HVLV Feed Connector Volume		Stone Volume		Cumulative Storage Volume		Total Cumulative Storage Volume		Elevation		
in	mm	ft^3	m^3	ft3	m3	ft^3	m^3	ft^3	m^3	ft^3	m^3	ft	m	
50.5	1283	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	2590.81	73.36	4.210	1.28	Top of Stone Elevation
49.5	1257	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	2554.92	72.35	4.130	1.26	
48.5	1232	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	2519.03	71.33	4.040	1.23	
47.5	1207	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	2483.14	70.31	3.960	1.21	
46.5	1181	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	2447.25	69.30	3.880	1.18	
45.5	1156	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	2411.36	68.28	3.790	1.16	
44.5	1130	0.0	0.0	0.0	0.0	17.9	0.5	17.959	0.5	2375.46	67.27	3.710	1.13	Top of Chamber Elevation
44.0	1118	3.8	0.1	0.0	0.0	34.4	1.0	38.192	1.1	2357.51	66.76	3.670	1.12	
43.0	1092	10.0	0.3	0.0	0.0	31.9	0.9	41.898	1.2	2319.31	65.68	3.580	1.09	
42.0	1067	21.3	0.6	0.0	0.0	27.4	0.8	48.672	1.4	2277.42	64.49	3.500	1.07	
41.0	1041	28.5	0.8	0.0	0.0	24.5	0.7	53.017	1.5	2228.74	63.11	3.420	1.04	
40.0	1016	33.9	1.0	0.0	0.0	22.3	0.6	56.212	1.6	2175.73	61.61	3.330	1.02	
39.0	991	38.1	1.1	0.0	0.0	20.6	0.6	58.768	1.7	2119.51	60.02	3.250	0.99	
38.0	965	41.5	1.2	0.0	0.0	19.3	0.5	60.813	1.7	2060.75	58.35	3.170	0.97	
37.0	940	44.5	1.3	0.0	0.0	18.1	0.5	62.602	1.8	1999.93	56.63	3.080	0.94	
36.0	914	47.1	1.3	0.0	0.0	17.1	0.5	64.135	1.8	1937.33	54.86	3.000	0.91	
35.0	889	49.4	1.4	0.0	0.0	16.1	0.5	65.541	1.9	1873.20	53.04	2.920	0.89	
34.0	864	51.3	1.5	0.0	0.0	15.4	0.4	66.691	1.9	1807.66	51.19	2.830	0.86	
33.0	838	53.0	1.5	0.0	0.0	14.7	0.4	67.714	1.9	1740.96	49.30	2.750	0.84	
32.0	813	56.0	1.6	0.0	0.0	13.5	0.4	69.503	2.0	1673.25	47.38	2.670	0.81	
31.0	787	56.9	1.6	0.0	0.0	13.1	0.4	70.014	2.0	1603.75	45.41	2.580	0.79	
30.0	762	57.7	1.6	0.2	0.0	12.8	0.4	70.710	2.0	1533.73	43.43	2.500	0.76	
29.0	737	58.6	1.7	0.2	0.0	12.5	0.4	71.188	2.0	1463.02	41.43	2.420	0.74	
28.0	711	59.4	1.7	0.1	0.0	12.1	0.3	71.692	2.0	1391.83	39.41	2.330	0.71	
27.0	686	61.1	1.7	0.1	0.0	11.4	0.3	72.713	2.1	1320.14	37.38	2.250	0.69	
26.0	660	62.2	1.8	0.1	0.0	11.0	0.3	73.349	2.1	1247.43	35.32	2.170	0.66	
25.0	635	62.6	1.8	0.1	0.0	10.8	0.3	73.598	2.1	1174.08	33.25	2.080	0.64	
24.0	610	65.0	1.8	0.1	0.0	9.9	0.3	74.995	2.1	1100.48	31.16	2.000	0.61	
23.0	584	65.2	1.8	0.1	0.0	9.8	0.3	75.118	2.1	1025.49	29.04	1.920	0.58	
22.0	559	65.6	1.9	0.1	0.0	9.7	0.3	75.358	2.1	950.37	26.91	1.830	0.56	
21.0	533	66.0	1.9	0.1	0.0	9.5	0.3	75.587	2.1	875.01	24.78	1.750	0.53	
20.0	508	66.5	1.9	0.0	0.0	9.3	0.3	75.799	2.1	799.43	22.64	1.670	0.51	
19.0	483	69.4	2.0	0.0	0.0	8.1	0.2	77.576	2.2	723.63	20.49	1.580	0.48	
18.0	457	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	646.05	18.29	1.500	0.46	Bottom of Chamber Elevation
17.0	432	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	610.16	17.28	1.420	0.43	
16.0	406	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	574.27	16.26	1.330	0.41	
15.0	381	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	538.38	15.25	1.250	0.38	
14.0	356	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	502.48	14.23	1.170	0.36	
13.0	330	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	466.59	13.21	1.080	0.33	
12.0	305	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	430.70	12.20	1.000	0.30	
11.0	279	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	394.81	11.18	0.920	0.28	
10.0	254	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	358.92	10.16	0.830	0.25	
9.0	229	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	323.03	9.15	0.750	0.23	
8.0	203	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	287.13	8.13	0.670	0.20	
7.0	178	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	251.24	7.11	0.580	0.18	
6.0	152	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	215.35	6.10	0.500	0.15	
5.0	127	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	179.46	5.08	0.420	0.13	
4.0	102	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	143.57	4.07	0.330	0.10	
3.0	76	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	107.68	3.05	0.250	0.08	
2.0	51	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	71.78	2.03	0.170	0.05	
1.0	25	0.0	0.0	0.0	0.0	35.9	1.0	35.892	1.0	35.89	1.02	0.080	0.03	
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	Bottom of Stone Elevation
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Brookfield, CT 06804

Phone: 203-775-4416
www.cultec.com
tech@cultec.com

Created on: 9/14/2019

Recharger 280HD Incremental Storage Volumes

Height of System		Chamber Volume		HVLV Feed Connector Volume		Stone Volume		Cumulative Storage Volume		Total Cumulative Storage Volume		Elevation		
in	mm	ft^3	m^3	ft3	m3	ft^3	m^3	ft^3	m^3	ft^3	m^3	ft	m	
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0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0
0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.00	0.00	0.000	0.00	0

WQMP Project Report

County of San Bernardino Stormwater Program

Santa Ana River Watershed Geodatabase

Tuesday, August 20, 2019

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

Project Site Parcel Number(s):	017121113, 017121114, , 017121117, 017121118, 017110116, 017110104, 017121119, 017121115, 017121121, 017121120, 017110113, 017110101, 017110105, 017110103, 017121125, 017121116, 017110115, 017110102, 017110106
Project Site Acreage:	3.699
HCOC Exempt Area:	No
Closest Receiving Waters: **(Applicant to verify based on local drainage facilities and topography.)**	**System Number** - 501 **Facility Name** - Zanja Creek **Owner** - OTHERS
Closest channel segment's susceptibility to Hydromodification:	EHM
Highest downstream hydromodification susceptibility:	High
Is this drainage segment subject to TMDLs?	No
Are there downstream drainage segments subject to TMDLs?	No
Is this drainage segment a 303d listed stream?	No
Are there 303d listed streams downstream?	Yes
Are there unlined downstream waterbodies?	No
Project Site Onsite Soil Group(s):	B
Environmentally Sensitive Areas within 200':	None
Groundwater Depth (FT):	-209
Parcels with potential septic tanks within 1000':	No
Known Groundwater Contamination Plumes within 1000':	Yes
Studies and Reports Related to Project Site:	CSDP 4 CALC SHEET FOR HYDRO CSDP 4 Hydrological Design Criteria Reservoir Canyon Storm Drain Drainage Invest SBVMWD High Groundwater / Pressure Zone Area

NOAA Atlas 14, Volume 6, Version 2
Location name: Redlands, California, USA*
Latitude: 34.0551°, Longitude: -117.1864°
Elevation: 1342.74 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.097** (0.080-0.117)	**0.124** (0.103-0.151)	**0.160** (0.133-0.195)	**0.190** (0.156-0.233)	**0.230** (0.183-0.293)	**0.262** (0.203-0.340)	**0.294** (0.223-0.392)	**0.328** (0.241-0.449)	**0.373** (0.264-0.534)	**0.409** (0.279-0.607)
10-min	**0.139** (0.115-0.168)	**0.178** (0.148-0.216)	**0.229** (0.190-0.279)	**0.272** (0.223-0.334)	**0.330** (0.262-0.420)	**0.375** (0.292-0.487)	**0.421** (0.320-0.561)	**0.469** (0.346-0.644)	**0.535** (0.378-0.766)	**0.587** (0.400-0.870)
15-min	**0.168** (0.140-0.203)	**0.215** (0.179-0.261)	**0.277** (0.230-0.338)	**0.329** (0.270-0.404)	**0.399** (0.317-0.507)	**0.454** (0.353-0.589)	**0.510** (0.386-0.679)	**0.568** (0.418-0.778)	**0.647** (0.457-0.926)	**0.710** (0.484-1.05)
30-min	**0.249** (0.207-0.302)	**0.319** (0.266-0.388)	**0.412** (0.342-0.502)	**0.489** (0.402-0.600)	**0.593** (0.471-0.754)	**0.674** (0.524-0.876)	**0.758** (0.575-1.01)	**0.844** (0.622-1.16)	**0.962** (0.679-1.38)	**1.06** (0.719-1.56)
60-min	**0.362** (0.301-0.439)	**0.464** (0.385-0.563)	**0.598** (0.496-0.729)	**0.709** (0.583-0.871)	**0.861** (0.684-1.10)	**0.979** (0.761-1.27)	**1.10** (0.834-1.47)	**1.23** (0.903-1.68)	**1.40** (0.986-2.00)	**1.53** (1.04-2.27)
2-hr	**0.511** (0.425-0.620)	**0.655** (0.544-0.796)	**0.845** (0.701-1.03)	**1.00** (0.823-1.23)	**1.22** (0.966-1.55)	**1.38** (1.07-1.80)	**1.55** (1.18-2.07)	**1.73** (1.27-2.37)	**1.97** (1.39-2.82)	**2.16** (1.47-3.20)
3-hr	**0.629** (0.524-0.764)	**0.807** (0.671-0.981)	**1.04** (0.863-1.27)	**1.23** (1.01-1.52)	**1.50** (1.19-1.90)	**1.70** (1.32-2.21)	**1.91** (1.45-2.54)	**2.13** (1.57-2.92)	**2.42** (1.71-3.47)	**2.65** (1.81-3.93)
6-hr	**0.885** (0.737-1.07)	**1.14** (0.945-1.38)	**1.47** (1.22-1.79)	**1.74** (1.43-2.13)	**2.11** (1.67-2.68)	**2.39** (1.86-3.11)	**2.68** (2.03-3.57)	**2.98** (2.20-4.09)	**3.39** (2.39-4.85)	**3.71** (2.53-5.50)
12-hr	**1.19** (0.990-1.44)	**1.53** (1.27-1.86)	**1.97** (1.64-2.40)	**2.34** (1.92-2.87)	**2.83** (2.25-3.59)	**3.20** (2.49-4.16)	**3.58** (2.72-4.78)	**3.98** (2.93-5.45)	**4.51** (3.18-6.45)	**4.92** (3.35-7.30)
24-hr	**1.60** (1.41-1.84)	**2.06** (1.82-2.38)	**2.66** (2.35-3.08)	**3.15** (2.76-3.68)	**3.81** (3.23-4.59)	**4.31** (3.58-5.30)	**4.82** (3.90-6.07)	**5.34** (4.21-6.91)	**6.04** (4.57-8.14)	**6.57** (4.81-9.16)
2-day	**1.99** (1.76-2.30)	**2.60** (2.30-3.00)	**3.41** (3.00-3.94)	**4.06** (3.55-4.73)	**4.95** (4.19-5.96)	**5.64** (4.68-6.93)	**6.33** (5.13-7.98)	**7.05** (5.56-9.13)	**8.03** (6.08-10.8)	**8.79** (6.43-12.3)
3-day	**2.15** (1.91-2.48)	**2.86** (2.53-3.30)	**3.80** (3.35-4.39)	**4.57** (4.00-5.34)	**5.65** (4.79-6.81)	**6.50** (5.39-7.99)	**7.37** (5.97-9.28)	**8.28** (6.52-10.7)	**9.53** (7.21-12.8)	**10.5** (7.70-14.7)
4-day	**2.33** (2.06-2.68)	**3.11** (2.75-3.59)	**4.17** (3.68-4.83)	**5.05** (4.42-5.89)	**6.29** (5.33-7.58)	**7.26** (6.03-8.93)	**8.28** (6.71-10.4)	**9.35** (7.37-12.1)	**10.8** (8.20-14.6)	**12.0** (8.80-16.8)
7-day	**2.71** (2.40-3.12)	**3.63** (3.21-4.19)	**4.88** (4.30-5.64)	**5.92** (5.18-6.91)	**7.38** (6.25-8.89)	**8.53** (7.08-10.5)	**9.74** (7.89-12.3)	**11.0** (8.68-14.2)	**12.8** (9.67-17.2)	**14.2** (10.4-19.8)
10-day	**2.94** (2.60-3.38)	**3.94** (3.49-4.55)	**5.31** (4.68-6.14)	**6.45** (5.65-7.52)	**8.05** (6.82-9.70)	**9.32** (7.74-11.5)	**10.6** (8.63-13.4)	**12.0** (9.49-15.6)	**14.0** (10.6-18.9)	**15.6** (11.4-21.7)
20-day	**3.64** (3.22-4.20)	**4.92** (4.35-5.68)	**6.66** (5.88-7.71)	**8.12** (7.11-9.47)	**10.2** (8.62-12.3)	**11.8** (9.81-14.5)	**13.5** (11.0-17.0)	**15.3** (12.1-19.9)	**17.9** (13.5-24.1)	**19.9** (14.6-27.8)
30-day	**4.28** (3.79-4.93)	**5.81** (5.13-6.70)	**7.88** (6.95-9.12)	**9.64** (8.43-11.2)	**12.1** (10.3-14.6)	**14.1** (11.7-17.3)	**16.2** (13.1-20.3)	**18.3** (14.5-23.8)	**21.4** (16.2-28.9)	**23.9** (17.5-33.4)
45-day	**5.09** (4.51-5.87)	**6.94** (6.13-8.00)	**9.44** (8.33-10.9)	**11.6** (10.1-13.5)	**14.5** (12.3-17.5)	**16.9** (14.1-20.8)	**19.4** (15.8-24.5)	**22.1** (17.4-28.6)	**25.9** (19.6-34.9)	**28.9** (21.2-40.3)
60-day	**5.94** (5.26-6.85)	**8.09** (7.16-9.34)	**11.0** (9.72-12.7)	**13.5** (11.8-15.7)	**17.0** (14.4-20.5)	**19.8** (16.4-24.3)	**22.7** (18.4-28.6)	**25.8** (20.4-33.5)	**30.3** (22.9-40.8)	**33.8** (24.7-47.1)

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

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

Please refer to NOAA Atlas 14 document for more information.

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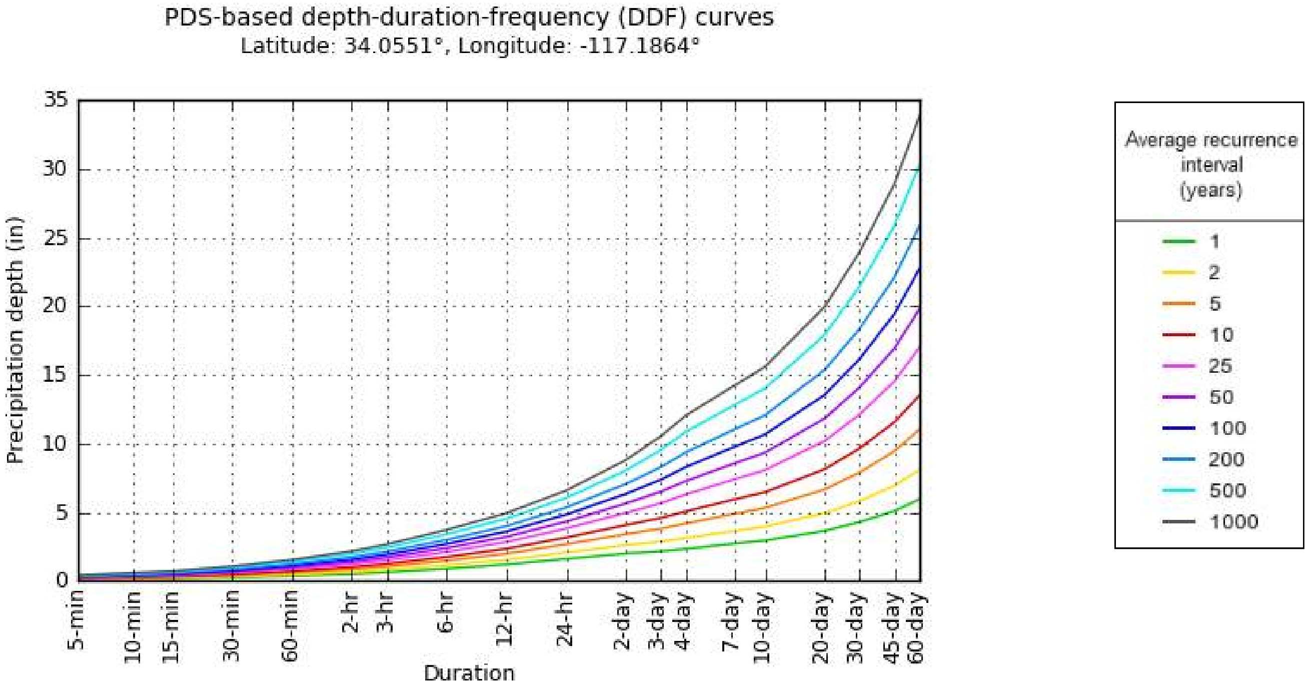
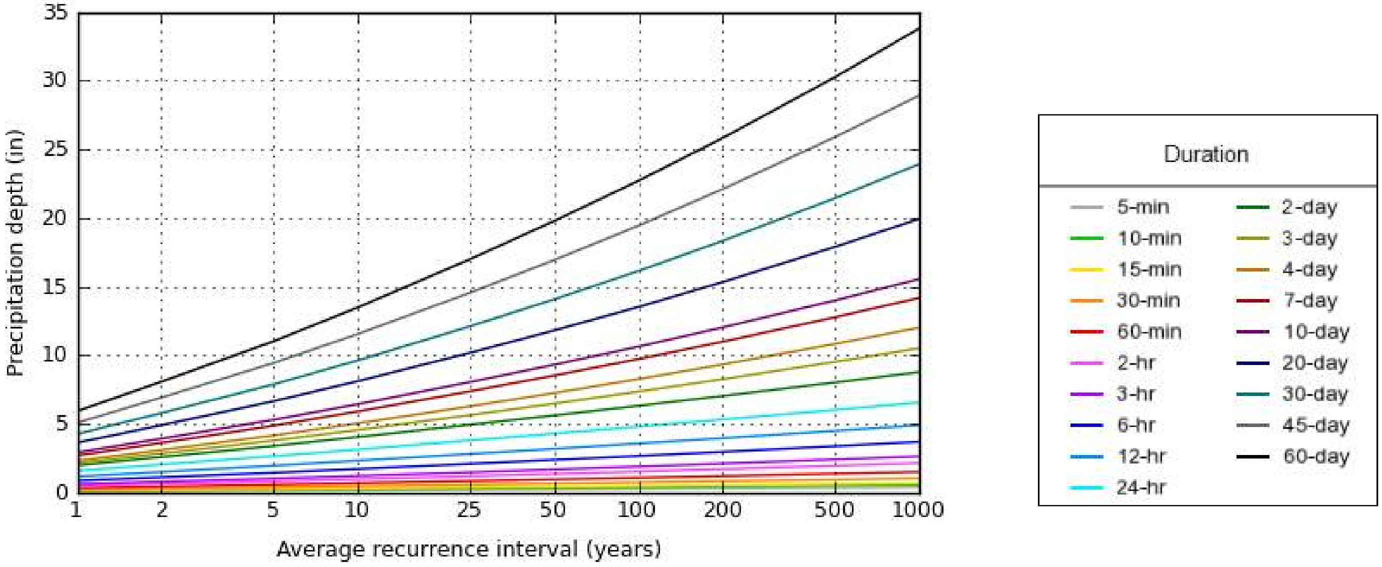
PF graphical





NOAA Atlas 14, Volume 6, Version 2

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Maps & aerials

Small scale terrain

Large scale terrain

Large scale map

Large scale aerial

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

Disclaimer

REPORT OF PRELIMINARY GEOTECHNICAL / GEOLOGIC STUDY & INFILTROMETER TESTING PROPOSED RESTAURANT PADS AND BUILDING RENOVATION 216 BROOKSIDE AVENUE, NORTHWEST CORNER OF EUREKA STREET AND BROOKSIDE AVENUE CITY OF REDLANDS SAN BERNARDINO COUNTY, CALIFORNIA

PROJECT NO.: 1151-A17
REPORT NO.: 1

FEBRUARY 12, 2018

SUBMITTED TO:

VANTAGE ONE REAL ESTATE INVESTMENTS V, LLC
4 CORPORATE PLAZA DRIVE, SUITE 210
NEWPORT BEACH, CA 92660

PREPARED BY:

HILLTOP GEOTECHNICAL, INC.
786 SOUTH GIFFORD AVENUE
SAN BERNARDINO, CA 92408

HILLTOP GEOTECHNICAL
INCORPORATED

786 S. GIFFORD AVENUE • SAN BERNARDINO • CALIFORNIA 92408
hilltopg@hgeotech.com • FAX 909-890-9055 • **909-890-9079**

February 12, 2018

Vantage One Real Estate Investments V, LLC
4 Corporate Plaza Drive, Suite 210
Newport Beach, CA 92660

Project No.: 1151-A17
Report No.: 1

Attention: Mr. Thomas N. Robinson

Subject: **Report of Preliminary Geotechnical / Geologic Study & Infiltrometer Testing, Proposed Restaurant Pads and Building Renovation, 216 Brookside Avenue, Northwest Corner of Eureka Street and Brookside Avenue, City of Redlands, San Bernardino County, California.**

References:

1. **GreenbergFarrow**, Undated, Unsigned, *Redlands, AC NWC Brookside Ave. & Eureka St.*, GFA Project No. 2016103.0, Sheet Nos. SP-5 & SP-6, Scales 1"=20' and 1"=40'.
2. **County of San Bernardino**, May 19, 2011, *Technical Guidance Document Appendices, Appendix VII., Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations.*
3. Technical References - See Appendix 'B.'

Mr. Robinson:

According to your request, we have completed a preliminary geotechnical / geologic study for the design and construction of the proposed restaurants and building renovation. We are presenting, herein, our findings and recommendations.

The recommendations presented in this report are considered preliminary since the proposed grading, the floor level elevations, the type of structures construction, the structural loads, etc. were not known at the time of this report. The findings of this study indicate that the project site is suitable for the proposed development and renovations provided the recommendations presented in the attached report are complied with and incorporated into the design and construction of the project.

Copies of this report should be forwarded to your other consultants for the project (i.e., Civil Engineer, Architect, Structural Engineer, etc.) as needed to implement the recommendations presented. The required number of the original, wet ink signed reports should be saved for submittal, and the other required documentation to the appropriate agency having jurisdiction over the project for review and permitting purposes.

If you have any questions after reviewing the findings and recommendations contained in the attached report, please do not hesitate to contact this office. This opportunity to be of professional service is sincerely appreciated.

Respectfully Submitted,
HILLTOP GEOTECHNICAL, INC.

MARK EDWARD HULETT
No.1623
CERTIFIED ENGINEERING GEOLOGIST
12/31/18

SUNDARAMOORTHY SRIRAJAN
2871
EXP. 9/30/19

Mark Hulett, CEG No. 1623
President

Sundaramoorthy Srirajan, PE No. 68601
Senior Engineer
Date Signed: 2-12-18

ashley Hulett
Ashley Hulett, GIT No. 574
Staff Geologist

AH/MH/SS/ss

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REPORT OF PRELIMINARY GEOTECHNICAL / GEOLOGIC STUDY & INFILTROMETER TESTING PROPOSED RESTAURANT PADS AND BUILDING RENOVATION 216 BROOKSIDE AVENUE, NORTHWEST CORNER OF EUREKA STREET AND BROOKSIDE AVENUE CITY OF REDLANDS SAN BERNARDINO COUNTY, CALIFORNIA

PROJECT NO.: 1151-A17
REPORT NO.: 1

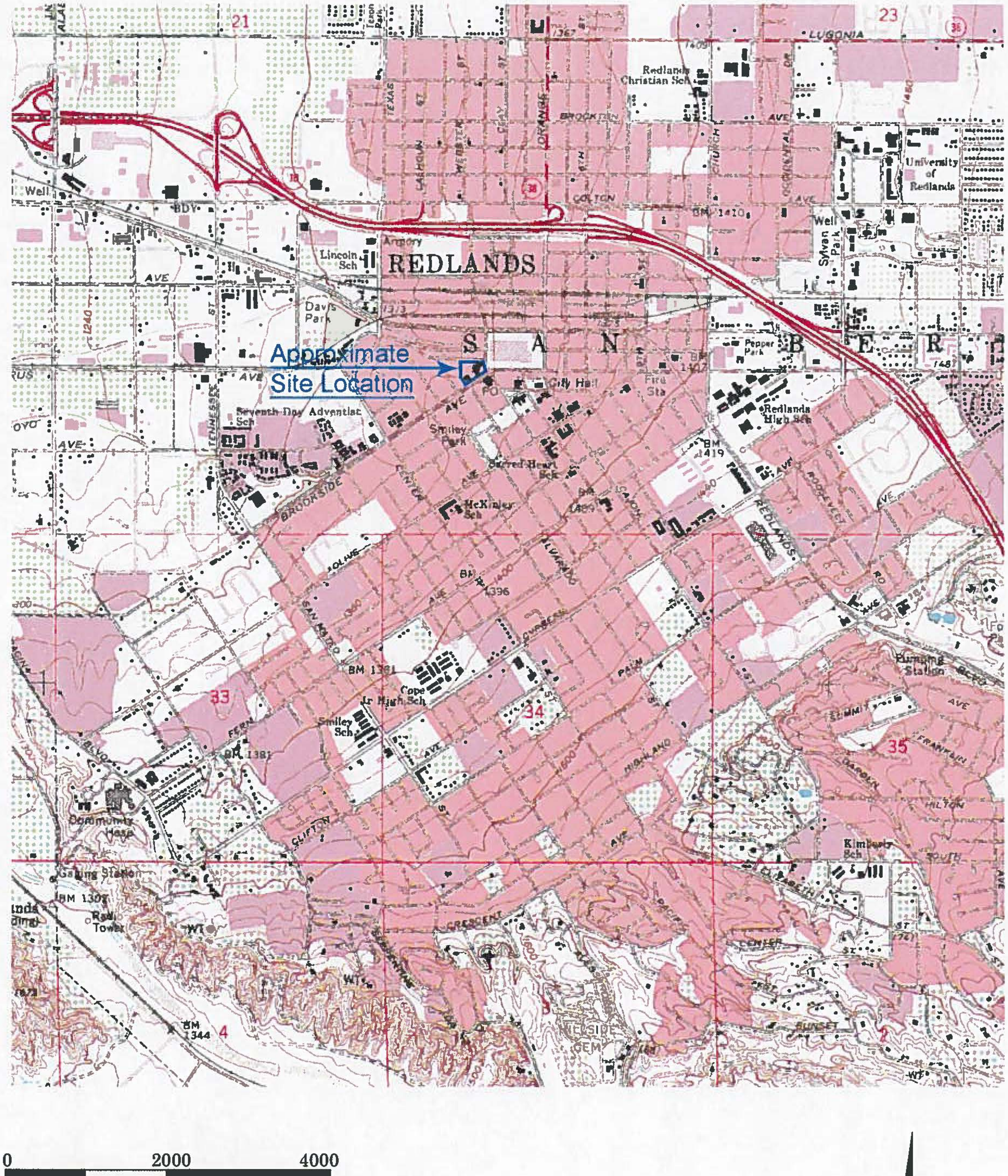
FEBRUARY 12, 2018

INTRODUCTION

AUTHORIZATION

This report presents results of the preliminary geotechnical / geologic study conducted on the subject site for the proposed restaurants and building renovation be located on the northwest corner of Eureka Street and Brookside Avenue at 216 Brookside Avenue in the City of Redlands, San Bernardino County, California. The general location of the subject site is indicated on the 'Site Location Map,' Figure No. 1.

Authorization to perform this study was in the form of a signed proposal from Mark Hulett of **Hilltop Geotechnical, Inc.** (Geotechnical / Geologic Consultant) to **Vantage One Real Estate Investments V, LLC** (Client), dated November 30, 2017, Proposal Number: P17196 and was received and signed by Mr. Thomas N. Robinson, the managing member, on December 14, 2017.



Reference: United States Department of the Interior, Geologic Survey, 1967, Photorevised 1988, *Redlands Quadrangle, California, San Bernardino Co.*, 7.5 Minute Topographic Series, Scale 1:24,000.

HILLTOP GEOTECHNICAL
INCORPORATED

SITE LOCATION MAP

By: AH	Date: 02/2018
Project No.: 1151-A17.1	Figure No.: 1

PURPOSE AND SCOPE OF STUDY

The scope of work performed for this study was designed to determine and evaluate the surface and subsurface conditions on the subject site with respect to geotechnical characteristics, including potential geologic hazards that may effect the development of the site, and to provide geotechnical recommendations and criteria for use in the design and construction of the proposed development. The scope of work included the following:

- Review of locally and easily available published and unpublished soil, geologic, and seismologic reports and data for the area (see References in Appendix 'B'), available historic photographs, flood hazard maps, well data, etc. to ascertain earth material, geologic, and hydrologic conditions of the area.
- Telephone conversations with the client and/or representatives of the client.
- Site reconnaissance.
- Subsurface exploration by means of borings to characterize the existing pavement section, earth materials, geologic, and groundwater conditions that could influence the proposed development.
- Sampling of on-site earth materials from the exploratory excavations.
- Laboratory testing of selected earth material samples considered representative of the subsurface conditions to determine the engineering properties and characteristics.
- Define the general geology of the subject site and evaluate potential geologic hazards which would have an effect on the proposed site development.
- Determine seismic classification of the site to meet the requirements of the 2016 California Building Code (CBC), effective on January 1, 2017.
- Engineering analysis of field and laboratory data to provide a basis for geotechnical conclusions and recommendations regarding site grading and foundation, floor slab, retaining wall, pavement, etc. design parameters.

- Preparation of this report to present the geotechnical and geologic conclusions and recommendations for the proposed site development.

This report presents our conclusions and/or recommendations regarding:

- The geologic setting of the site.
- Potential geologic hazards (including landslides, seismicity, faulting, liquefaction potential, etc.)
- General subsurface earth conditions.
- Presence and effect of expansive, collapsible, and compressible earth materials.
- Groundwater conditions within the depth of our subsurface study.
- Excavation characteristics of the on-site earth materials.
- Characteristics and compaction requirements of proposed fill and backfill materials.
- Recommendations and guide specifications for earthwork.
- Seismic design coefficients for structural design purposes.
- Types and depths of foundations.
- Allowable bearing pressure and lateral resistance for foundations.
- Estimated total and differential settlements.
- Preliminary corrosion potential evaluation for concrete in direct contact with the on-site earth materials.
- Temporary and permanent cut and fill slope recommendations.
- Utility trench excavation and backfill recommendations.

- Slope maintenance and protection recommendations.
- Preliminary pavement recommendations.
- Percolation parameters.

The scope of work performed for this report did not include any testing of earth materials or groundwater for environmental purposes, an environmental assessment of the property, or opinions relating to the possibility of surface or subsurface contamination by hazardous or toxic substances. In addition, evaluation of on-site private sewage disposal systems for the proposed development was not part of this study.

This study was prepared for the exclusive use of **Mr. Thomas N. Robinson** of **Vantage One Real Estate Investments V, LLC**, and his consultants for specific application to the proposed restaurant pads and building renovation in accordance with generally accepted standards of the geotechnical and geologic professions and generally accepted geotechnical (soil and foundation) engineering and geologic principles and practices at the time this report was prepared. Other warranties, implied or expressed, are not made. Although reasonable effort has been made to obtain information regarding geotechnical / geologic and subsurface conditions of the site, limitations exist with respect to knowledge of unknown regional or localized off-site conditions which may have an impact at the site. The conclusions and recommendations presented in this report are valid as of the date of this report. However, changes in conditions of a property can occur with passage of time, whether they are due to natural processes or to works of man on this and/or adjacent properties.

If conditions are observed or information becomes available during the design and construction process which are not reflected in this report, **HGI**, as Geotechnical / Geologic Consultant of record for the project, should be notified so that supplemental evaluations can be performed and conclusions and recommendations presented in this report can be verified or modified in writing, as necessary. Changes in applicable or appropriate standards of care in the geologic / geotechnical professions occur, whether they result from legislation or the broadening of knowledge and experience. Accordingly, the conclusions and recommendations presented in this report may be invalidated, wholly or in part, by changes outside the influence of the project Geotechnical / Geologic Consultant which occur in the future.

PREVIOUS SITE STUDIES

No previous geotechnical and/or geological studies for design and/or the construction of existing structures and associated improvements on the subject property were available for review at the time of this study. A records request was submitted to the City of Redlands on January 17, 2018 for all documents that refer the soils related projects such as grading reports, plans, preliminary geotechncial reports, and soils reports etc. On February 5, 2018 the City of Redlands, Jimmy Nguyen, responded to the request via email. The response concluded that the City does not have any records responsive to our request. It is our understanding the existing building and basement was once the City of Redlands Police Department, and is anticipated to be demolished for the new proposed development.

PROJECT DESCRIPTION / PROPOSED DEVELOPMENT

As part of our study, we have discussed the project with Mr. Thomas N. Robinson, the client, and Mr. Matt Hicks of Hicks and Hartwick, the civil engineer for the project. We have also been provided with the referenced plans for the project noted on the first page of the cover letter for this report.

Based on information presented to this firm, it is our understanding that the proposed project will consist of two new restaurant buildings with accompanying Hot Mix Asphaltic (HMA) concrete parking lot, Portland Cement concrete (PCC) driveways, curbs and gutters, a decorative concrete block perimeter wall, and a trash enclosure. It is our understanding that the building previously occupied by the police department will be demolished. The existing office building on the southwest portion of the site will be renovated. Additionally, we understand that the existing parking lot will be removed and replaced with new asphalt.

The proposed new restaurant buildings are expected to be a single-story structure consisting of wood trusses on wood beams and steel columns, wood studs, and veneered walls. It is assumed that light to moderate loads will be imposed on the foundations. The foundation loads are not anticipated to exceed 3,500 pounds per lineal foot (plf) for continuous footings and 60 kips for column footings. The proposed structure ground level floor will consist of a concrete slab cast on compacted subgrade. Finish floor elevation for the structure had not been furnished at the time of our study, but it is anticipated to be within 3.0 feet of existing site grades. Therefore, no cut or fill slopes are anticipated to be required for the development of the site. Subterranean construction is not anticipated for the proposed structure. It is anticipated that low height retaining walls may also be needed to develop the subject site. On-site stormwater drainage system for Water Quality Management Plan (WQMP) is anticipated to be constructed in the west portion of the subject site.

The above project description and assumptions were used as the basis for the field exploration, laboratory testing program, the engineering analysis, and the conclusions and recommendations presented in this report. **HGI** should be notified if structures, foundation loads, grading, and/or details other than those represented herein are proposed for final development of the site so a review can be performed, a supplemental evaluation made, and revised recommendations submitted, if required.

FIELD EXPLORATION AND LABORATORY TESTING

The field study performed for this report included a visual reconnaissance of existing surface conditions of the subject site and surrounding area. A study of the property's subsurface condition was performed to evaluate underlying earth strata and the presence of groundwater. Surface and subsurface conditions were explored on January 4, 2018.

The subsurface exploration consisted of excavating four (4) exploratory borings and two (2) shallow infiltration borings in the area of the proposed structures on the subject property. The approximate locations of the exploratory excavations are shown on the 'Exploratory Excavation Location Plan,' Plate No. 1, presented in Appendix 'A' of this report. The exploratory excavations were observed and logged by a representative of **HGI**. Earth materials encountered in the exploratory excavations were visually described in the field in general accordance with the current Unified Soils Classification System (USCS), ASTM D2488, visual-manual procedures, as illustrated on the attached, simplified 'Subsurface Exploration Legend,' Plate No. 2, presented in Appendix 'A' of this report. The results are presented on the 'Subsurface Exploration Log,' Plate Nos. 3a through 6, presented in Appendix 'A' of this report.

A more detailed explanation of the field study which was performed for this report is presented in Appendix 'A'of this report.

Relatively undisturbed ring samples, and representative bulk samples of on-site fill and natural earth materials were collected during the field exploration and returned to the laboratory for testing. Laboratory tests were conducted to evaluate the index and engineering properties of on-site earth materials and included in-situ dry density and moisture content tests, an expansion index test, a soluble sulfate chemical tests, a sieve analysis test, a maximum dry density / optimum moisture content relationship test, and consolidation tests. A more detailed explanation of laboratory tests performed for this study and test results are presented in Appendix 'A' of this report, Plate Nos. 7 through 10.

FINDINGS

SITE DESCRIPTION

The subject property comprises approximately 3.03 acres and was irregular in shape as shown on the Reference No. 1 'Site Plan' noted on the first page of this report. The property to be demolished is located at 216 Brookside Avenue in the City of Redlands, San Bernardino County, California. The building to be renovated was located on Brookside Avenue and connected via parking lot to the adjacent property on the northwest corner of Eureka Street and Brookside Avenue. The properties are located in southeast one-quarter of T1S, R3W of the San Bernardino Principle Meridian at Latitude: 34.0556° North, Longitude: 117.1860° West.

Currently the site contains two buildings with basements, a parking lot, various planter boxes, a fountain, light vegetation, and sidewalks. The parking lot was generally open with many access points from the surrounding streets. Additionally, a flag pole stood on the southern side of the eastern building along with a radio tower. It is our understanding the eastern building, proposed to be demolished, was the past City of Redlands Police Department.

The subject property is bounded by Brookside Avenue to the south, Eureka Street to the east, existing residences to the west and north, and an additional access point on the northwest portion of the site from Citrus Avenue. The two proposed restaurant pads are to be located on the eastern portion of the site, where the existing building is to be demolished. The renovations are proposed to be furnished on the existing office building on the south southwest portion of the site, as shown on the 'Exploratory Excavation Location Plan,' Plate No. 1, presented in Appendix 'A' of this report. It is our understanding that the proposed renovations do not require any geotechnical consideration.

Overall the site had a shallow, downward inclination toward the northeast at an average gradient of approximately 3.5 percent. Total on-site relief was approximately 15 feet. On-site drainage was accomplished by sheetflow toward the northeast. It was noted on the eastern portion of the site the ground was sloping away from the building towards the associated streets and drive areas, and was likely a fill during previous construction.

At the time of the field study, utilities consisting of electric, telephone, gas, sewer, water, as well as other unknown underground and overhead lines, were observed to be present on and adjacent to the site. Underground service alert (USA) had marked the known utility lines on the site prior to the date of drilling. Due to the age of the structures and the fact the building was once utilized as a police station, unknown utilities likely traverse the site. The oldest photos available on Google Earth revealed the age of the buildings to be older than 1994.

At the time of the field study, vegetation was light and consisted of landscaped areas with seasonal native grasses, flowers and shrubs. It was noted the grass on the eastern portion of the site had not been watered for sometime. Small to medium sized, palms and oak trees were on site in addition to remnant trunks of trees that had been removed.

ENGINEERING GEOLOGIC ANALYSIS

Regional Geologic Setting

San Bernardino and its namesake valley lie very near the northern margin of the Peninsular Ranges Physiographic Province, one (1) of 11 provinces recognized in California. The physiographic provinces are topographic-geologic groupings of convenience based primarily on landforms, characteristic lithologies, and late Cenozoic structural and geomorphic history. The Peninsular Ranges encompass southwestern California west of the Imperial-Coachella Valley trough and south of the elevated terraces of the San Gabriel, San Bernardino, and Santa Monica Mountains. Most of the province lies outside of California, continuing south to include much of the Baja California Peninsula. The province is characterized by youthful, steeply sloped, northwest-trending, elongated ranges and intervening valleys. In gross aspect, average elevations across the province rise slowly to the east, usually culminating in abrupt escarpments near the eastern margin. Approaching the northern edge of the province, however, several anomalously flat and low basins stretch from the San Bernardino region to western Los Angeles as a result of fault junctures and tectonic interaction with the adjacent Transverse Ranges.

Structurally, the bulk of the Peninsular Ranges are composed of a number of relatively stable crustal blocks bounded by active strike-slip faults of the San Andreas transform system. Although some folding and minor faulting has occurred within the blocks, intense structural deformation and earthquake activity are mostly limited to block margins. The anomalous east-west trending San Bernardino Valley itself defines a small, irregularly-shaped block bounded by the San Andreas fault to the northeast, the San Jacinto fault to the southwest, and an arcuate set of sometimes obscure faults trending southwest through the Yucaipa, Redlands, and Loma Linda areas. The valley is not an erosional feature, but a deep structural basin that apparently continues to slowly subside in response to the transference of slip from the San Jacinto fault to the San Andreas fault.

The province contains a diverse array of metamorphic, sedimentary, volcanic, and intrusive igneous rocks. In general, the metamorphic rocks represent the highly altered host rocks for the emplacement of very large masses of granitic rock of varying composition. Closer to the coastline, younger rocks include thick sequences of marine and non-marine clastic sedimentary rocks of Mesozoic and Tertiary age, ranging from claystones to conglomerate. Inland, the province is dominated by crystalline basement rock, but the San Bernardino region also contains thick sequences of pre-Quaternary, continental, sedimentary rocks. These rocks are widely exposed in the hills bounding the south side of the San Bernardino Valley, and underlie the valley floor at depth.

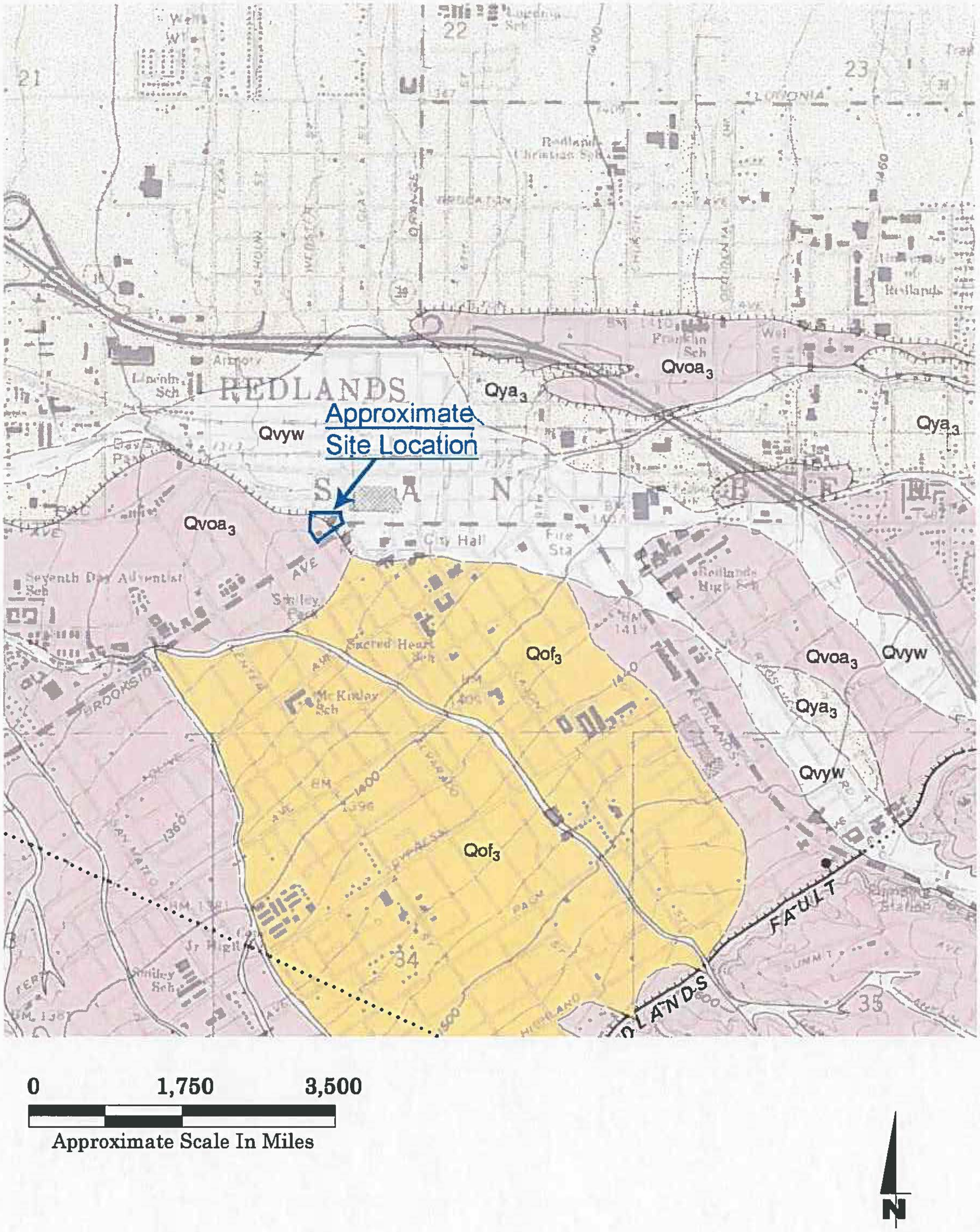
The site had been surficially mapped with two geologic units, a very young wash deposit (Qvwy) and an older axial valley deposit ($Qvoa_3$). The younger wash deposit was characterized as sand and gravel deposits in active washes, and are generally coarser in nature than the older axial valley deposits. The older axial valley deposits are generally alluvial in nature and were sandy clays to consolidated silt sand and gravel. Locally, the older axial valley deposits appear to interfinger with the young wash deposits. The general geology in the area of the subject site is shown on the 'Regional Geology Map,' Figure No. 2a, and the 'Regional Geology Map Legend,' Figure No. 2b.

Local Subsurface Conditions

Earth Materials Description: Presented as follows are brief descriptions of the earth materials encountered in the exploratory excavations. More detailed descriptions of encountered earth materials are presented on the 'Subsurface Exploration Log,' Plate Nos. 3a through 6, presented in Appendix 'A' of this report. The earth material strata, as shown on the logs, represent conditions at the actual exploratory excavation locations. Other variations may occur beyond and/or between the excavations. Lines of demarcation between earth materials on the logs represented the approximate boundary between the material types; however, the transition may be gradual.

The earth materials encountered on the subject site during the field exploration were identified as Hot Mix Asphalt (HMA) concrete pavement over, man-made fill (af), over (Qvyw) very young wash deposits or ($Qvoa_3$) very old axial valley deposits.

Hot Mix Asphalt thickness was measured from Boring B-4 and two shallow percolation tests performed in the existing parking lot. The pavement was measured to be three (3) inches in thickness at the location of Boring B-4. The two shallow percolation borings excavated on the northern portion of the site had a measured asphalt thickness of 1.75 inches and 2.0 inches. No base materials were encountered within any of the borings excavated in the pavement.



Reference: California Department of Conservation, Division of Mines and Geology, 2003, Johnathon C. Matti, Douglas M. Morton, Brett F. Cox, Katherine J. Kendrick, and others, Geologic Map of the Redlands 7.5' Quadrangle, San Bernardino and Riverside Counties, Version 1.0, Open File Report 03-302, Scale: 1:24,000.

HILLTOP GEOTECHNICAL
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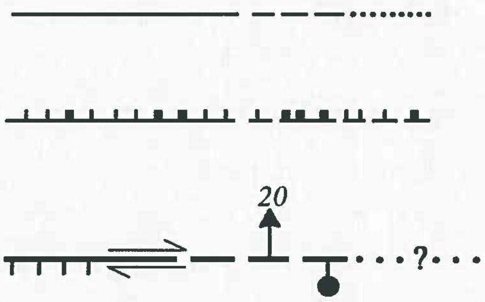
REGIONAL GEOLOGY MAP

By: AH
Date: 02/2018
Project No.: 1151-A17.1
Figure No.: 2a

Legend for Geologic Symbols and Units



Separates geologic-map units. Solid where meets map-accuracy standard; dashed where may not meet map-accuracy standard; dotted where concealed

Contact—Separates terraced alluvial units where younger alluvial unit is incised into older alluvial unit; hachures at base of slope, point toward topographically lower surface. Solid where meets map-accuracy standard; dashed where may not meet map-accuracy standard

Fault—Solid where meets map-accuracy standard; dashed where may not meet map accuracy standard. Dotted where concealed by mapped covering unit; queried where existence uncertain. Hachures indicate scarp, with hachures on downdropped block. Paired arrows indicate relative movement; single arrow indicates direction and amount of fault-plane dip. Bar and ball on down-thrown block.

Qvyw	Qvyw - Very Young Wash Deposit, active (latest Holocene).
Qya3	Qya3 - Young Axial Valley Deposit, Unit 3 (middle Holocene).
Qvoa3	Qvoa3 - Very Old Axial Valley Deposit, Unit 3 (late to middle Pleistocene).
Qof3	Qof3 - Old Alluvial Fan Deposits, Unit 3 (late to middle Pleistocene).

Reference: **California Department of Conservation, Division of Mines and Geology**, 2003, Johnathon C. Matti, Douglas M. Morton, Brett F. Cox, Katherine J. Kendrick, and others, Geologic Map of the Redlands 7.5' Quadrangle, San Bernardino and Riverside Counties, Version 1.0, Open File Report 03-302, Scale: 1:24,000.

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INCORPORATED

REGIONAL GEOLOGY MAP LEGEND

By: AH	Date: 02/2018
Project No.: 1151-A17.1	Figure No.: 2b

Man made fill was encountered at all of the boring locations. The fill extended to a maximum depth of approximately 7.0 feet at the location of the exploratory excavations. The fill generally consisted of clayey fine to coarse sand which was red-brown in color, dry at the surface to moist with depth, and loose to medium dense in relative density. The in-place density tests indicated that the fill had an average relative compaction of approximately 85 percent. The fill is considered to be undocumented and unsuitable for support of structural fill and/or a building structure. The axial valley deposits and young wash deposits were encountered beneath the fill.

The very young wash deposits were encountered in the locations of the building demolition and proposed new construction within in borings B-1 through B-3. The young wash deposits generally consisted of silty fine to medium sands to silty fine to coarse sand with various amounts of gravel (SM), slightly silty fine to coarse sand (SP/SM) and gravelly fine to coarse sand with a variable amount of cobbles (SP). The materials ranged from red brown, pale brown, gray brown, and orange brown in color. The wash deposits extended to a depth of 42.0 feet at the location of B-1. Due to the contact between the wash deposits and the axial valley deposits some inter-fingering of clayey materials was also noted within boring B-4.

The old axial valley deposits were generally encountered in the existing parking lot on the western half of the site. The axial valley deposits generally consisted of silty fine to coarse sands with varying amounts of gravel and cobbles (SM), clayey fine to coarse sands with some gravel (SC). The axial valley deposit was generally reddish brown in color and dry near the surface to moist with depth. Locally, the axial valley deposits extended to depths in excess of 21.5 feet below the existing ground surface at the excavation location of B-4. A distinct but very gradual coarsening of the materials with depth was noted. Boring B-4 and the percolation test borings were terminated in the old axial valley deposit.

Existing Pavement Evaluation

The existing pavement on the eastern portion of the site differed from the pavement on the western portion of the site, and both areas showed signs of distress. The eastern half of the property had a thicker pavement section, and appeared to be older than the adjacent western parking lot. The eastern portion of the site contained speed bumps near the entrances and was highly alligatored. Subsurface materials were exposed in some areas and weeds had begun to grow from within the cracks. The western portion appeared to had been recently sealed, as shown in the Google Earth 10/21/2016 photograph. Large pavement cracks were evident on the surface and smaller cracks were beginning to appear around the larger cracks. No aggregate base materials were encountered or observed beneath the pavement in both locations.

Groundwater: Groundwater was not encountered in the exploratory excavations to the maximum depth explored of approximately 42.0 feet below existing ground surface at the boring locations at the time the field study was performed for this report.

A review of available groundwater contour maps indicated the historical minimum depth to groundwater in the general area has been approximately 75 feet (1985, Matti, J.C. and Carson, S.E.).

Depth to groundwater data for the site area was available through the **California Department of Water Resources** internet web site. The depth to groundwater in State Well No. 01S03W28J001S, located approximately 0.25 mile west of the site, was 193.1 feet on December 6, 2017. The surface elevation of this well is approximately 50 feet lower (topographically) than that of the site. Based on this information, the current depth to static groundwater beneath the site is estimated to be greater than 50 feet. Based on proposed lot grading and the inferred groundwater depths, groundwater should not be a factor for project design or long-term performance.

Surface Water: Surface water was not observed on the subject site at the time the field study was performed for this report.

Site Variations: Based on results of our subsurface exploration and experience, variations in the continuity and nature of surface and subsurface conditions should be anticipated. Due to uncertainty involved in the nature and depositional characteristics of earth materials at the site, care should be exercised in extrapolating or interpolating subsurface conditions between and beyond the exploratory excavation locations.

Groundwater observations were made in the exploratory excavations at times and under conditions stated on the boring logs. These data have been reviewed and interpretations made in the text in other sections of this report. However, it should be noted that fluctuations in levels of groundwater, springs, and/or perched water may occur due to variations in precipitation, temperature, and other factors.

Faulting and Regional Seismicity

The site is situated in an area of active and potentially active faults, as is most of metropolitan southern California. Active faults present a variety of potential risks to structures, the most common of which are strong ground shaking, dynamic densification, liquefaction, mass wasting, and surface rupture at the fault plane.

Generally speaking, the following four (4) factors are the principal determinants of seismic risk at a given location:

- Distance to seismogenically capable faults.
- The maximum or "characteristic" magnitude earthquake for a capable fault.
- Seismic recurrence interval, in turn related to tectonic slip rates.
- Nature of earth materials underlying the site.

Surface rupture represents the primary potential hazard to structures built in an active fault zone. A review of official maps delineating State of California earthquake fault zones (**California Department of Conservation, Division of Mines and Geology**, Effective January 1, 1977, *State of California Special Studies Zones, Redlands Quadrangle, Revised Official Map*, Scale 1:24,000) indicated the site is not located within a zone of mandatory study for active faulting. In addition, the site is not located within a zone of mandatory study for active faulting per the **San Bernardino County Planning Department**, *San Bernardino County Land Use Plan, GENERAL PLAN, Geologic Hazard Overlays*, Sheet FH31 C Redlands, Plot Date: 03/09/2010, Scale: 1:14,400 (http://www.co.san-bernardino.ca.us/landuseservices/general). Reviews of other geology maps of the Redlands region revealed no known faults that cross the subject site. Additionally, no known active faults trend toward the subject property.

The most recent, large earthquake that occurred in close proximity to the subject property was the June 28, 1992 Big Bear earthquake. The epicenter of this quake was located approximately 37.5 kilometers northeast of the subject property at Latitude: 34.2030° North, Longitude: 116.8270° West. The Big Bear quake had a measured magnitude of 6.7, had no surface rupture, and is believed to have occurred on a blind thrust fault, the exact location and geometry of which currently are unknown. Several aftershocks also were centered very near the epicenter, including a magnitude 5.6 aftershock.

Ground shaking is judged to be the primary hazard most likely to affect the site, based upon proximity to seven (7) regionally significant active faults as listed in the following table. Other significant fault zones, including the Pinto Mountain fault, the Chino-Central Avenue fault, and several zones in the high desert area are located at distances exceeding 40 kilometers from the site. Greater distances, lower slip rates, and lesser maximum magnitudes indicate much lower risk to the site from the latter fault zones than the seven (7) closest faults including the regionally significant San Andreas fault. Characteristics of the major active fault zones selected for inclusion in analysis of strong ground shaking are listed in the following table:

Fault Zone[1]	**Distance (km)**[2] **/ Direction from Site**	**Fault Length (km)**[1]	**Slip Rate (mm/yr)**[1]	**Reference Earthquake $M_{(Max)}$**[1]	**Fault Type**[1]
San Jacinto (San Jacinto Valley Segment) (rl-ss)	6.1 / Southwest	43±4	12.0±6.0	6.9	A
San Jacinto (San Bernardino Segment) (rl-ss)	6.4 / Southwest	36±4	12.0±6.0	6.7	A
San Andreas (San Bernardino Segment) (rl-ss)	9.4 / Northeast	103±10	24.0±6.0	7.5	A
North Frontal (Western Segment) (r, 45 S)	20.3 / North	51±5	1.0±0.5	7.2	B
Cleghorn (ll-ss)	25.1 / Northwest	25±3	3.0±2.0	6.5	B

Fault Zone[1]	**Distance (km)**[2] **/ Direction from Site**	**Fault Length (km)**[1]	**Slip Rate (mm/yr)**[1]	**Reference Earthquake** $M_{(Max)}$[1]	**Fault Type**[1]
Cucamonga (r,45 N)	27.0 / Northwest	28±3	5.0±2.0	6.9	B
North Frontal (Eastern Segment) (r,45 S)	39.3 / North Northeast	27±3	0.5±0.3	6.7	B

1. **Tianqing, C.W., Bryant, W.A., Rowshandel, B., Branum, D., and Wills, C.J.**, June 2003, *The Revised 2002 California Probabilistic Seismic Hazards Maps (Appendix A - 2002 California Fault Parameters).*
   California Department of Conservation, Division of Mines and Geology, 1996, *Probabilistic Seismic Hazard Assessment for the State of California*, DMG Open-File Report 96-08.
2. **Blake, Thomas F.**, 2000, *Preliminary Fault-Data for EQFault, EQSearch and FriskSP* and **Blake, Thomas, F.**, *Computer Services and Software, Users Manuals, FriskSP v. 4.00, EQSearch v. 3.00, and EQFault v. 3.00.*
3. Fault Geometry: (ss) strike slip; (r) reverse; (n) normal; (rl) right lateral; (ll) left lateral; (O) oblique; (45 N) direction.

Probabilistic seismic hazard maps and data files prepared by the **California Geological Survey (CGS)** determine ground motions with a 10-percent probability of being exceeded in the next 50 years (475 years mean return time) as a fraction of the acceleration due to gravity for peak ground acceleration (PGA) and spectral accelerations (Sa) for short and moderately long periods, 0.2 seconds and 1.0 second, respectively. This data was available at the **CGS** 'PSHA Ground Motion Interpolator (2008)' web site (http://www.quake.ca.gov/gmaps/PSHA/psha_interpolator.html). The values are presented in the following table for reference:

GROUND MOTION*	**SITE ACCELERATION Site Class D****
PGA	0.633g
Sa @ 0.2 Sec.	1.348g

GROUND MOTION*	SITE ACCELERATION Site Class D**
Sa @ 1.0 Sec.	0.928g

* 10-percent probability of being exceeded in the next 50 years (475 years mean return time).

** Shear Wave Velocity of 274 m/sec was assumed for the on-site materials.

California Geological Survey (CGS) assign a 2-percent likelihood that a Peak Horizontal Ground Acceleration (PGA) of approximately 0.995g will occur at this site within the next 50 years (2,475 years mean return time). This data was available at the **CGS** 'PSHA Ground Motion Interpolator (2008)' web site (http://www.quake.ca.gov/gmaps/PSHA/psha_interpolator.html).

Actual shaking intensities at the site from any seismic source may be substantially higher or lower than estimated for a given earthquake magnitude, due to complex and unpredictable effects from variables such as:

- Near-source directivity effects.
- Direction, length, and mechanism of fault rupture (strike-slip, normal, reverse).
- Depth and consistency of unconsolidated sediments.
- Topography.
- Geologic structure underlying the site.
- Seismic wave reflection, refraction, and interference.

Secondary Seismic Hazards

Secondary hazards include induced landsliding or mass wasting, liquefaction, flooding (from ruptured tanks and reservoirs, surface oscillations in larger lakes, or seismic sea waves), and subsidence as a result of soil densification. Landsliding and liquefaction susceptibility maps have been prepared for much of coastal Los Angeles and Orange County, California by the **CGS**. However, this area of San Bernardino County, California is not presently scheduled for mapping by the State.

Landslide: The subject site is not located within a designated area as having a landslide susceptibility per **San Bernardino County Planning Department**, *San Bernardino County Land Use Plan, GENERAL PLAN, Geologic Hazard Overlays*, Sheet FH31 C Redlands Plot Date: 03/09/2010, Scale: 1:14,400 (http://www.co.san-bernardino.ca.us/landuseservices/general).

Due to the flat-lying nature of the site, on-site landsliding or debris flows sourced from higher elevations should not be considered to be a geologic constraint at this site.

Liquefaction: Liquefaction is a phenomenon in which cohesionless, saturated, fine-grained sand and sandy silt soils lose shear strength due to ground shaking. The subject site is not located within a designated area as having a liquefaction potential per **San Bernardino County Planning Department**, *San Bernardino County Land Use Plan, GENERAL PLAN, Geologic Hazard Overlays*, Sheet FH31 C Redlands, Plot Date: 03/09/2010, Scale: 1:14,400 (http://www.co.san-bernardino.ca.us/landuseservices/general).

It is our opinion that liquefaction potential at the subject site is very low due to an estimated depth of groundwater of 50 feet or greater beneath the existing ground surface on the site.

Seismically Induced Subsidence: Loose sandy soils subjected to moderate to strong ground shaking can experience settlement. Experience from the Northridge Earthquake indicates that structural distress can result from such seismic settlement. Based upon the results of this study, the subject site is underlain at depth by dense to very dense or hard, consolidated deposits that should not be prone to a significant degree of seismic settlement. Where applicable, loose, near-surface, young wash deposits, alluvial soils and undocumented fills should be removed and recompacted to uniform high densities to mitigate both settlement and consolidation potentials.

Lateral Spreading: Lateral spread is the most pervasive type of liquefaction-induced ground failure. Lateral spreads can occur on gently sloping ground or where nearby drainage or stream channels can lead to static shear stress biases on essentially horizontal ground. During lateral spread, blocks of mostly intact, surficial earth material displace downslope or towards a free face along a shear zone that has formed within the liquefied sediment. The resulting ground deformation typically has extensional fissures or a graben at the head of the failure, shear deformations along the side margins, and compression or buckling of the earth material at the toe. The amount of lateral displacement typically ranges from a few centimeters to several meters and can cause considerable damage to engineered structures and lifelines.

A formal lateral spread analysis was not performed as part of this study. The lateral spread potential of the subject site is not considered to be a geologic hazard for the proposed structure on the subject property.

Seiching: Seiching involves an enclosed body of water oscillating due to ground shaking, usually following an earthquake. Lakes and water towers are typical bodies of water affected by seiching. However, the site does not appear to be within the influence of large bodies of water and, as such, seiching should not be considered a geologic hazard for the development of the subject site.

Tsunamis: Because of the inland geographic location of the site, tsunamis are not considered a geologic hazard for the development of the subject site.

Lurching: Lurching is a phenomena in which ground cracking and/or secondary faulting occurs as a result of ground shaking. Generally, lurching primarily occurs in the immediate vicinity of faulting or within typical building setback zones or "No Human Occupancy" zones. No evidence of faulting was encountered on the site and although the potential for lurching cannot be entirely ruled out, the likelihood for lurching to impact the site is considered to be low.

OTHER GEOLOGIC HAZARDS

Flooding

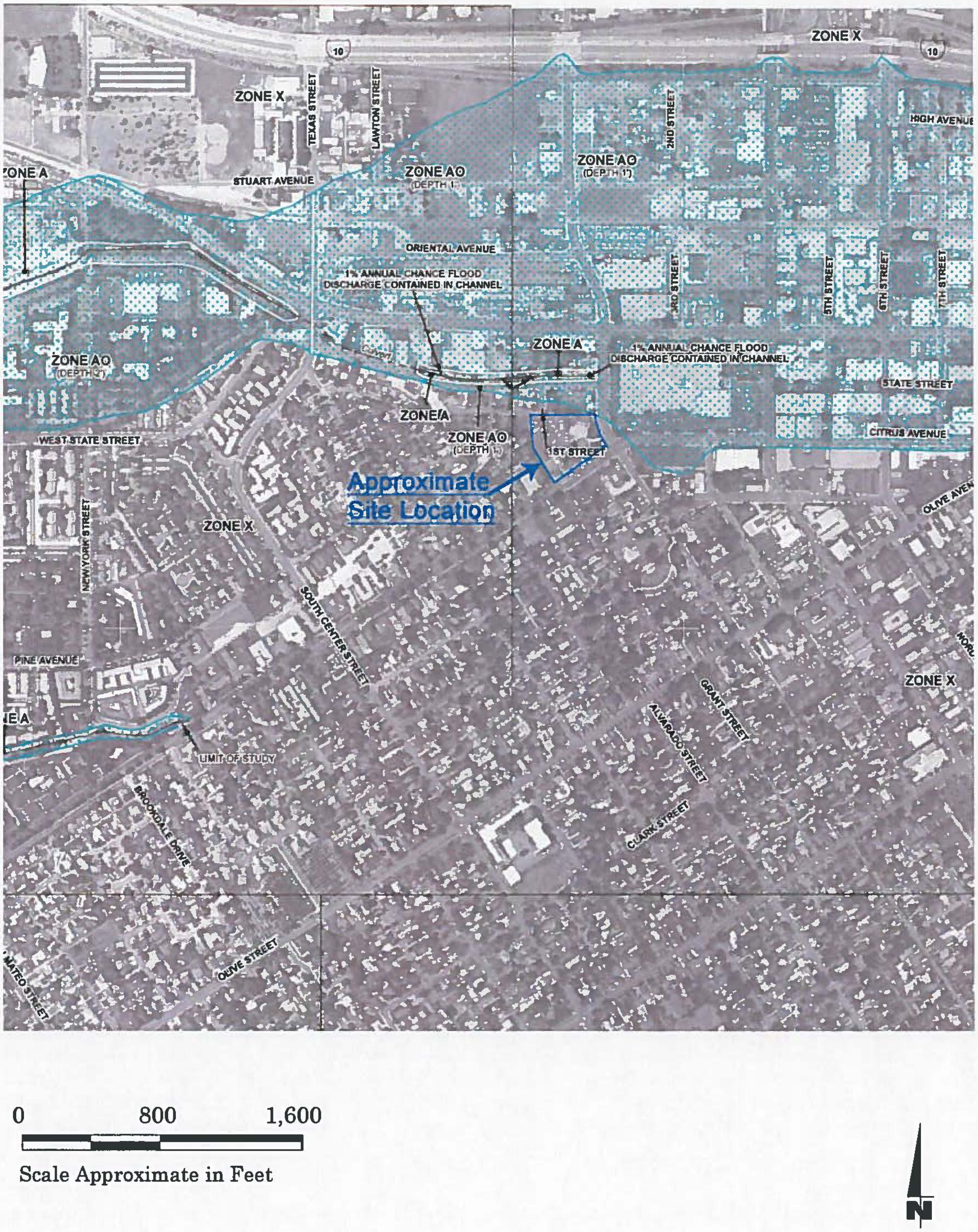
The subject site is not located within a designated area as having a flooding potential per **San Bernardino County Planning Department**, *San Bernardino County Land Use Plan, GENERAL PLAN, Hazard Overlays*, Sheet FH31 B Redlands, Plot Date: 03/09/2010, Scale: 1:14,400 (http://www.co.san-bernardino.ca.us/landuseservices/general).

Flood Insurance Rate Maps (FIRM) were compiled by the **Federal Emergency Management Agency (FEMA)** for the Flood Insurance Program and are available for most areas within the United States at the **FEMA** web site (http://msc.fema.gov/). The attached 'FEMA Flood Hazard Map' and 'FEMA Flood Hazard Map Legend,' Figure Nos. 3a and 3b, respectively, are based on FIRMs provided by **FEMA** and are specific to the area around the subject site. The 'FEMA Flood Hazard Map,' Figure 3a, indicates that the site is located within 'Zone X' (an area of 0.2-percent annual chance flood; an area of 1-percent annual chance flood (100 year flood) with average depths of less than 1.0 foot or with drainage areas less than 1.0 square mile; and an area protected by levees from the 1-percent annual chance flood).

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

The conclusions and recommendations presented in this report are preliminary since a grading plan, the type of structure construction, structural loads, finish floor elevations, etc. were not available and are, in part, based on information provided to this firm, the results of the field and laboratory data obtained from four (4) exploratory excavations located on the subject property, experience gained from work conducted by this firm on projects within the general vicinity of the subject site, the project description and assumptions presented in the 'Project Description / Proposed Development' section of this report, engineering analyses, and professional judgement. Based on a review of the field and laboratory data and the engineering analysis, the proposed development is feasible from a geotechnical / geologic standpoint. The subject property can be developed without adverse



Reference: **U.S. Federal Emergency Management Administration (FEMA)**, Maps Revised August 28, 2008, *Flood Insurance Rate Map*, Map Nos. 06071C 8712 H, 06071C 8716 H. Site specific information obtained through FEMA website, Map Service Center (http://msc.fema.gov/).

HILLTOP GEOTECHNICAL INCORPORATED	FEMA FLOOD HAZARD MAP	
	By: AH	Date: 02/2018
	Project No.: 1151-A17.1	Figure No.: 3a

LEGEND

▒ SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

▨ FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

▒ OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

☐ OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

▧ COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

▧ OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

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FEMA FLOOD HAZARD MAP LEGEND

By: AH	Date: 02/2018
Project No.: 1151-A17.1	Figure No.: 3b

impact onto or from adjoining properties providing the recommendations contained within this report are adhered to during project design and construction.

The average in-situ moisture contents and in-situ dry densities of the upper 5.0 feet of the near-surface alluvial materials on the subject site suggests that the soils have an average relative compaction of less than 85 percent.

The field observations indicate that up to 7.0 feet of material present on the subject site was an undocumented fill material. The artificial fills on the site are also considered loose and compressible. The man-made fills are not considered suitable for the support of structural fills, foundations, slab-on-grade floor slabs, hardscape, and/or pavement.

The laboratory tests suggest that the alluvial materials on the site are subject have a 0.7 to 8.1 collapse potential if they should become saturated while under a load (hydroconsolidation). This was emphasized by the laboratory consolidation tests that collapsed from 0.7 to 8.1 percent under a load of 1,600 psf when water was added during the testing procedure. An additional consolidation test was run on a sample at the same depth to verify the amount of hydro-collapse. Theoretically, a 0.7 to 8.1 percent collapse of 3.0 feet of soil beneath a footing and/or structural fills would result in an additional settlement of approximately 0.25 to 2.92 inches, respectively, beyond what would normally be anticipated. Greater collapse potentials and/or a deeper zone of saturation would result in a larger settlement. Depending on the uniformity of the depth and the area of saturation, the settlement may not be uniform throughout the structure and/or fill area.

Some remedial grading consisting of removals and replacement will have to be performed within loose, compressible, artificial fill, and moisture sensitive loose, near-surface alluvium in the area of proposed structural fills, structures, exterior hardscapes, and/or pavement.

The actual conditions of the near-surface supporting material across the site may vary. The nature and extent of variations of the surface and subsurface conditions between the exploratory excavations may not become evident until construction. If variations of the material become evident during construction of the proposed development, **HGI** should be notified so that the project Geotechnical / Geologic Consultant can reevaluate the characteristics of the material and the conclusions and recommendations of this report, and, if needed, make revisions to the conclusions and recommendations presented herein.

Specific recommendations for site grading, foundations, slab support, pavement design, are presented in the subsequent paragraphs.

SITE PREPARATION RECOMMENDATIONS

General

The grading recommendations presented in this report are intended for: 1) the rework of unsuitable, near-surface, fill and alluvial earth materials to create a uniformly thick engineered building pads and satisfactory support for exterior hardscape (i.e., sidewalks, patios, etc.) and pavement; and 2) the use of shallow foundation system and concrete slabs cast on-grade for the proposed structures.

If hardscape and pavement subgrade earth materials are prepared at the time of grading of the building sites, and the improvements are not constructed immediately, additional observations and testing of the subgrade earth material will have to be performed to locate areas which may have been damaged by construction traffic, construction activities, and/or seasonal wetting and drying.

The additional observations and testing should be performed before placing aggregate base material, Hot Mix Asphalt (HMA) concrete, and/or Portland Cement concrete (PCC) in those areas.

The grading should be performed in accordance with the recommendations presented in this report. We recommend that **HGI**, as the Geotechnical Engineer / Geologist of Record, be retained by the owner of the proposed project to observe the excavation and grading operations, foundation preparation, and test the compacted fill and utility trench backfill. If **HGI** were not selected to perform the required observation and testing of earthwork construction, **HGI** would cease to be the Geotechnical Consultant of Record for the project. A pregrading conference should be held at the site with representatives of the owner, the grading contractor, the City of Redlands, the Civil Engineer, and a representative of **HGI** in attendance. Special grading procedures and/or concerns can be addressed at that time.

Earthwork observation services allow the testing of only a small percentage of the fill placed at the site. Contractual arrangements with the grading contractor by the project owner should contain the provision that he is responsible for excavating, placing, and compacting fill in accordance with the recommendations presented in this report and the approved project grading plans and specifications. Observation by the project Geotechnical / Geologic Consultant and/or his representatives during grading should not relieve the grading contractor of his responsibility to perform the work in accordance with the recommendations presented in this report and the approved project plans and specifications.

The following recommendations may need to be modified and/or supplemented during grading as field conditions require.

Final Grading Plan Review

The project Civil Engineer should review this report, incorporate critical information on to the grading plan and/or reference this geotechnical / geologic study, by Company Name, Project No., Report No., and report date, on the grading plan. Final grading plans should be reviewed by **HGI** when they become available to address the suitability of our grading recommendations with respect to the proposed improvements.

Clearing and Grubbing

Debris from the demolition of the existing structure, grasses, weeds, brush, and other deleterious materials should be removed from the proposed building, exterior hardscape and pavement areas and areas to receive structural fill before grading is performed. Any organic material and miscellaneous / demolition debris should be legally disposed of off site. Any topsoil or highly organic soils encountered should be stripped and stockpiled for use on finished grades in landscape areas or exported from the site. Disking or mixing of organic material into the earth materials proposed to be used as structural fill should not be permitted.

Man-made objects encountered (i.e., septic tanks, leach lines, irrigation systems, underground utilities, old foundations, construction debris, etc.) should be overexcavated, exported from the site, and legally disposed of off site. Cesspools or seepage pits, if encountered (none were encountered during this study), should be abandoned and capped according to directions and supervision of San Bernardino County Department of Health, the State of California, and/or the appropriate governmental agency procedures which has jurisdiction over them before fill and/or pavement is placed over the area. If no procedures are required by the Health Department or if the following recommendations are more stringent, the cesspool or seepage pit should be pumped free of any liquid and filled with a low strength sand cement slurry to an elevation 5.0 feet below the final site grade in the area. The upper 5.0 feet of the cesspool or seepage pit should be excavated and the area backfilled with a properly compacted fill material. The location of the cesspool or seepage pit should be surveyed and plotted on the final 'As-Graded' plan prepared by the project Civil Engineer.

Wells, if encountered, should be abandoned and capped according to directions and supervision of San Bernardino County Department of Health, the State of California, and/or the appropriate governmental agency procedures which has jurisdiction over the well before fill and/or pavement is placed over the area.

Excavation Characteristics

Excavation and trenching within the subject property to the depths anticipated for the proposed development is anticipated to be relatively easy in the near-surface undocumented fills and alluvial materials on the subject site and should be accomplished with conventional earth-moving equipment since the drill rig equipped with flight augers was able to penetrate to the indicated depths. Materials were not encountered or are anticipated at shallow depths that would require heavy ripping or blasting to excavate. It is not anticipated that a significant amount of oversized rock material (i.e., 12 inches in greatest dimension) will be generated during the removal and replacement process within the alluvial materials which will require special handling during the development of the site.

Suitability of On-Site Materials as Fill

In general, the on-site earth materials present below any topsoil and/or highly organic materials are considered satisfactory for reuse as fill. Fill materials should be free of significant amounts of organic materials and/or debris and should not contain rocks or clumps greater than 12 inches in maximum dimension. It is noted that the average in-situ moisture content of the near-surface fill and alluvial earth materials on the subject site at the time this field study was performed was below the optimum moisture content for the on-site materials and that moisture will have to be added to the on-site earth materials if the earth materials are to be used as compacted fill material in the near future. No significant amount of oversized rock materials are anticipated to be generated from the cuts performed in the local materials.

The existing HMA concrete and PCC concrete that are located on the site can be crushed down to a particle size of 3.0 inches or less in maximum dimension and incorporated into the fills required to achieve the finish grades for the subject development.

Removal and Recompaction

Uncontrolled or undocumented fills and/or unsuitable, loose, or disturbed near-surface alluvial earth material in proposed areas which will support structural fills, structures (i.e., buildings, decorative block walls, retaining walls, trash enclosure walls, etc.), exterior hardscape (i.e., sidewalks, patios, curb / gutters, etc.), and pavement should be prepared in accordance with the following recommendations for grading in such areas. If overexcavation of undocumented fill or moisture sensitive, collapsible earth materials is elected not to be performed in hardscape, curb / gutter, pavement, and decorative block wall or fence areas, penetration of irrigation water with time may cause some settlement and distress to the improvements in those areas. The cost of the additional grading verses the risk of distress and cost of repairs to the structures needs to be evaluated by the project owner.

- The near-surface undocumented fill and the loose, collapsible, near-surface alluvial materials on the site are recommended to be overexcavated and recompacted. Based upon our exploratory excavations borings and laboratory test results, we anticipate that the overexcavation will extend to a depth of approximately 11 feet below existing ground surface and to a uniform elevation within the horizontal limits of the overexcavation in the areas which will receive structural fill, building structures, retaining walls, trash enclosure walls, and decorative concrete block walls. A relative compaction of 85 percent or greater should be obtained in the exposed earth material at the overexcavation depth prior to performing any scarification, moisture conditioning, and recompaction. If 85 percent relative compaction is not present, the overexcavation should be deepened until a minimum of 85 percent relative compaction is present. Moreover, the depth of the overexcavation within the perimeter of the proposed structures should be to a uniform elevation throughout the limits of the structures. It is noted that fill placed to construct slopes and/or support sidewalks, patios, retaining walls, block walls, driveways, and pavement are considered to be structural fill.

- In the proposed exterior hardscape (i.e., sidewalks, patio slabs, etc.), and pavement areas where structural fill will not be placed or cuts are proposed, the existing near-surface earth materials need only be processed to a depth of 6.0 to12 inches below existing site grades or proposed subgrade elevation, whichever is deeper unless old, undocumented fill materials are encountered at exposed grades. If undocumented fills are encountered, they will need to be overexcavated and properly compacted fill replaced to achieve proposed grades.

  Due to the collapsible nature of the near-surface alluvial earth materials on the subject site, if overexcavation and replacement is not performed under the exterior concrete slabs, hardscape, pavement, curb / gutters, etc,, there is a risk of settlement and vertical differential movement if the subgrade earth materials are allowed to become saturated. Therefore, proper drainage should be established away from such improvements and minimal precipitation or irrigation water allowed to percolate into the earth materials adjacent to the exterior concrete hardscape, pavement, curbs / gutters, etc.

- Additional overexcavation will need to be performed in areas where the exposed subgrade can not be properly processed and recompacted per the following recommendations presented in this section of this report.

- The limits of overexcavation for the building pads should extend to a distance of 5.0 feet or to the depth of the overexcavation beneath the finish pad grade for the structure, whichever is greater, beyond the structure perimeter or footing edges. The limits of overexcavation for the decorative concrete block perimeter wall footings and/or retaining wall footings should extend to a distance of 4.0 feet beyond the footing edges or to the depth of the overexcavation beneath the footing grade, whichever is greater. The limits of processing or overexcavation for exterior hardscape, curb / gutter, and pavement areas should extend to a distance of 2.0 feet beyond the edge of the exterior hardscape, curb / gutter, or pavement, or to the depth of the overexcavation beneath the finish subgrade elevation, whichever is greater.

- It is noted that localized areas, once exposed, may warrant additional overexcavation for the removal of existing undocumented fills, loose, near-surface earth material, porous, moisture sensitive alluvial earth materials, and subsurface obstructions and/or debris which may be associated with the existing structure or past usage of the site or may be not have been located during the field study performed for this report. Actual depths of removals and the competency of the exposed overexcavation bottoms should be determined by the project Geotechnical / Geologic Consultant and/or his representative during grading operations at the time they are exposed and before scarification and recompaction or the placement of fill.

- Any underground fuel and waste oil storage tanks and contaminated material, if present, should be removed in accordance with County of San Bernardino Department of Environmental Health, Hazardous Materials Management Divisions criteria and procedures. The excavations should be cleaned of loose materials. It is recommended that tank removal excavations with depths of 5.0 feet or deeper be cut back according to the 'Temporary Construction Cut' section of this report or be properly shored during construction.

- The exposed overexcavation bottom surfaces should be scarified to a depth of 6.0 to 12 inches, brought to optimum moisture content to 3.0 percent above optimum moisture content, and compacted to 90 percent or greater relative compaction before placement of fill. Maximum dry density and optimum moisture content for compacted materials should be determined according to current ASTM D1557 procedures. The scarification and recompaction of the exposed overexcavation bottoms in alluvial materials may be deleted upon approval by the project Geotechnical / Geologic

Consultant, and/or his representative when in-place density test results in the undisturbed alluvial materials indicate a relative compaction of 90 percent or greater.

Import Material

Import fill should be 'Non-Expansive' as defined in Section 1803.5.3, 'Expansive Soil,' in the 2016 CBC (i.e., Expansion Index ≤ 20) as determined by current ASTM D4829 procedures and have strength parameters equivalent to or greater than the on-site earth materials. Import fill material should be approved by the project Geotechnical / Geologic Consultant prior to it being brought on-site.

The existing pavement materials can be crushed down to a maximum practical size of 3.0 inches and incorporated into the fills materials required to achieve the finish subgrade elevations for the project.

Fill Placement Requirements

Fill material, whether on-site material or import, should be approved by the project Geotechnical / Geologic Consultant and/or his representative before placement. Fill material should be free from vegetation, organic material, debris, and oversize material (i.e., 3 inches in maximum dimension). Approved fill material should be placed in horizontal lifts not exceeding 6.0 to 12 inches in compacted thickness or in thicknesses the grading contractor can demonstrate that he can achieve adequate compaction and watered or aerated to obtain optimum moisture content to 3.0 percent above optimum moisture content. Each lift should be spread evenly and should be thoroughly mixed to ensure uniformity of earth material moisture. Fill soils should be compacted to 90 percent or greater relative compaction. Maximum dry density and optimum moisture content for compacted materials should be determined in accordance with current ASTM D1557 procedures.

Compaction Equipment

It is anticipated that the compaction equipment to be used for the project will include a combination of rubber-tired, track-mounted, sheepsfoot, and/or vibratory rollers to achieve compaction. Compaction by rubber-tired or track-mounted equipment, by itself, may not be sufficient. Adequate water trucks, water pulls, and/or other appropriate equipment should be available to provide sufficient moisture and dust control. The actual selection of equipment and compaction procedures are the responsibility of the contractor performing the work and should be such that uniform compaction of the fill is achieved.

Shrinkage, Bulking, and Subsidence

There will be a material loss due to the clearing and grubbing operations. The following values are exclusive of losses due to clearing, grubbing, or the removal of other subsurface features and may vary due to differing conditions within the project boundaries and the limitations of this study.

Volumetric shrinkage of the near-surface earth materials (i.e., undocumented fill and near-surface alluvium) on the subject site that are excavated and replaced as controlled, compacted fill should be anticipated. It is estimated that the average shrinkage of the near-surface earth materials within the upper 10 feet of the site which will be removed and replaced will be approximately 10 to 16 percent, based on fill volumes when compacted to 90 to 95 percent of maximum dry density for the earth material type based on current ASTM D1557 procedures. For example, a 10 percent shrinkage factor would mean that it would take 1.10 cubic yards of excavated material to make 1.0 cubic yard of compacted fill at 90 percent relative compaction. A higher relative compaction would mean a larger shrinkage value.

A subsidence factor (loss of elevation due to compaction of existing undocumented fill and/or the near-surface alluvial earth materials in-place) of 0.09 to 0.14 foot per foot of compacted earth material should be used in areas where the existing earth materials are compacted in-place to 90 to 95 percent relative compaction and to a depth of 12 inches.

Subsidence of the site due to settlement from the placement of less than 3.0 feet of fill (not including the depth of overexcavation and replacement) during the planned grading operation is expected to be minimal.

Although the above values are only approximate, they represent the recommended estimate of some of the respective factors to be used to calculate lost volume that will occur during grading.

Abandonment of Existing Underground Lines

Abandonment of existing underground irrigation, utility, or pipelines, if present within the zone of construction, should be performed by either excavating the lines and filling in the excavations with documented, properly compacted fill or by filling the lines with a low strength sand / aggregate / cement slurry mixture. Filled lines should not be permitted closer than 3.0 feet below the bottom of proposed footings and/or concrete slabs on-grade. The lines should be cut off at a distance of 5.0 feet or greater from the area of construction. The ends of the lines should be plugged with 5.0 feet or more of concrete exhibiting minimal shrinkage characteristics to prevent water or fluid migration into or from the lines. Capping of the lines may also be needed if the lines are subject to line pressures. The slurry should consist of a fluid, workable mixture of sand, aggregate, cement, and water. Plugs should be placed at the ends of the line prior to filling with the slurry mixture. Cement should be Portland cement conforming to current ASTM C150 specifications. Water used for the slurry mixture should be free of oil, salts, and other impurities which would have an adverse effect on the quality of the slurry. Aggregate, if used in the slurry, mixture should meet the following gradation or a suitable equivalent:

SIEVE SIZE	PERCENT PASSING
1.5"	100
1.0"	80-100
3/4"	60-100
3/8"	50-100
No. 4	40-80
No. 100	10-40

The sand, aggregate, cement, and water should be proportioned either by weight or by volume. Each cubic yard of slurry should not contain less than 188 pounds (2.0 sacks) of cement. Water content should be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while being placed. The slurry should be placed within 1.0 hour of mixing. The contractor should take precautions so that voids within the line to be abandoned are completely filled with slurry.

Local ordinances relative to abandonment of underground irrigation, utility, or pipelines, if more restrictive, supersede the above recommendations.

Temporary Roads

Temporary roads created during grading should be removed in their entirety or replaced as documented compacted fill as part of the rough grading of the tract.

Protection of Work

During the grading process and prior to the completion of construction of permanent drainage controls, it is the responsibility of the grading contractor to provide good drainage and prevent ponding of water and damage to the in progress or finished work on the site and/or to adjoining properties.

Observation and Testing

During grading, observation and testing should be conducted by the project Geotechnical / Geologic Consultant and/or his representatives to verify that the grading is being performed according to the recommendations presented in this report. The project Geotechnical / Geologic Consultant and/or his representative should observe and test the overexcavation bottoms and the placement of fill and should take tests to verify the moisture content, density, uniformity and degree of compaction obtained. The contractor should notify the project Geotechnical / Geologic Consultant when cleanout and/or overexcavation bottoms are ready for observation and prior to scarification and recompaction. Typically, one (1) in-place density test should be performed for every 2.0 vertical feet of fill material, or one (1) test for every 500 cubic yards of fill, which ever requires the greater number of tests. In-place density and moisture content tests should be performed during the placement of the fill materials during the grading operations in general accordance with the following current ASTM test procedures:

> Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) - ASTM D6938.
>
> Test Method for Density and Unit Weight of Soil in Place by Sand Cone Method - ASTM D1556.
>
> Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock - ASTM D2216.

Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method - ASTM D4959.

Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method - ASTM D4643.

Where testing demonstrates insufficient density, additional compaction effort, with the adjustment of the moisture content when needed, should be applied until retesting shows that satisfactory relative compaction has been obtained. The results of observations and testing services should be presented in a formal 'Grading Report' following completion of the grading operations. Grading operations undertaken at the site without the project Geotechnical / Geologic Consultant and/or his representative present may result in exclusions of the affected areas from the grading report for the project. The presence of the project Geotechnical / Geologic Consultant and/or his representative will be for the purpose of providing observations and field testing and will not include supervision or directing of the actual work of the contractor or the contractor's employees or agents. Neither the presence and/or the non-presence of the project Geotechnical / Geologic Consultant and/or his field representative nor the field observations and testing will excuse the contractor for defects discovered in the contractor's work. If **HGI** does not perform the observation and testing of the earthwork for the project and is replaced as Geotechnical / Geologic Consultant of record for the project, the work on the project should be stopped until the replacement Geotechnical / Geologic Consultant has reviewed the previous reports and work performed for the project, agreed in writing to accept the recommendations and prior work performed by **HGI** for the subject project, or has performed their own studies and submitted their revised recommendations. If **HGI** were not selected to perform the required observation and testing of earthwork construction, **HGI** would cease to be the Geotechnical Consultant of Record for the project.

Earth Material Expansion Potential

The preliminary expansion potential of the on-site earth materials is discussed in the subsequent foundation and floor slab recommendation sections of this report. Upon completion of grading for the building pad areas, near-surface samples should be obtained for expansion potential testing to verify the preliminary expansion test results and the foundation / slab-on-grade recommendations presented in this report.

Earth Material Corrosion Potential

The preliminary corrosion potential of the on-site earth material is discussed in the subsequent corrosion recommendation sections of this report. Upon completion of grading for the building pad areas, near-surface samples should be obtained for corrosion potential testing to verify the preliminary chemical test results and the recommendations presented in this report for protection of concrete and bare metal which will be in direct contact with the on-site earth materials and to present preliminary evaluation of the potential for corrosion of bare metal, if desired, which will be in direct contact with the on-site earth materials.

2016 CBC SEISMIC DESIGN CRITERIA

Per the **California Building Standards Commission**, *2016 California Building Code* (CBC), California Code of Regulations, Title 24, Part 2, Volume 2 of 2, Section 1613, 'Earthquake Loads,' the followings coefficients and factors relevant to seismic mitigation and design for new construction include:

- **Site Class**

  Categorizing the upper 30 meters (±100 ft.) of earth materials into one (1) of the Site Classes 'A,' 'B,' 'C,' 'D,' 'E,' and 'F' that are based on average shear wave velocities, Standard Penetration Test blow counts, or undrained shear strength.

- **Occupancy Category**
  Relationship between the number of lives placed at risk by a failure of the structure as determined from Figure C1-1, 'Approximate Relationship between Number of Lives Placed at Risk by a Failure and Occupancy Category,' in Chapter C1 of ASCE 7-10.

- **Mapped, Maximum Considered Earthquake (MSC), 5.0 Percent Damped, Spectral Response Acceleration Parameters at Short Period and at 1-Second Period**
  Mapped, Maximum Considered Earthquake (MSC), 5.0 percent damped, spectral response acceleration parameters at short period (0.2 second) and at long period (1-second), S_s and S_1, respectively, for Site Class 'B' are determined from Java Ground Motion Parameter Calculator - Version 5.0.9a available at the USGS web site (http://earthquake.usgs.gov/research/hazmaps/design/).

- **Site Coefficients**
  Short period site coefficient (at 0.2 second period), F_a, and long-period site coefficient (at 1.0 second period), F_v, are based on 'Site Class' and the 'Mapped Spectral Response Acceleration at Short Period and at 1-Second Period,' S_a and S_1, respectively.

- **Seismic Design Category**
  A classification assigned to a structure based on its 'Risk Category' and the severity of the design earthquake ground motion at the site (i.e., Short Period Response Acceleration (S_{DS}) and Long Period Response Acceleration (S_{D1}) Parameters).

Based on our understanding of local geologic conditions, the 'Site Class' judged applicable to this site is 'D', with a soil profile name of 'Stiff Soil' per Table 20.3-1, 'Site Classification,' in Chapter 20 of ASCE 7-10 with an average Shear Wave Velocity of 600 to 1,200 feet/second (ft./s) or an average Standard Penetration Test value of 15 to 50 blows per foot of penetration in the upper 100 feet (30.48 m) of the site.

The following table presents supplemental coefficients and factors relevant to seismic mitigation and design for new construction built according to the 2016 CBC based on a 2-percent probability of being exceeded in the next 50 years (2,475 years mean return time).

Site Location	Latitude: 34.0556° N Longitude: 117.1860° W
Occupancy Category[1]	I, II, or III
Site Class[2]	D
Mapped, Maximum Considered Earthquake (MCE), 5.0 Percent Damped, Spectral Response Acceleration Parameter at Short Period (S_s)[3] (0.2 Second) for Site Class 'D.'	1.717
Mapped, Maximum Considered Earthquake (MCE), 5.0 Percent Damped, Spectral Response Acceleration Parameter at 1-Second (S_1)[3] for Site Class 'D.'	0.779
Site Coefficients (F_a)[3] for Site Class 'D.'	1.0
Site Coefficients (F_v)[3] for Site Class 'D.'	1.5
The MSC, 5.0 Percent Damped, Spectral Response Acceleration Parameter at Short Periods Adjusted for Site Class 'D' Effects (S_{MS})[3].	1.717
The MSC, 5.0 Percent Damped, Spectral Response Acceleration Parameter at 1-Second Adjusted for Site Class 'D' Effects (S_{M1})[3]	1.168
Design, 5.0 Percent Damped, Spectral Response Acceleration Parameter at Short Periods (S_{DS})[3] for Site Class 'D.'	1.145
Design, 5.0 Percent Damped, Spectral Response Acceleration Parameter at 1-Second (S_{D1})[3] for Site Class 'D.'	0.779
Seismic Design Catagory[4]	E
Model Magnitude Earthquake (M)[5]	7.5
Average Shear Wave Velocity in the Top 30m of the Site for Site Class 'D.'[5]	274 m/s
Peak Ground Acceleration (PGA)[3]	0.677
Site Coefficient (F_{PGA})[4]	1.0
$PGA_M = F_{PGA} * PGA$[5]	0.677g

1. Determined from Figure C1-1, 'Approximate Relationship between Number of Lives Placed at Risk by a Failure and Occupancy Category,' in Chapter C1 of **ASCE 7-10**, 2010 Edition.
2. Per Table 20.3-1, 'Site Classification,' in Chapter 20 of **ASCE 7-10**, 2010 Edition.
3. Java Ground Motion Parameter Calculator - Version 5.1.0 (2-10-2011) available at **USGS** web site (http://earthquake.usgs.gov/research/hazmaps/design/). Data based on **ASCE 7-10**, 2010 Edition, 'Standard, Minimum Design Loads for Buildings and Other Structures.'
4. Per Table 11.6-1, 'Seismic Design Category Based on Short Period Response Acceleration Parameters' and Table 11.6-2, 'Seismic Design Category Based on 1-S Period Response Acceleration Parameters' in Chapter 11 of **ASCE 7-10**, 2010 Edition.
5. Per Table 11.8-1, 'Mapped Maximum Considered Geometric Mean (MCE_G) Peak Ground Acceleration, PGA,' in Chapter 11 of **ASCE 7-10**, 2010 Edition.
6. Per Section 11.8.3 in Chapter 11 of **ASCE 7-10**, 2010 Edition.

Actual shaking intensities at the site from any seismic source may be substantially higher or lower than estimated for a given earthquake magnitude, due to complex and unpredictable effects from variables such as:

- Near-source directivity effects.
- Direction, length, and mechanism of fault rupture (strike-slip, normal, reverse).
- Depth and consistency of unconsolidated sediments.
- Topography.
- Geologic structure underlying the site.
- Seismic wave reflection, refraction, and interference.

FOUNDATION DESIGN RECOMMENDATIONS

General

The recommendations presented in the subsequent paragraphs for foundation design and construction are based on geotechnical characteristics and 'Non-Expansive' conditions for the supporting earth materials as defined in Section

1803.5.3, 'Expansive Soil,' in the 2016 CBC and should not preclude more restrictive structural requirements. Foundations for the proposed structures may consist of conventional column and continuous wall footings founded upon undisturbed, documented, properly, compacted fill.

The Structural Engineer for the project should determine the actual footing width, depth, and reinforcing to resist design vertical, horizontal, and uplift forces under static and seismic conditions. Reinforcement recommendations presented in this report are considered the minimum for the earth material conditions present on the site and are not intended to supersede the design of the project Structural Engineer or the criteria of the governing agencies for the project. The project Structural Engineer may design a 'Slab-on-Ground Foundation' system based on the current **Wire Reinforcement Institute, Inc.** procedures or a 'Post-Tension Slab-on-Ground' system based on the current **Post Tensioning Institute** as an alternative to conventional reinforced concrete foundations and cast-on-grade concrete floor slabs. Geotechnical parameters for the design of a 'Slab-on-Ground Foundation' system or a 'Post-Tension Slab-on-Ground' system can be submitted upon request, if needed.

Foundation Size

Continuous footings should have a width of 12 inches or greater. Footings supporting a roof only shall be as required for supporting one (1) floor. Continuous footings should be continuously reinforced with a minimum of one (1) No. 4 steel reinforcing bar located near the top and one (1) No. 4 steel reinforcing bar located near the bottom of the footings to minimize the effects of slight differential movements which may occur due to minor variations in the engineering characteristics or seasonal moisture change in the supporting soils. Column footings should have a width of 18 inches by 18 inches or greater and be suitably reinforced, based on structural requirements. The continuous footings should extend across doorway and garage entrances and should be founded at the same depths and reinforced the same as the adjacent footings.

Depth of Embedment

Exterior and interior footings supported in undisturbed, documented, properly compacted fill should extend to a depth of 12 inches or greater below lowest adjacent finish grade. Footings should extend to a depth of 12 inches or greater into the bedrock material underlying the unsuitable on-site earth materials due to the expansion potential of the supporting earth materials. Frost is not considered a design factor for foundations in the City of Redlands, California, since there will not be any significant frost penetration in the winter months.

Footing Setback

Embedment of footings on or near existing or planned slopes should be determined by a setback distance measured from the bottom outside edge of the footing to the slope face in accordance with Section 1808.7, 'Foundations on or Adjacent to Slopes,' in the 2016 CBC or the current City of Redlands, California codes and ordinances, whichever is greater.

Bearing Capacity

Provided the recommendations for site earthwork and for footing width and depth of embedment are incorporated into the project design and construction, the allowable bearing value for design of continuous and column footings for the total dead plus frequently-applied live loads is 2,000 pounds per square foot (psf) for footings that are 12 inches in width and a depth of embedment of 12 inches or greater below lowest adjacent finished grade in accordance with Table 1806.2, 'Presumptive Load-Bearing Values,' in the 2016 CBC for footings founded in undisturbed, documented, properly, compacted fill material (Class 4 Material). For eccentrically loaded footings and/or overturning moments, the resultant force should be in the middle one-third of the footing and the average bearing value across the footing should not exceed the recommended allowable bearing value. The allowable bearing value has a factor of safety of 3.0 or greater and may be increased by 33.3 percent for short durations of live and/or dynamic loading such as wind or seismic forces.

Settlement

Footings designed according to the recommended bearing value, the assumed maximum wall and column loads, and founded in undisturbed, documented, properly, compacted fill material are not expected to exceed a total settlement of 1.0 inch or a differential settlement of 0.25 inch between similarly sized and loaded footings.

Lateral Capacity

Resistance to lateral loads can be provided by a combination of friction acting at the base of the foundation and passive earth pressure on the sides of the footings and stem walls. Foundation design parameters, based on undisturbed, documented, properly compacted fill (Class 4 Material) for resistance to static lateral dead forces are as follows:

ALLOWABLE LATERAL BEARING PRESSURE
(Equivalent Fluid Pressure), Passive Case

Material Type	Bearing Pressure
Undisturbed, Documented, Compacted, 'Non-Expansive' Fill**	150 pcf*
Undisturbed, Existing, On-Site Soil	***

* Pounds per square foot per foot of depth (pcf).
** Per Table 1806.2, 'Presumptive Load-Bearing Values,' for a Class 4 Material (SW, SP, SM, SC, GM, and GC) in the 2016 CBC with a relative compaction of 85% or greater.
*** Materials are to be removed and replaced as properly compacted fill to support foundations.

ALLOWABLE LATERAL SLIDING RESISTANCE BETWEEN SOIL AND CONCRETE

Material Type	Coefficient of Friction
Undisturbed, Documented, Compacted, 'Non-Expansive' Fill*	0.25
Undisturbed, Existing, On-Site Soil	**

* Per Table 1806.2, 'Presumptive Load-Bearing Values,' for a Class 4 Material (SW, SP, SM, SC, GM, and GC) in the 2016 CBC with a relative compaction of 85% or greater.
** Materials are to be removed and replaced as properly compacted fill to support foundations.

The above values are allowable design values and have safety factors of 2.0 or greater incorporated into them and may be used in combination without reduction in evaluating the resistance to lateral loads. The recommended lateral resistance assumes a horizontal surface for the earth material mass extending to a distance of 10 feet or greater from the face of the footing, or three (3) times the height of the surface generating passive pressure, whichever is greater. The allowable values may be increased by 33.3 percent for short durations of live and/or dynamic loading, such as wind or seismic forces. For the calculation of the allowable lateral bearing pressure (passive earth resistance), the upper 1.0 foot of material should be neglected unless confined by a concrete slab or pavement. The largest recommended allowable lateral bearing pressure (passive earth resistance) is 15 times the recommended design value for the appropriate CBC class of material.

Interim Foundation Plan Review

It is recommended that **HGI** review the foundation plans for the structures as they become available. The purpose of this review is to determine if these plans have been prepared in accordance with the recommendations contained in this report. This review will also provide **HGI** an opportunity to submit additional recommendations as conditions warrant.

Final Foundation Design Recommendations

Final foundation recommendations should be made upon completion of grading and be included in the 'Report of Grading' prepared by the Geotechnical / Geologic Consultant for the project.

Foundation Excavations

Foundation excavations should be observed by the project Geotechnical / Geologic Consultant and/or his representative prior to placement of forms, reinforcing steel, or placement of concrete for the purpose of verification of the recommendations presented in this report and for compliance with the project plans and specifications. The foundation excavations should be trimmed neat, level, and square. Any loose or sloughed material and debris should be removed from the foundation excavations prior to placement of reinforcing steel and removed again prior to the placement of concrete. Earth materials removed from the foundation excavations should not be placed in slab-on-grade, hardscape, and/or pavement areas unless compacted to 90 percent or greater relative compaction. The maximum dry density and optimum moisture content for the earth material should be determined in accordance with current ASTM D1557 procedures.

SLAB-ON-GRADE FLOOR RECOMMENDATIONS

The recommendations for concrete slabs on-grade, both interior and exterior, excluding Portland Cement Concrete (PCC) pavement, are based on geotechnical characteristics and 'Non-Expansive' conditions for the supporting earth material as defined in Section 1803.5.3, 'Expansive Soil,' in the 2016 CBC. The expansion potential of the slab subgrade areas should be verified at the completion of grading of the building pad areas. Concrete slabs should be designed to minimize cracking as a result of shrinkage. Joints (isolation, contraction, and construction) should be placed in accordance with the current **American Concrete Institute (ACI)** or **Portland Cement Association (PCA)** guidelines. Special precautions should be taken during placement and curing of concrete slabs. Excessive slump (high water / cement ratio) of the concrete and/or improper curing procedures used during either hot or cold weather conditions could result in excessive shrinkage, cracking, or curling in the slabs. It is recommended that concrete proportioning, placement, and curing be performed in accordance with ACI recommendations and procedures.

Interior Floor Slabs

Interior concrete floor slabs-on-grade should be 4.0 inches or greater in thickness and be placed on properly prepared subgrade per the 'Earthwork Recommendations' section of this report. The concrete for the floor slab should have a compressive strength of 2,500 pounds per square inch (psi) or greater at 28 days. Slab reinforcement should consist of a minimum of No. 3 reinforcing bars placed 30 inches on center in both directions, or an equivalent substitute. The amount of reinforcing in the floor slab should be increased as necessary based on the structural loads placed on the floors. The reinforcing should be placed at mid-depth to 1.5 inches below the top surface of the slab to minimize cracking. The concrete section, reinforcing steel, and/or design concrete compressive strength should be increased appropriately for anticipated excessive or concentrated floor loads. A

Modulus of Subgrade Reaction (k_s) of 150 pounds per square inch per inch of deflection is recommended for the design of structural slabs cast on grade for excessive floor loads. A compacted sand or gravel bedding layer beneath lightly loaded floor slabs is not needed but may be desirable to enhance the design section for heavy floor loads. If gravel bedding is used, it should consist of a well graded, crushed aggregate. The sand or gravel layer should be compacted to 90 percent or greater of maximum dry density, as determined by current ASTM D1557 procedures.

If a vapor barrier / moisture retarder is used under the floor slab and it is placed on well graded, crushed, gravel material, it is recommended that a 1.0 inch thick layer of sand or other approved granular material be placed beneath the vapor barrier / moisture retarder to prevent punctures from angular gravel fragments and projections. If open graded gravel (capillary break) is placed beneath the vapor barrier or retarder, the gravel layer should be 6.0 inches or greater in thickness. If open graded gravel is used, a separation fabric such as Mirafi 140N series, or an equivalent substitute, should be used in-leu of a sand cushion to protect the vapor barrier / moisture retarder from punctures.

Subgrade soils should be moisture conditioned to optimum moisture content to 3.0 percent above optimum moisture content to a depth of 12 inches and proof compacted to 90 percent or greater relative compaction based on current ASTM D1557 procedures immediately before placing the gravel material, the moisture barrier, or pouring concrete.

Vapor Barrier / Moisture Retarder Recommendations

HGI does not practice in the field of moisture vapor transmission evaluation / mitigation. Therefore, it is recommended that a qualified person or firm be engaged or consulted with to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction. This person or firm should provide recommendations for mitigation of potential adverse impact of moisture vapor transmission on various components of the structure as deemed appropriate in accordance with ACI, PCA, ASTM, PTI, the California Building Code, and/or the International Residential Code.

In heated / air conditioned areas in a structure where moisture sensitive floor coverings are anticipated over the floor slab, the use of a vapor barrier / moisture retarder beneath the slab should be considered. Typically, a vapor retarder is not utilized under the floor slabs in garages, utility buildings, and other unheated accessory structures, driveways, walks, patios, and/or other flatwork not likely to be enclosed and heated at a later date. The use or non-use of a vapor barrier / moisture retarder, the thickness of the vapor barrier / moisture retarder, the use of a granular layer over the vapor barrier / moisture retarder, the thickness of the granular materials, the type of granular material, etc. should be determined by the Structural Engineer who is designing the floor slab in conjunction with the Architect who is specifying the use and the type of floor coverings to be placed over the floor slab, and/or a person or firm that practices in the field of moisture vapor transmission evaluation / mitigation. The vapor barrier / moisture retarder recommendations provided by the supplier of the flooring materials should also be incorporated into the project plans.

EXTERIOR CONCRETE FLATWORK

Exterior concrete slabs cast on finish subgrade (i.e., pedestrian walkways, patios, sidewalks, etc., with the exception of PCC pavement) should be 4.0 inches or greater in thickness and be underlain by 12 inches or greater of earth material that has been prepared in accordance with the 'Earthwork Recommendation' section of this report. Reinforcing in the slab, the design compressive strength of the concrete, and the use of a compacted sand or gravel base beneath the slabs should be according to the current codes and ordinances of the City of Redlands, California. Subgrade earth materials should be moisture conditioned to optimum moisture content to 3.0 percent above optimum moisture content to a depth of 12 inches or greater and proof compacted to 90 percent or greater relative compaction based on current ASTM D1557 procedures immediately before placing aggregate base material, placing reinforcing steel, or placing the concrete.

RETAINING WALL RECOMMENDATIONS

Low height retaining walls may be needed to achieve finish grades for the proposed building pads, driveways, parking areas, and/or landscape areas. Retaining walls should be designed in accordance with the recommendations in the following sections. If earth reinforced walls, crib wall, keystone walls, etc. are used for the development of the subject site, the design requirement of the proprietary retaining wall system should supercede the following recommendations if there are any conflicts.

Static Lateral Earth Pressures

Retaining walls backfilled with 'Non-Expansive' granular soil (i.e., Expansion Index (EI) ≤ 20 and Unified Soil Classifications of SP, SW, SM, GP, GW, and GM) within a zone extending upward and away from the heel of the footing at a slope of 0.5H:1V (Horizontal to Vertical) or flatter for level backfill and 0.7H:1V for a 2H:1V slope behind the retaining wall can be designed to resist static lateral earth pressures equivalent to those recommended in the following table:

LATERAL EARTH PRESSURE

Condition	Level Backfill and Soil Classification*			2H:1V Sloped Backfill and Soil Classification***		
	SP, SW, GP, GW	GM	SM	SP, SW, GP, GW	GM	SM
Active	30 pcf**	40 pcf	45 pcf	40 pcf	62 pcf	81 pcf
At-Rest	60 pcf	60 pcf	60 pcf	87 pcf	110 pcf	120 pcf

* Per Table 1610.1, 'Lateral Soil Load,' in the 2016 CBC.

** Equivalent fluid Pressure, pounds per square foot per foot of depth (pcf).

*** Based on a moist unit weight of 125 pcf and an Angle of Internal Friction of 38 degrees for SP, SW, GP, and GW backfill soils, 31 degrees an for GM backfill soils, and 28 for an Angle of Internal Friction of 28 for SM backfill soils.

The designer of the retaining wall should specify the type of backfill material to be used in the active / at-rest zone behind the retaining wall. Any expansive soils which may be encountered on the subject site should not be used as backfill for retaining walls. Retaining walls that are free to deflect 0.001 radian at the top should be designed for the above-recommended active condition. Retaining walls that are not capable of this movement should be assumed rigid and designed for the at-rest condition. The above values assume well-drained backfill and that a buildup of hydrostatic pressure will not occur. Surcharge loads, dead and/or live (i.e., construction loads, etc.), acting on the backfill within a horizontal distance behind the retaining wall, equivalent to or less than the vertical height of the retaining wall, should also be considered in the design. Uniform surcharge pressures should be applied as an additional uniform (rectangular) pressure distribution. The lateral earth pressure coefficient for a uniform vertical surcharge load behind the retaining wall is 0.50. Seismic and wind loads should also be added to the design loads on the retaining walls, if applicable.

Seismic Lateral Earth Pressure

In accordance with Section 1803.5.12, 'Seismic Design Categories D through F,' in the 2016 CBC for the habitable structures, seismic loads should also be added to the design loads on the retaining walls retaining more than 6.0 feet in height. Recommended seismic lateral earth pressures can be provided upon request.

Foundation Design

Retaining wall footings should be founded to the same depths below lowest adjacent finished grade and offsets from the face of slopes, and into undisturbed, observed and tested, compacted fill. The foundations may be designed for the same average allowable bearing value across the footing (as long as the resultant force is located in the middle one-third of the footing), and with the same allowable static and seismic allowable lateral bearing pressure, allowable passive earth pressure, and allowable sliding resistance as recommended in the 'Foundation Design Recommendations' section of this report. Retaining walls should be designed for a factor of safety of 1.5 against lateral sliding and overturning per Section 1807.2.3, 'Safety Factor,' in the 2016 CBC. When using the allowable lateral pressure and allowable lateral sliding resistance, a factor of safety of 1.0 may be used. If ultimate values are used for design, an approximate factor of safety (i.e., 1.5) should be achieved.

Foundation Size: Continuous footings should have a width of 12 inches or greater. Continuous footings should be continuously reinforced with a minimum of one (1) No. 4 steel reinforcing bar located near the top and one (1) No. 4 steel reinforcing bar located near the bottom of the footings to minimize the effects of slight differential movements which may occur due to minor variations in the engineering characteristics or seasonal moisture change in the supporting expansive earth materials.

Depth of Embedment: Footings should extend to a depth of 12 inches or greater below lowest adjacent finish grade.

Footing Setback: Embedment of footings on or near existing or planned slopes should be determined by a setback distance measured from the bottom outside edge of the footing to the slope face in accordance with Section 1808.7, 'Foundations on or Adjacent to Slopes,' in the 2016 CBC or the current City of Redlands, California building codes, whichever is greater.

Bearing Capacity: Provided the recommendations for site earthwork and for footing width and depth of embedment are incorporated into the project design and construction, the allowable bearing value for design of retaining wall footings for the total dead plus frequently-applied live loads is 2,000 pounds per square foot (psf) for footings that are 12 inches in width and a depth of embedment of 12 inches below lowest adjacent finish grade in accordance with Table 1806.2, 'Presumptive Load-Bearing Values,' in the 2016 CBC for footings founded in undisturbed, documented, properly, compacted fill material (Class 4 Material). For eccentrically loaded footings and/or overturning moments, the resultant force should be in the middle one-third of the footing and the average bearing value across the footing should not exceed the recommended allowable bearing value. The allowable bearing values have a factor of safety of 3.0 or greater and may be increased by 33.3 percent for short durations of live and/or dynamic loading such as wind or seismic forces.

Settlement: Footings designed according to the recommended bearing values are not expected to exceed a total settlement of 1.0 inch or a differential settlement of 0.5 inch between similarly sized and loaded footings.

Lateral Capacity

Resistance to lateral loads can be provided by a combination of friction acting at the base of the foundation and passive earth pressure on the sides of the footings and stem walls. Foundation design parameters, based on undisturbed, documented, properly compacted fill (Class 4 Material) for resistance to static lateral dead forces per Table 1806.2, 'Presumptive Load-Bearing Values,' in the 2016 CBC are as follows:

Allowable Lateral Bearing Pressure
(Equivalent Fluid Pressure), Passive Case:

Undisturbed, Documented, Compacted, 'Non-Expansive' Fill - 150 pcf*
Undisturbed, On-Site, 'Non-Expansive,' Alluvial Soil** - 150 pcf
Undisturbed, Existing, On-Site Soil - ****
* Pounds per square foot per foot of depth (pcf).
** Per Table 1806.2, 'Presumptive Load-Bearing Values,' for a Class 4 Material (SW, SP, SM, SC, GM, and GC) in the 2016 CBC.
*** Materials are to be removed and replaced as properly compacted fill to support foundations.

Allowable Lateral Sliding Coefficient of
Friction Between Soil and Concrete:

Undisturbed, Documented, Compacted, Non-Expansive' Fill** - 0.25
Undisturbed, On-Site, 'Non-Expansive,' Alluvial Soil** - 0.25
Undisturbed, Existing, On-Site Soil - ***
** Per Table 1806.2, 'Presumptive Load-Bearing Values,' for a Class 4 Material (SW, SP, SM, SC, GM, and GC) in the 2016 CBC.
*** Materials are to be removed and replaced as properly compacted fill to support foundations.

The above values are allowable design values and have safety factors of 2.0 or greater incorporated into them and may be used in combination without reduction in evaluating the resistance to lateral loads. The recommended lateral resistance assumes a horizontal surface for the earth material mass extending to a distance of 10 feet or greater from the face of the footing, or three (3) times the height of the surface generating passive pressure, whichever is greater. The allowable values may be increased by 33.3 percent for short durations of live and/or dynamic loading, such as wind or seismic forces. For the calculation of the allowable lateral bearing pressure (passive earth resistance), the upper 1.0 foot of material should be neglected unless confined by a concrete slab or pavement. The largest recommended allowable lateral bearing pressure (passive earth resistance) is 15 times the recommended design value for the appropriate class of material.

Subdrain

A subdrain system should be constructed behind, and at the base of retaining walls to allow drainage and to prevent the buildup of excessive hydrostatic pressures. The subdrain system should be designed by the project Civil Engineer. The use of water-stops, impermeable barriers, or other dampproofing or waterproofing methods should be considered for any retaining walls where moisture migration through the retaining wall is considered critical to the performance and/or appearance of the retaining walls. A waterproofing consultant should be retained to provide specific waterproofing recommendations for the project, if required.

Typical subdrains may include weep holes with a continuous free draining gravel gallery, perforated pipe surrounded by free draining filter rock, or another approved system. The option of providing an ungrouted, open coarse of block at the bottom of a retaining wall is not a recommended drainage option since the openings in this coarse are so often covered by landscape soil, hardscape, and or pavement. Gravel galleries and/or filter rock, if not designed and graded for the on-site and/or import materials, should be enclosed in a geotextile fabric such as Mirafi 140N series, or an equivalent substitute, to prevent infiltration of fine soil particles into the subdrain and clogging of the system. Before placement of the fabric, the top of the footing should be cleared of loose soil materials, large stones, and/or other debris. Any large depressions or holes should be filled with a concrete slurry or a suitable equivalent to permit close contact of the fabric with the surrounding surface. The fabric should be placed smoothly without folds or excessive wrinkles. Successive sheets of the fabric should be placed with an overlap of 24 inches or more in the direction of the flow of the water in the pipe with the upstream layer overlapping the downstream layer. The fabric should be folded over the top of the free draining granular material producing an overlap of 12 inches or more. The perforated pipes should be Schedule 40 or stronger and 4.0 inches or greater in diameter. Perforations may be either bored 0.25-inch diameter holes or 0.1875-inch (3/16-inch) wide slots placed on the bottom one-third of the pipe perimeter. If the pipe is bored, a minimum of 10 holes per linear foot should be uniformly placed along the pipe. If slots are used, they should not exceed 2.0 inches in length and should not be closer than 2.0 inches on center along the length of the pipe. The total length of the slots should not be less than 50 percent of the pipe length and should be uniformly spaced along the length of the pipe. Pipe perforations should be placed downward. Gravel filters should have a volume of 3.0 cubic feet or greater per linear foot of pipe. Subdrains should maintain a positive flow gradient and have outlets that drain in a non-erosive manner.

Prefabricated drainage products such as 'Miradrain,' or a suitable equivalent, may also be used for the purpose of providing drainage behind retaining walls when installed in accordance with the manufacturers recommendations.

Backfill

Backfill directly behind retaining walls (if backfill width is less than 3.0 feet) may consist of 0.5- to 1.5-inch diameter, rounded to subrounded gravel with less than 5.0 percent passing the 0.5 inch sieve enclosed in a geotextile fabric such as Mirafi 140N series, or an equivalent substitute, or a clean sand (Sand Equivalent Value greater than 50) water jetted into place to obtain compaction. If water jetting is used, the subdrain system should be in place. Even if water jetting is used, the sand should be densified to 90 percent or greater relative compaction. If the specified density is not obtained by water jetting, mechanical methods will have to be used. If other types of soil or gravel are used for backfill, mechanical compaction methods will have to be used to obtain a relative compaction of 90 percent or greater of maximum dry density. Backfill directly behind retaining walls should not be compacted by wheel, track or other rolling by heavy construction equipment unless the retaining wall is designed for the surcharge loading. If gravel, clean sand, or other imported backfill is used behind retaining walls in unpaved areas, the upper 12 to 18 inches of backfill should consist of typical on-site material compacted to 90 percent or greater relative compaction to prevent the influx of surface run-off into the granular backfill and into the subdrain system. Maximum dry density and optimum moisture content for backfill materials should be determined according to current ASTM D1557 procedures.

V-Drain Design

A V-drain should be constructed directly behind retaining walls which have a sloping backfill to intercept surface water and drain it from the back of the retaining wall. The V-drain should be designed and constructed in accordance with the current typical standards of the City of Redlands, California. The V-drain should direct water from the back of the retaining wall to an adequate down drain and discharge it in a non-erosive manner.

Observation and Testing

During retaining wall construction, observation and testing should be conducted by the project Geotechnical / Geologic Consultant and/or his representatives to verify that the work is being performed according to the recommendations presented in this report.

The foundation excavations should be observed by the project Geotechnical / Geologic Consultant and/or his representative prior to placement of forms, reinforcing steel, or placement of concrete for the purpose of verification of the recommendations presented in this report and for compliance with the project plans and specifications. The foundation excavations should be trimmed neat, level, and square. Any loose or sloughed material and debris should be removed from the foundation excavations prior to placement of reinforcing steel and removed again prior to the placement of concrete.

The placement and construction of the subdrain system behind the retaining walls should be observed by the project Geotechnical / Geologic Consultant and/or his representatives to verify that the work is being performed according to the recommendations presented in this report.

During backfill of the retaining walls, observation and testing should be conducted by the project Geotechnical / Geologic Consultant and/or his representatives to verify that the backfilling is being performed according to the recommendations presented in this report. The project Geotechnical / Geologic Consultant and/or his representative should observe the placement of fill and should take tests to verify the moisture content, density, uniformity and degree of compaction obtained. Where testing demonstrates insufficient density, additional compaction effort, with the adjustment of the moisture content when needed, should be applied until retesting shows that satisfactory relative compaction has been obtained. The results of observations and testing services should be presented in a formal report following completion of the construction operations. Retaining wall backfill operations undertaken at the site without the project Geotechnical / Geologic Consultant and/or his representative present may result in exclusions of the affected areas from the final report for the project.

The presence of the project Geotechnical / Geologic Consultant and/or his representative will be for the purpose of providing observations and field testing and will not include supervision or directing of the actual work of the contractor or the contractor's employees or agents. Neither the presence and/or the non-presence of the project Geotechnical / Geologic Consultant and/or his field representative nor the field observations and testing will excuse the contractor for defects discovered in the contractor's work.

CORROSION POTENTIAL EVALUATION

The recommendations for corrosion protection should be verified at the completion of grading of the building pads on the subject site. Bulk samples of the near surface, on-site earth materials were obtained during the field study to evaluate the potential for corrosivity. Results from the tests are included in the 'Summary of Laboratory Test Results' presented in Appendix 'A.'

Concrete Corrosion Potential

A preliminary test on a sample of near-surface, on-site earth material suggest a soluble sulfate concentration of 0.0021 percent. Earth materials with a water soluble sulfate (SO_4) concentration of less than 0.10 percent are considered to be Category S, Class S0 in accordance with Table 19.3.1.1, 'Exposure Categories and Classes,' in **American Concrete Institute (ACI)** 318-14. Therefore the requirements in Table 19.3.2.1, 'Requirements for Concrete by Exposure Class,' in **ACI** 318-14 are applicable. The referenced **ACI** Table 19.3.2.1 should be used to determine the type cement, the maximum water cement ratio, and the minium compressive strength to be used for normal weight concrete which comes in direct contact with the on-site earth materials (i.e., foundations, floor slabs, driveway slabs, sidewalks, patios, curbs / gutters, etc.). The applicable portion of the referenced **ACI** Table 19.3.2.1, as presented on Figure No. 4, should be used to determine the type cement, the maximum water cement ratio, and the minium compressive strength to be used for normal weight concrete which comes in direct contact with the on-site earth materials (i.e., storm drain pipe / box culvert, driveway slabs, sidewalks, curbs / gutters, etc.). A lower water / cement ratio or higher compressive strength may be required for design of concrete for water tightness or for protection against freezing and thawing, or for corrosion protection of concrete reinforcement per Section 1904, 'Durability Requirements,' in the 2016 CBC, if applicable.

Experience in the southern California area has shown that even though the earth materials do not contain levels of soluble sulfate which would require the use of sulfate resistant cement, maximum water cement ratios, or minimum compressive strength for concrete, concrete corrosion and erosion problems still occur. These problems are the result of concentrations of soluble sulfate, chloride, and other salts and/or acids present in groundwater, irrigation water, rain water, and potable water sources, and in fertilizers or amendments used to promote plant growth (i.e., some domestic water sources contain levels of dissolved sulfate which would be a Class S1 exposure to concrete which comes in contact with it). Therefore, it may be wise to use a concrete designed for a Category S, Class S1 criteria that comes into contact with surface run-off or other sources of water. Higher strength, lower water / cement ratio, and denser concrete may also be effective in reducing the potential for corrosion to occur and preventing damage due to salt or acid exposure. The use of sulfate resistant concrete for non-structural elements (i.e., driveway slabs, sidewalks, patios, curbs / gutters, etc.), is considered to be a value / risk assessment and decision to be made by the owner / developer.

Metallic Corrosion Potential

The life of buried metals depends on type of material, thickness, and construction details. Since **HGI** does not practice metallic corrosion engineering, if corrosion protection is considered to be a design issue, an engineer specializing in corrosion should be consulted regarding the potential damage due to corrosion. The corrosion engineer should recommend appropriate types of piping and/or protective measures where needed.

A preliminary minimum resistivity test on a sample of the near-surface, on-site, earth material of 5,561 ohm-cm suggest a mild to moderate corrosive environment for buried ferrous metal in direct contact with the on-site earth materials when the earth materials are wet. Soils with a minimum resistivity of less than 1,000 ohm-cm indicates a severe corrosive environment and a minimum resistivity of 2,000 ohm-cm or greater indicates a mild to moderate corrosive environment for buried ferrous metal in direct contact with the soils when the soils are wet.

A preliminary test on a sample of near-surface, on-site, earth material suggests a soluble chloride concentration of 23 parts per million (ppm). Earth materials with greater than 300 and 500 ppm of soluble chloride are considered to be aggressive to buried ferrous and copper material respectively, in direct contact with the earth materials.

Earth material pH is a general indicator of the corrosivity of earth materials. The measured pH of a sample of near-surface, on-site, earth material of 8.2 indicates a non-corrosive environment to copper and ferrous metals when in direct contact with the on-site earth materials.

Sulfide in soils is a general indicator of the corrosivity of earth materials. The measured sulfide of the samples of near-surface, on-site, earth material tested as part as part of this report from the finish building pads was 'Negative' which indicates a non-corrosive environment to copper and ferrous metals when in direct contact with the on-site earth materials.

Salt Crystallization Exposure

Damage of concrete, concrete masonry units, slump stone block, etc. surface can occur when evaporation of moisture takes place at the surface of the materials. As evaporation takes place, salts (i.e,. carbonates, chloride, sulfur, sodium, potassium, etc.) are deposited in or form on the surfaces. As the salts crystalize, they can exert extreme pressures in the pore spaces of the materials they are deposited in and/or on. The formation of the crystals within the pore spaces of the material can result in what is generally called 'salt crystallization damage.' This results in the scaling and/or etching of the surface of the material on which they are deposited. The damaging effects of this phenomenon can be greatly reduced and/or even eliminated by the following or other such methods: 1) either using a higher strength concrete or a denser, low porosity product; 2) seal the surface of the material with a water proofing substance which will prevent the evaporation of the moisture from within the cementitious product. If 'salt crystallization damage' is considered to be an issue, an engineer or chemist specializing in this area should be consulted regarding the potential damage due evaporation and the deposition of salts. The engineer or chemist should recommend appropriate types of materials or protective measures where needed.

PRELIMINARY PAVEMENT RECOMMENDATIONS

The following are preliminary recommendations for the structural pavement section for the proposed parking areas, and driveway areas for the subject development. The Hot Mix Asphalt (HMA) concrete pavement sections have been determined in general accordance with current **California Department of Transportation (CALTRANS)** design procedures using the CalFP Ver. 1.1 'Hot Mix Asphalt

Empirical Design' computer program developed by the **CALTRANS, Office of Pavement Design** and are based on a an assumed Traffic Index (TI) of 5.5 for a 20 year design life and an assumed R-Value of at least 40 based on past experience in the vicinity of the site and visual textural classification of the on-site earth material and/or import materials which are anticipated to be at subgrade elevation.

Portland Cement Concrete (PCC) pavement sections are based on an equivalent structural numbers as the recommended HMA concrete pavement section and a compressive strength of 2,500 psi or greater at 28 days for the concrete.

The preliminary recommendations for the pavement sections should consist of the following:

RECOMMENDED PAVEMENT SECTIONS

Site Area	Traffic Index*	Subgrade R-Value**	Pavement Section
Driveway and Parking Areas for Autos and Light Weight Vehicles Only.	≤5.5	≥40	3.5" Hot Mix Asphaltic (HMA) Concrete over 5.0" Aggregate Base (AB) or 5.5" PCC @ 2,500 psi over properly prepared subgrade.

* Traffic Index was assumed for the project.
** R-Value was assumed for the project.

It is noted that the City of Redlands minimum pavement sections may override the above pavement recommendations without prior City review and approval.

HMA concrete pavement materials should be as specified in Section 39, 'Hot Mix Asphalt,' in the current CALTRANS 2010 'Standard Specifications' with the 7-18-

2014 Revisions, or an equivalent substitute. Aggregate base should conform to Class 2 Material, 1-1/2" Maximum or 3/4" Maximum, as specified in Section 26-1.02B, 'Class 2 Aggregate Base,' in the current, CALTRANS 2010 'Standard Specifications' with the 7-18-2014 Revisions, or an equivalent substitute.

Portland Cement Concrete sections are based on a compressive strength of 2,500 psi or greater at 28 days for the concrete. Higher strength design for the concrete can permit thinner pavement sections. Lower strength design for the concrete will require thicker pavement sections. Joints (longitudinal, transverse, construction, and expansion), jointing arrangement, joint type, pavement and/or joint reinforcing, as well as drainage, crowning, finishing and curing of PCC pavement should be in accordance with current Portland Cement Association (PCA) recommendations.

The subgrade earth material, including utility trench backfill, should be compacted to 90 percent or greater relative compaction to a depth of 1 foot or greater below the finish pavement subgrade elevation. The aggregate base material should be compacted to 95 percent or greater relative compaction. If asphaltic concrete and/or PCC pavement is placed directly on subgrade, the upper 1.0 foot of the subgrade should be compacted to 95 percent or greater relative compaction. Maximum dry density and optimum moisture content for subgrade and aggregate base materials should be determined according to current ASTM D1557 procedures. The asphalt concrete pavement should be densified to 95 percent or greater of the density obtained by current California Test 304 and 308 procedures (Hveem compacted laboratory samples).

If semi-trailers are to be parked on the asphalt concrete pavement, such that a considerable load is transferred from small, steel wheels, it is recommended that a strip of rigid Portland Cement concrete pavement with a thickness of 6.0 inches or greater be provided in these areas. This will provide for the distribution of loads to the subgrade without causing deformation of the pavement surface. Special consideration should also be given to areas where truck traffic will negotiate small radius turns and/or in areas utilized by solid tired forklifts or other material handling equipment. HMA concrete pavement in these areas should utilize stiffer emulsions or the areas should be paved with Portland Cement concrete. Where HMA concrete pavement abuts concrete aprons, drives, walks, or curb and gutter sections, a thickened edge transition zone is recommended for the HMA concrete section to minimize the effects of impact loading as vehicles transition from PCC paving to HMA concrete paving. This thickened edge should consist of an increased thickness of 2.0 inches for parking areas and 4.0 inches for areas of heavy truck usage. This thickened edge should extend to a distance of 3.0 feet or greater from the edge of pavement and then gradually taper back to the design pavement thickness. If pavement subgrade earth materials are prepared at the time of grading of the building site and the areas are not paved immediately, additional observations and testing will have to be performed before placing aggregate base material, asphaltic concrete, or PCC pavement to locate areas that may have been damaged by construction traffic, construction activities, and/or seasonal wetting and drying. In the proposed pavement areas, earth material samples should be obtained at the time the subgrade is graded for Resistance (R-Value) testing according to current California Test 301 procedures to verify the pavement design recommendations.

Because the full design thickness of the HMA concrete is frequently not placed prior to construction traffic being allowed to use the parking lots, rutting and pavement failures can occur prior to project completion. To reduce this occurrence, it is recommended that either the full-design pavement section be placed prior to use by the construction traffic, or a higher Traffic Index (TI) be specified where construction traffic will use the pavement.

Surface water infiltration beneath pavements could significantly reduce the pavement design life. To limit the need for additional long-term maintenance of the pavement or pre-mature failure, it would be beneficial to protect at-grade pavements from landscape water infiltration by means of a concrete cutoff wall, deepened curbs, or equivalent. Pavement cut-off barriers should be considered where pavement areas are located downslope of any landscape areas that are to be irrigated. The cut-off barrier should extend to a depth of at least 4.0 inches below the pavement section aggregate base material.

Gradation is not the only quality guidelines for aggregate base material. The longevity and performance of pavements utilizing aggregate base material for support is dependent upon the quality of the material which composes the aggregate base. CALTRANS specifications do not specifically exclude the use of material other than a natural, crushed rock and rock dust for Class 2 Aggregate Base material as the 'Standard Specifications for Public Works Construction' (2012 Edition of the 'Greenbook' with the 2014 Cumulative Supplement), Section 200-2.2, does for Crushed Aggregate Base material. Often times, reclaimed Portland Cement concrete, Hot Mix Asphalt concrete, lean concrete base, and cement treated base are crushed, combined with broken stone, crushed gravel, natural rough surfaced gravel, and sand per the current Section 26-1.02B, 'Class 2 Aggregate Base,' of the current CALTRANS 2010 'Standard Specifications,' with the 7-18-2014 Revisions, and graded to produce a Class 2 Aggregate Base material per CALTRANS gradation specifications. Bricks, concrete masonry units, tile, glass, ceramics, porcelain, wood, plastic, metal, etc. **are not** an acceptable reclaimed material for use in a Class 2 Aggregate Base material per the current CALTRANS

2010 'Standard Specifications' with the 7-18-2014 Revision. If a reclaimed material is proposed for use on the project as a Class 2 Aggregate Base, the reclaimed materials should not exceed 50 percent of the total volume of the aggregate used. The aggregate base material should be tested prior to delivery to the subject project site for the following quality requirements per the current, appropriate CALTRANS test procedures:

TEST	TEST METHOD NO.	QUALITY REQUIREMENT	
		OPERATING RANGE	CONTRACT COMPLIANCE
Resistance (R-Value)	Calif. Test 301	--	78 Minimum
Sand Equivalent	Calif. Test 217	25 Minimum	22 Minimum
Durability Index	Calif. Test 229	--	35 Minimum

If a reclaimed material or a pit run aggregate is proposed for use on the project as a 'Greenbook' Crushed Miscellaneous Base (CMB), the materials should be tested for the following quality requirements prior to delivery to the subject project, per the current 'Greenbook,' 2012 Edition with the 2014 Cumulative Supplement, Section 200-2.4.3, and appropriate procedures as well as the required gradation and other requirements:

TEST	TEST METHOD NO.	QUALITY REQUIREMENT
Resistance (R-Value)	Calif. Test 301	78 Minimum[1]
Sand Equivalent	Calif. Test 217	35 Minimum
Percent Wear[2] 100 Revolutions 500 Revolutions	ASTM C131	 15 Maximum 52 Maximum

TEST	TEST METHOD NO.	QUALITY REQUIREMENT
1. R-Value requirement may be waived if Sand Equivalent is 40 or more. 2. The percentage wear requirements may be waived if the material has a minimum Durability Index of 40 in accordance with CALTRANS Test Method 229.		

A 'Greenbook' CMB may contain broken or crushed asphalt concrete or Portland Cement concrete and may contain crushed aggregate base or other rock materials. The CMB may contain no more than 3.0 percent brick retained on the # 4 sieve by dry weight of the total sample.

Samples of the proposed aggregate base using reclaimed material should be sampled from the manufacturer's stockpiles and tested prior to delivery to the project. The samples should be obtained at a time as near the delivery to the project as possible but would allow enough time to complete the testing and report the results before delivery to the site. Samples should again be obtained and tested for quality compliance from the materials delivered to the project. In addition, per the current CALTRANS 2010 'Standard Specifications' with the 7-18-2014 Revisions, an aggregate grading and Sand Equivalent test shall not represent more than 500 cubic yards or one (1) days production if less than 500 cubic yards.

Concrete gutters should be provided at flow lines in paved areas. Pavements should be sloped to permit rapid and unimpaired flow of runoff water. In addition, paved areas should be protected from moisture migration and ponding from adjacent water sources. Saturation of aggregate base and/or subgrade materials could result in pavement failure and/or premature maintenance. The gutter material and construction methods should conform to the current standards of the City of Redlands, California.

POST-GRADING CRITERIA

Earth materials generated from the excavation of foundations, utility trenches, etc., to be used on-site, should be moisture conditioned to optimum moisture content to 3.0 percent above optimum moisture content and compacted to 90 percent or greater of the maximum dry density for the material type as determined by current ASTM D1557 procedures when it is to be placed under floor slabs, under hardscape areas, and/or in paved areas. The placement of the excess material should not alter positive drainage away from structures and/or off the lot and should not change the distance from the weep screed on the structure to the finished adjacent earth material grade per the 'Finish Surface Drainage Recommendations' presented in a subsequent section of this report.

UTILITY TRENCH RECOMMENDATIONS

Utility trenches within the zone of influence of foundations or under building floor slabs, exterior hardscape, and/or pavement areas should be backfilled with documented, compacted earth material. Utility trenches within the building pad and extending to a distance of 5.0 feet beyond the building exterior footings should be backfilled with on-site or similar earth material. Where interior or exterior utility trenches are proposed to pass beneath or parallel to building, retaining wall, and/or decorative concrete block perimeter wall footings, the bottom of the trench should not be located below a 1H:1V (Horizontal to Vertical) plane projected downward from the outside bottom edge of the adjacent footing unless the utility lines are designed for the footing surcharge loads.

Trench Excavation

It is recommended that utility trench excavations be designed and constructed in accordance with current OSHA regulations. These regulations provide trench sloping and shoring design parameters for trenches up to 20 feet in vertical depth based on a description and field verification of the earth material types encountered. Trenches over 20 feet in vertical depth should be designed by the Contractor's Engineer based on site specific geotechnical analyses. For planning purposes, we recommend that the following OSHA earth material type designations and temporary slope inclinations be used:

EARTH MATERIAL	OSHA SOIL TYPE*	TEMPORARY SLOPE INCLINATION (H:V)**
Undocumented Fill	C	1.5:1
Compacted Fill	C	1.5:1
Alluvium	C	1.5:1

* Type 'C': Cohesive soils with an unconfined compressive strength of 0.5 tsf or less: or Granular soils including sands, gravels, loamy, clayey or silty sands, etc.

** Steepest allowable slopes for excavations less than 20 feet in vertical height. Slopes for excavations greater than 20 feet in vertical height should be designed by a Registered Professional Engineer with experience in Geotechnical Consulting and Soil Mechanics.

Excavations of less than 5.0 feet in depth may also be subject to collapse due to water, vibrations, previously disturbed earth materials, or other factors and may require protection for workers such as temporary slopes, shoring, or a shielding protective system. The excavations should be observed by a qualified, competent person (as defined in the current OSHA regulations) looking for signs of potential cave-ins on a daily basis before start of work, as needed throughout the work shifts, and after every rainstorm or other hazard-increasing occurrence.

Surcharge loads (i.e., spoil piles, earthmoving equipment, trucks, etc,) should not be allowed within a horizontal distance measured from the top of the excavation slope equivalent to 1.5 times the vertical depth of the excavation (for medium stiff or dense earth materials). Excavations should be initially observed by the project Geotechnical / Geologic Consultant and/or his representative to verify the recommendations presented or to make additional recommendations to maintain stability and safety. Moisture variations, differences in the cohesive or cementation characteristics, or changes in the coarseness of the deposits may require slope flattening or, conversely, permit steepening upon review and appropriate testing by the project Geotechnical / Geologic Consultant and/or his representative. The excavations should be observed by a qualified, competent person (as defined in the current OSHA regulations) looking for signs of potential problems on a daily basis before start of work, as needed throughout the work shifts, and after every rainstorm or other hazard-increasing occurrence. Deep utility trenches may experience caving which will require special considerations to stabilize the walls and expedite trenching operations. Surface drainage should be controlled along the top of the construction slopes to preclude erosion of the slope face. If excavations are to be left open for long periods, the slopes should be sprayed with a protective compound and/or covered to minimize drying out, raveling, and/or erosion of the slopes.

Utility Line Foundation Preparation

If the utility trench excavation bottom is in material that is not suitable for support of the utility pipe, the material should be removed to a minimum depth of 1.0 foot below the bottom of the pipe and replaced with concrete slurry, sand, or crushed gravel meeting the following appropriate gradation limits or some other suitable equivalent as specified by the utility designer.

SIEVE SIZE	CRUSHED ROCK OR GRAVEL (PERCENT PASSING)
1"	100

SIEVE SIZE	CRUSHED ROCK OR GRAVEL (PERCENT PASSING)
3/4“	90-100
½“	30-60
3/8“	0-20
No. 4	0-5

SIEVE SIZE	SAND (PERCENT PASSING)
3/8"	100
No. 4	75-100
No. 30	12-50
No. 100	5-20
No. 200	0-15

Most of the granular native earth materials encountered on the subject site **are not** expected to meet the above granular earth material criteria.

We recommend, that where the bottom of the pipe foundation excavation is loose or soft, the foundation earth materials be removed to firm materials as determined by the Engineer. This condition would likely only apply where fill underlies the pipe in localized areas along a utility alignment. If firm material is not encountered within 24 inches of the bottom of the pipe zone, the contractor may then elect to stabilize the trench bottom with 24 inches of crushed rock as described above. Alternately, soft or loose material may be excavated to firm earth material and the overexcavation replaced with select earth material.

The bottom of the utility trench excavation should be proof compacted to 90 percent or greater relative compaction prior to placement of compacted fill. Maximum dry density and optimum moisture content for compacted materials should be determined according to current ASTM D1557 procedures.

Prior to placement of trench slurry or crushed rock, the bottom need only be cleaned of loose materials created by the excavation process. Where the bottom of the trench contains rocks or hard objects protruding above a depth of 6.0 inches below the pipe bottom, such objects should be removed or broken and any resulting cavities filled to produce a smooth surface.

Bedding Requirements

It is recommended that the pipe be bedded on either clean sand, gravel, crushed rock or any approved suitable material in order to provide a smooth, firm, and uniform foundation for the pipe. The pipe bedding material, thickness, shaping, and placement should satisfy the design requirements as determined by the design Civil Engineer and/or in accordance with Section 306-1.2.1 of the 2012 Edition of the 'Greenbook' with the 2014 Cumulative Supplement.

Trench Zone Backfill

The excavated earth materials from the trench may be used as backfill in the trench zone unless more restrictive specifications are required by the design engineer or the permitting agency. The trench backfill material should consist of approved earth materials free of trash debris, vegetation or other deleterious matter, and oversize particles (i.e., 12 inch in maximum dimension). Trench zone backfill should be compacted to 90 percent or greater relative compaction. Maximum density and optimum moisture content for compacted materials should be determined according to current ASTM D1557 procedures.

Trench backfill material should be placed in a lift thickness appropriate for the type of backfill material and compaction equipment used. Backfill material should be brought to optimum moisture content to 3.0 percent above optimum moisture content and compacted to 90 percent or greater relative compaction by mechanical means. Jetting or flooding of the backfill material will **not** be considered a satisfactory method for compaction. Maximum dry density and optimum moisture content for backfill material should be determined according to current ASTM D1557 procedures.

FINISH SURFACE DRAINAGE RECOMMENDATIONS

Positive drainage should be established away from the tops of slopes, the exterior walls of structures, the back of retaining walls, trash enclosure walls, decorative concrete block walls, etc. Finish surface gradients in unpaved areas should be provided next to tops of slopes and buildings to guide surface water away from foundations, hardscape, pavement, and from flowing over the tops of slopes. The surface water should be directed toward adequate drainage facilities. Ponding of surface water should not be allowed next to structures or on pavements. Design criteria for finish lot drainage away from structures and off the lot should be determined by the project Structural Engineer designing the foundations and slabs in conjunction with the project Civil Engineer designing the precise grading for lot drainage, respectively, in accordance with the 2016 CBC and/or the current City of Redlands, California codes and ordinances and the earth material types and expansion characteristics for the earth materials contained in this report. Finished landscaped and hardscape or pavement grades adjacent to the proposed structures should maintain a vertical distance below the bottom elevation of the weep screed per the 2016 CBC and/or the current City of Redlands codes and ordinances. Landscape plants with high water needs and trees should be planted at a distance away from the structure equivalent to or greater than the width of the canopy of the mature tree or 6.0 feet, whichever is greater. Downspouts from roof drains should discharge to a permanent all-weather surface which slopes away from the structure. Downspouts from roof drains should not discharge into planter areas immediately adjacent to the building unless there is positive drainage out of the planter and away from the structure in accordance with the recommendations of the project foundation and slab designer and/or the project Civil Engineer designing the precise grades for the lot drainage.

PLANTER RECOMMENDATIONS

Planters around the perimeter of the structures should be designed so that adequate drainage is maintained and minimal irrigation water is allowed to percolate into the earth materials underling the buildings. This should include enclosed or trapped planter areas that are created as a result of sidewalks. Planters with solid bottoms, independent of the underlying earth material, are recommended within a distance of 6.0 feet from the buildings. The planters should drain directly onto surrounding paved areas or into a designed subdrain system. If planters are raised above the surrounding finished grades or are placed against the building structure, the interior walls of the planter should be waterproofed.

INFILTRATION RECOMMENDATIONS

Location of Shallow Percolation Tests

The shallow percolation test boring locations were located within the proposed infiltration area, in the existing parking lot. The approximate percolation test locations are shown on the 'Exploratory Excavation Location Plan,' Plate No. 1, presented in Appendix 'A.'

Earth Material Characteristics of the Subject Site

- The earth material characteristics for the subject site are defined as moderately favorable.

- Clayey, moderately favorable soil conditions are anticipated for the infiltration system.
- There was no visible evidence of shallow groundwater or impervious bedrock materials.
- Tests performed agreed with the visual evidence.
- The existing pavement surface in the infiltration area is sloping at an approximate 3.5 percent gradient.

Number of Exploratory Borings

- Four (4) exploratory borings and two (2) shallow percolation borings were drilled in the proposed infiltration area.
- The materials underlying the subject site consisted of artificial fill over native clayey sands and gravelly clayey sands (Old Axial Valley Deposits). The earth material was generally moist and loose to medium dense in consistency. The infiltration borings were terminated at approximately 5.67 feet below existing grade, and the deepest exploratory boring was excavated to 42.0 feet.

Earth Material Profile

- The earth materials encountered in the exploratory borings in the infiltration area are described on the 'Subsurface Exploration Logs,' Plate Nos. 11 and 12, presented in Appendix 'A.'
- No low permeability layers were observed.
- The alluvial soils in the exploratory borings were classified in general accordance with the Unified Soil Classification System as SC.
- All colors described on the boring logs were moist earth material colors. There was no reduction-oxidation mottling observed in the exploratory borings.
- No roots were noted in our percolation test holes.

- There were no wet or saturated earth material encountered in the subsurface exploration borings.

- No groundwater was encountered on the site.

Percolation Testing Procedures

Test Borings:

- The exploratory borings were performed by using a truck-mounted drill rig equipped with 8-inch outside diameter, hollow stem augers. The exploratory excavations were explored to a depth 5.67 feet below the existing ground surface at the excavation locations. The bottom of the borings were in natural, undisturbed earth material.

- Slotted PVC pipe, 3.25 inches in diameter, was installed in the boring excavation through the center of the hollow stem auger prior to removing the augers. Gravel was placed around the outside of the pipe after removal of the augers from the boring.

Pre-Soak:

- Soaking Period: The test borings were pre-soaked with water beginning in the afternoon on January 4, 2018, and ending when the percolation testing began on January 5, 2018.

- Soaking Method: A 2-inch hose was used to fill the holes from a 300-gallon water tank that was carried on a pickup truck. The hose was placed into the pipe and each hole was filled to the approximate surface of the ground to a few inches below.

Percolation Measurement:

- Testing was performed on January 5, 2018.

- Each boring was filled to the approximate surface to commence the percolation testing. After setting the initial water level, the drop in the water depth was measured and recorded at 25 minute intervals. In percolation test P-2, more than half the wetted depth percolated through the test hole over two timed 25 minute intervals, and therefore the test was run for an additional one hour with a refill of the percolation hole after each 10 minute reading. Percolation test P-1 percolated for one 25 minute interval and was found to have under 6 inches of water seep away. Percolation test P-1 was then tested for a period of approximately six (6) hours with a refill and measurement after each 30 minute reading. Calculations were based on the above recorded readings at approximate 30-minute and 10-minute intervals.

Percolation Test Results

Detailed percolation test results, in general accordance with San Bernardino County Technical Guidance Document Appendices, are included in Appendix 'C' as Plate Nos. 13 and 14. Percolation Rates were converted to Infiltration Rates utilizing the Porchet Method, the average and steady state infiltration rates given in (cm/hr) are listed below:

INFILTRATION TEST RESULTS

TEST BORING NO.	BOTTOM OF TEST DEPTH (ft.)	SOIL CLASS-IFICATI-ON	AVERAGE INFILTRATION RATE (cm / hr)	STEADY STATE INFILTRATION RATE (cm/hr)
P-1	5.67	SC	2.276	2.362
P-2	5.67	SC	17.447	13.744

The earth materials within the test borings were observed to be older alluvial soils that were classified in general accordance with the Uniform Soils Classification system as SC and SC/SM. Percolation test P-1 contained silty to clayey, fine to medium sand. The clayey, fine grained nature of the deposits caused the percolation rates to be slow to moderate. Percolation test P-2 contained slightly clayey, fine to coarse grained sand, with the majority of the boring containing gravel up to 4 inches in dimension. The coarser nature and the location of the gravels (generally in the lower portion of the test boring) allowed the percolation rates to be fast to moderate. In the design phase, the slowest percolation rate should be utilized in the infiltration design. No groundwater or impermeable layers were encountered in the percolation test borings. A small amount of materials caved around the slotted pipe, particularly in test hole P-1 over the 6 hour time period, but did not appear to interfere with the percolation rates or test.

Caution should be used in determining a percolation rate for infiltration systems. Eventual siltation can drastically reduce the percolation rate over time. We recommend that suitable methods to prevent siltation be incorporated in the project design.

LIMITATIONS

REVIEW, OBSERVATION, AND TESTING

The recommendations presented in this report are contingent upon review of final plans and specifications for the project by **HGI**. The project Geotechnical / Geologic Consultant should review and verify in writing the compliance of the final grading plan and the final foundation plans with the recommendations presented in this report.

It is recommended that **HGI** be retained to provide continuous Geotechnical / Geologic Consulting services during the earthwork operations (i.e., rough grading, utility trench backfill, subgrade preparation for slabs-on-grade and pavement areas, finish grading, etc.) and foundation installation process. This is to observe compliance with the design concepts, specifications and recommendations and to allow for design changes in the event that subsurface conditions differ from those anticipated prior to start of construction. If **HGI** is replaced as Geotechnical / Geologic Consultant of record for the project, the work on the project should be stopped until the replacement Geotechnical / Geologic Consultant has reviewed the previous reports and work performed for the project, agreed in writing to accept the recommendations and prior work performed by **HGI** for the subject project, or has submitted their revised recommendations.

UNIFORMITY OF CONDITIONS

The recommendations and opinions expressed in this report reflect our understanding of the project requirements based on an evaluation of subsurface earth material conditions encountered at the subsurface exploration locations and the assumption that earth material conditions do not deviate appreciably from those encountered. It should be recognized that the performance of the foundations may be influenced by undisclosed or unforeseen variations in earth material conditions that may occur in intermediate and unexplored areas. Any unusual conditions not covered in this report that may be encountered during site development should be brought to the attention of the **HGI** so that we may make modifications, if necessary.

CHANGE IN SCOPE

HGI should be advised of any changes in the project scope of proposed site grading so that it may be determined if recommendations contained herein are valid. This should be verified in writing or modified by a written addendum.

TIME LIMITATIONS

The findings of this report are valid as of this date. Changes in the condition of a property can, however, occur with the passage of time, whether they be due to natural processes or the work of man on this or adjacent properties. In addition, changes in the State-of-the-Art and/or government codes may occur. Due to such changes, the findings of this report may be invalidated wholly or in part by changes beyond our control. Therefore, this report should not be relied upon after a period of two (2) years without a review by **HGI** verifying the validity of the conclusions and recommendations.

PROFESSIONAL STANDARD

In the performance of our professional services, we comply with the standard of care and skill ordinarily exercised under similar circumstances by members of the geologic / geotechnical professions currently practicing under similar conditions and in the same locality. The client recognizes that subsurface conditions may vary from those encountered at the locations where our surveys and exploratory excavations were made, and that our data, interpretations, and recommendations are based solely on information obtained by us. We will be responsible for those data, interpretations, and recommendations, but should not be responsible for interpretations by others of the information presented and/or developed. Our services consist of professional consultation and observation only, and other warranties, expressed or implied, are not made or intended in connection with work performed by **HGI** or by the proposal for consulting or other services or by the furnishing of oral or written reports or findings.

CLIENT'S RESPONSIBILITY

It is the responsibility of the client and/or the client's representatives to ensure that information and recommendations contained herein are brought to the attention of the Engineers and Architect for the project and incorporated into project plans and specifications. It is further their responsibility to take measures so that the contractor and his subcontractors carry out such recommendations during construction.

APPENDIX A

FIELD EXPLORATION

The field study performed for this report included a visual reconnaissance of existing surface conditions of the subject site and surrounding area. Site observations were conducted on January 4th and 5th, 2018 by a representative of **HGI**. The aerial distribution of the earth materials observed is shown on the 'Exploratory Excavation Location Plan,' Plate No. 1, presented in this Appendix.

A study of the property's subsurface condition was performed to evaluate underlying earth strata and the presence of groundwater. Four (4) exploratory borings and (2) percolation test excavations were performed on the on the subject site on January 4, 2018. Locations of the exploratory excavations were determined in the field by pacing, tape measuring, and sighting from the adjacent existing streets, adjacent structures, and topographic features as shown on the Reference No. 1, 'Site Plan,' noted on the first page of the cover letter for this. Approximate locations of the exploratory excavations are denoted on the 'Exploratory Excavation Location Plan,' Plate No. 1, presented in this Appendix. Approximate elevations at the locations of the exploratory excavations were determined from the Google Earth Website (http://www/google.com/earth). Locations and elevations of the exploratory excavations should be considered accurate only to the degree implied by the method used in determining them.

The exploratory borings were performed by using a truck-mounted drill rig equipped with 8-inch outside-diameter, hollow-stem augers. The exploratory excavations were explored to depths ranging from approximately 5.67 to 42.0 feet below existing ground surface at the excavation locations. Bulk and relatively undisturbed samples of encountered earth materials were obtained at various depths in the exploratory excavations and returned to our laboratory for testing and verification of field classifications. Bulk samples were obtained from cuttings developed during the excavation process and represent a mixture of earth materials within the depth indicated on the logs. Relatively undisturbed samples of encountered earth materials were obtained by driving a thin-walled, steel sampler lined with 1-inch high, 2.416-inch inside diameter brass rings. The sampler was driven with successive drops of a 140-pound weight having a free fall of approximately 30 inches. Blow counts for each successive 6.0 inches of penetration, or fraction thereof, are shown on the 'Subsurface Exploration Log,' Plate Nos. 3a through 6, presented in this Appendix. Ring samples were retained in close-fitting moisture-proof containers and returned to our laboratory for testing. Standard Penetration Tests were also performed at various depths in the borings. The test was performed in general accordance with current American Society of Testing Materials (ASTM) D1586 procedures using a standard penetration sampler (2.0-inch outside diameter, 1.375-inch inside diameter) driven with a 140 weight dropping 30 inches. The blow counts to drive the sampler for three (3) successive 6.0 inch intervals are recorded on the 'Subsurface Exploration Log,' Plate Nos. 3a through 6, presented in this Appendix. The standard penetration resistance ('N' value) is the sum of the blow counts for the last two (2) 6.0 inch intervals.

Groundwater observations were made during, and at the completion of the excavation process and are noted on the 'Subsurface Exploration Log' presented in this Appendix, if encountered.

The exploratory excavations were logged by a representative of **HGI** for the existing pavement section thickness, fill material, natural earth material, and subsurface conditions encountered. Earth materials encountered in the exploratory excavations were visually described in the field in general accordance with the current Unified Soils Classification System (USCS), ASTM D2488, visual-manual procedures, as illustrated on the attached, simplified 'Subsurface Exploration Legend,' Plate No. 2, presented in this Appendix. The visual textural description, color of the earth material at natural moisture content, apparent moisture condition of the earth materials, and apparent relative density or consistency of the earth materials, etc., were recorded on the field logs. The 'Relative Density' of granular soils (SP, SW, SM, SC, GP, GW, GM, GC) is given as very loose, loose, medium dense, dense, or very dense and is based on the number of blows to drive the sampler 1.0 foot or fraction thereof. The 'Consistency' of silts or clays (ML, CL, MH, CH) is given as very soft, soft, medium stiff, stiff, very stiff, or hard and is also based on the number of blows to drive the sampler 1.0 foot or fraction thereof. The field log for each excavation contains factual information and interpretation of earth material conditions between samples. The 'Subsurface Exploration Log' presented in this Appendix represent our interpretation of the field log contents and results of laboratory observations and tests performed on samples obtained in the field from the exploratory excavations.

Perforated pipe was installed in the two (2) borings in the proposed infiltration area. The pipe was installed for use in performing percolation tests in this area of the subject site. The remaining exploratory boring excavations were backfilled with excavated earth materials and with reasonable effort to restore the areas to their initial condition before leaving the site but were not compacted to a relative compaction of 90 percent or greater. In an area as small and deep as a boring excavation, consolidation and subsidence of backfill earth material may result in time, causing a depression of the excavation areas. The client is advised to observe exploratory excavation areas periodically and, when needed, backfill noted depressions.

Percolation tests were performed in the infiltration area in general accordance with **County of San Bernardino**, May 19, 2011, *Technical Guidance Document Appendices, Appendix VII., Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations.*

LABORATORY TESTING PROGRAM

Laboratory tests were performed on selected, relatively undisturbed ring and bulk samples obtained from exploratory excavations during the field study. Tests were performed in general accordance with generally accepted American Society for Testing and Materials (ASTM), State of California - Department of Transportation (CALTRANS), Environmental Protection Agency (EPA) or other suitable test methods or procedures. The remaining samples obtained during the field study will be discarded 30 days after the date of this report. This office should be notified immediately if retention of samples will be needed beyond 30 days. A brief description of the tests performed is presented below:

CLASSIFICATION

The field classification of earth material materials encountered in the exploratory excavations was verified in the laboratory in general accordance with the current Unified Soils Classification System, ASTM D2488, 'Standard Practice for Determination and Identification of Soils (Visual-Manual Procedures).' The final classification is shown on the 'Subsurface Exploration Log,' Plate Nos. 3a through 6, presented in this Appendix.

IN-SITU MOISTURE CONTENT AND DRY DENSITY

The in-situ moisture content and dry density were determined in general accordance with current ASTM D2216 (Moisture Content) and D2937 (Drive Cylinder) procedures, respectively, for selected undisturbed samples obtained. This information was an aid to classification and permitted recognition of variations in material consistency with depth. The dry density is determined in pounds per cubic foot and the moisture content is determined as a percentage of the oven dry weight of the earth material. Test results are shown on the 'Subsurface Exploration Log,' Plate Nos. 3a through 6, presented in this Appendix.

EXPANSION TEST

A laboratory expansion test was performed on a selected sample of near-surface earth material in general accordance with the current ASTM D4829 procedures. In this testing procedure, a remolded sample is compacted in two (2) layers in a 4-inch inside diameter mold to a total compacted thickness of approximately 1.0 inch by using a 5.5-pound weight dropping 12 inches and with 15 blows per layer. The sample should be compacted at a saturation between 48 and 52 percent. After remolding, the sample is confined under a pressure of 144 pounds per square foot (psf) and allowed to soak for 24 hours. The resulting volume change due to the increase in moisture content within the sample is recorded and the Expansion Index (EI) calculated. The test results are summarized in the 'Summary of Laboratory Test Results,' Plate No. 7, presented in this Appendix.

SOLUBLE SULFATE TEST

The concentration of soluble sulfate was determined on a selected sample of near-surface earth material in general accordance with current EPA 300.0 procedures. The test results are summarized in the 'Summary of Laboratory Test Results,' Plate No. 7, presented in this Appendix.

SIEVE ANALYSIS

The percent by weight finer than a No. 200 sieve (silt and clay content) was determined for a selected sample of earth material in general accordance with current ASTM D1140 procedures. The test is performed by taking a known weight of an oven dry sample of earth material, washing it over a No. 200 sieve, and oven drying the earth material retained on the No. 200 sieve. The dry weight of earth material retained on the No. 200 sieve is measured and the resulting percentage retained is calculated based on the original total dry earth material sample weight. The percent passing the No. 200 sieve is determined by subtracting the percent retained from 100. The test results are summarized in the 'Summary of Laboratory Test Results,' Plate No. 7, presented in this Appendix.

CHEMICAL AND MINIMUM ELECTRICAL RESISTIVITY

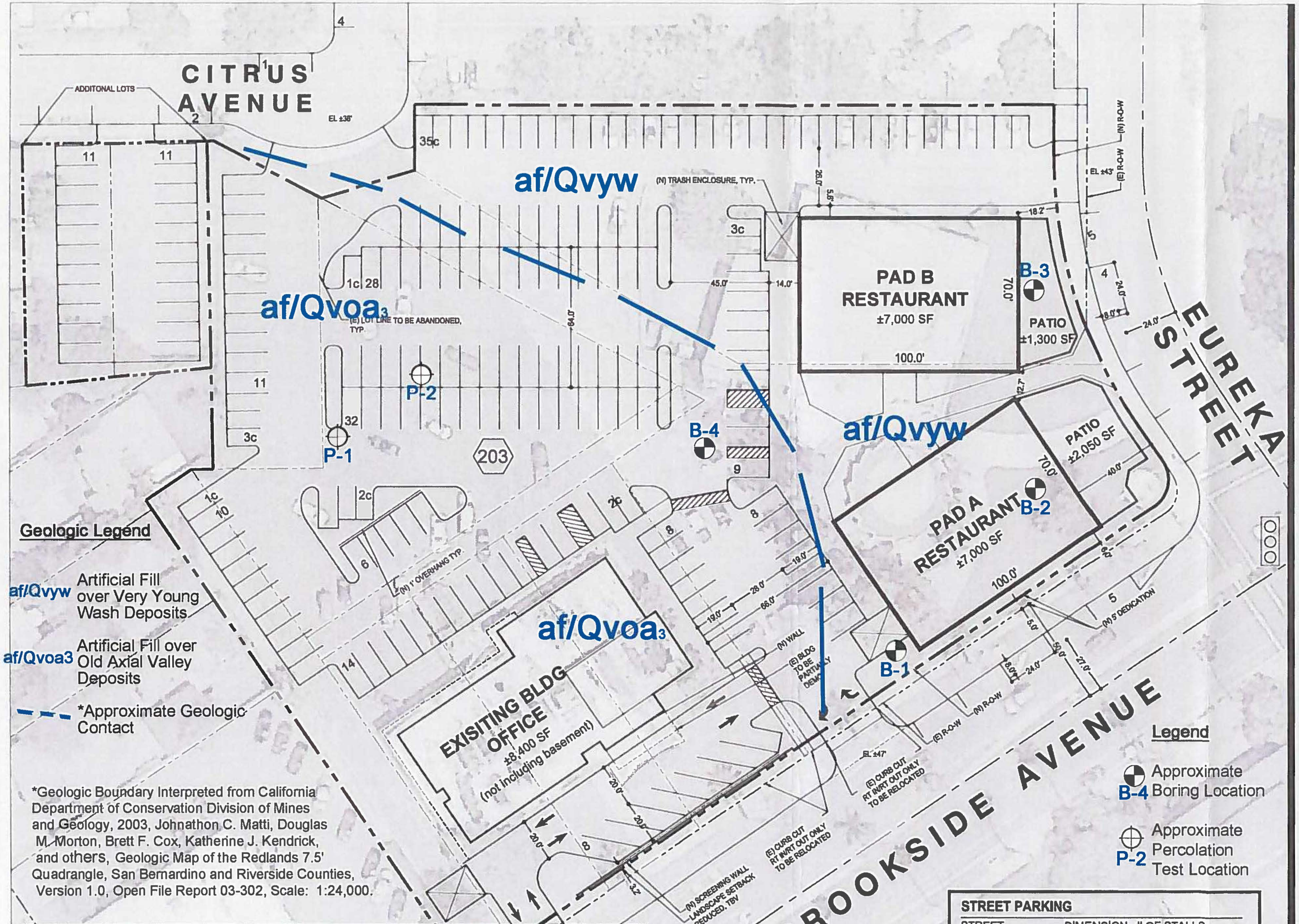
The concentration of soluble chloride, pH, as well as other chemical constituents and the minimum electrical resistivity were determined for a selected sample of near-surface earth material. The pH test was performed in general accordance with current EPA 9045C procedures. The Chloride test was performed in general accordance with current EPA 300.0 procedures. The test results are summarized in the 'Summary of Laboratory Test Results,' Plate No. 8, presented in this Appendix.

CONSOLIDATION TESTS

Hydroconsolidation or the Collapse Potential, I_C, of the on-site earth material behavior under load were made on the basis of consolidation tests that were performed on selected relatively undisturbed ring samples of the alluvial soils in general accordance with current ASTM D5333 procedures. The consolidation apparatus is designed to receive a 1-inch high, 2.416-inch diameter ring sample. Porous stones are placed in contact with the top and bottom of each specimen to permit addition and release of pore water. A load of 1,600 pounds per square foot (psf) was applied normal to the face of the specimen at field moisture condition and the sample was allowed to consolidate. Upon completion of the consolidation process, water was added to the test apparatus to create a submerged condition and to measure the collapse (hydroconsolidation) or expansion potential of the sample. The resulting change in sample thickness was recorded. The test results are summarized in the 'Summary of Laboratory Test Results,' Plate No. 8, presented in this Appendix.

MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT RELATIONSHIP TEST

A maximum dry density / optimum moisture content relationship determination was performed on a sample of near-surface earth material in general accordance with current ASTM D1557 procedures using a 4-inch diameter mold. Samples were prepared at various moisture contents and compacted in five (5) layers using a 10-pound weight dropping 18 inches and with 25 blows per layer. A plot of the compacted dry density versus the moisture content of the specimens was constructed and the maximum dry density and optimum moisture content determined from the plot. The test results are summarized in the 'Maximum Dry Density / Optimum Moisture Content Relationship Test Results,' Plate No. 9, presented in this Appendix.



*Geologic Boundary Interpreted from California Department of Conservation Division of Mines and Geology, 2003, Johnathon C. Matti, Douglas M. Morton, Brett F. Cox, Katherine J. Kendrick, and others, Geologic Map of the Redlands 7.5' Quadrangle, San Bernardino and Riverside Counties, Version 1.0, Open File Report 03-302, Scale: 1:24,000.

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Exploratory Excavation & Percolation Test Location Plan

By: AH	Date: 02/2018
Project No.: 1151-A17.1	Plate No.: 1

STREET PARKING

STREET	DIMENSION	# OF STALLS
EUREKA ST	8' X 24'	± 5
BROOKSIDE AVE	8' X 24'	± 5
CITRUS AVE	8' X 24'	± 6
TOTAL		±16

GreenbergFarrow

19000 MacArthur Blvd, Suite 250
Irvine, CA 92612
t: 949 296 0450 f: 949 296 0479

PROJECT INFORMATION

VICINITY MAP

SITE AREA

NET SITE AREA	±2.75 AC
ADDITIONAL LOTS	±0.21 AC
STREET DEDICATIONS	±0.07 AC
GROSS SITE AREA	±3.03 AC

BUILDING AREA

PAD A	±7,000 SF
PAD B	±7,000 SF
EXISTING BLDG* (not incl basement)	±8,000 SF
TOTAL BLDG AREA	±22,000 SF
SITE COVERAGE	±16.7% (±6,145 SF/AC)

* EXISTING BLDG AREA IS ±8,400 SF NOT INCLUDING BASEMENT. PROPOSING PARTIALLY DEMO.

PARKING SUMMARY

USER	RATIO REQUIRED	SPACES REQ'D	SPACES PROV'D
PAD A - RESTAURANT	**	78	
PAD A - RESTAURANT	**	78	
EX. BLDG - MEDICAL OFFICE	1 SP/ 200 SF	40	
STANDARD			148
COMPACT	25% ALLOWED	(±23.15 %)	47
HANDICAPPED			8
TOTAL		196	203
TOTAL RATIO PROVIDED			9.23 SP/1000 SF
STREET PARKING AVAILABLE			±16 STALLS

** PARKING REQUIRED FOR SIT DOWN RESTAURANTS BASED ON 1 SP/3 SEATS OR 1 SP/50 SF OF SERVING AREA WHICHEVER IS LARGER PLUS 1 SP/2 EMPLOYEES. SERVING AREA SSUMED 50% OF BLDG AREA.

ZONING INFORMATION

JURISDICTION	CITY OF REDLANDS, CA
EXISTING ZONING:	A-P DISTRICT - ADMINISTRATIVE & PROFESSIONAL OFFICE DISTRICT W/CIVIC DESIGN DISTRICT OVERLAY
PROPOSED ZONING:	C-3 - GENERAL COMMERCIAL

PROJECT NOTES

1. THIS PLAN IS BASED ON A PDF OF THE ASSESSOR'S PARCEL MAP AND AN AERIAL.
2. THIS PLAN IS A CONCEPTUAL SITE PLAN IS FOR PLANNING PURPOSES ONLY.

DRAWING ISSUE/REVISION RECORD

DATE	NARRATIVE	INITIALS
01.29.2016	PREPARING SP-1	II
02.19.2016	PREPARING SP-2	MM
12.08.2016	PREPARING SP-3	II
12.11.2016	PREPARING SP-4	II
02.21.2017	PREPARING SP-4 PARKING STUOY	II/KQ
03.06.2017	PREP SP-5	II

CLIENT	VANTAGE ONE
CLIENT REPRESENTATIVE	TOM ROBINSON
PROJECT MANAGER/DESIGNER	II
SITE DEV. COORDINATOR	FRANK CODA

REDLANDS, CA
NWC BROOKSIDE AVE &
EUREKA ST

GFA PROJECT NUMBER	20160103.0

SCALE: 1"=20'-0"
0 10 20 40 60 80

SP-5

SUBSURFACE EXPLORATION LEGEND

UNIFIED SOIL CLASSIFICATION SYSTEM
Visual-Manual Procedure (ASTM D2488-09a)

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
Coarse-Grained Soils* More than 50 % Retained on No. 200 Sieve	Gravels 50 % or more of Coarse Fraction Retained on No. 4 Sieve	Clean Gravels	GW	Well Graded Gravels and Gravel-Sand Mixtures, Little or no Fines
			GP	Poorly Graded Gravels and Gravel-Sand Mixtures, Little or no Fines
		Gravels with Fines	GM	Silty Gravels, Gravel-Sand-Silt Mixtures**
			GC	Clayey Gravel, Gravel-Sand-Clay Mixtures**
	Sands More than 50 % of Coarse Fraction Passes No. 4 Sieve	Clean Sands	SW	Well Graded Sands and Gravely Sands, Little or no Fines
			SP	Poorly Graded Sands and Gravelly Sands, Little or no Fines
		Sands with Fines	SM	Silty Sands, Sand-Silt Mixtures**
			SC	Clayey Sands, Sand-Clay Mixtures**
Fine Grained Soils* 50 % or more Passes No. 200 Sieve	Silts and Clays Liquid Limits 50 % or less		ML	Inorganic Silts, Sandy Silts, Rock Flour
			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 Limits Greater than 50 %		MH	Inorganic Silts, Micaceous or Diatomaceous silts, Plastic Silts
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Clays of Medium to High Plasticity
Highly Organic Soils			PT	Peat, Muck, or Other Highly Organic Soils

CONSISTENCY / RELATIVE DENSITY

CRITERIA

Reference: 'Foundation Engineering', Peck, Hansen, Thornburn, 2nd Edition.

Standard Penetration Test
Granular Soils

Penetration Resistance, N, (Blows / Foot)	Relative Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
> 50	Very Dense

Standard Penetration Test
Cohesive Soils

Penetration Resistance, N, (Blows / Foot)	Consistency	Unconfined Compressive Strength, (Tons / Sq. Ft.)
< 2	Very Soft	< 0.25
2 - 4	Soft	0.25 - 0.5
5 - 8	Firm (Medium Stiff)	0.5 - 1.0
9 - 15	Stiff	1.0 - 2.0
16 - 30	Very Stiff	2.0 - 4.0
> 31	Hard	> 4.0

* Based on material passing the 3-inch sieve.

** More than 12% passing the No. 200 sieve; 5% to 12% passing No. 200 sieve requires use of duel symbols (i.e., SP-SM., GP-GM, SP-SC, GP-GC, etc.); Border line classifications are designated as CH/Cl, GM/SM, SP/SW, etc.

U.S. Standard Sieve Size 12" 3" 3/4" #4 #10 #40 #200

Unified Soil Classification Designation	Boulders	Cobbles	Gravel		Sand			Silt and Clay
			Coarse	Fine	Coarse	Medium	Fine	

Moisture Condition

Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp but no visible moisture.
Wet	Visible free water, usually below the water table.

Material Quantity

Trace	< 5 %
Few	5 - 10%
Little	15 - 25%
Some	30 - 45 %

Other Symbols

C - Core Sample
S - SPT Sample
B - Bulk Sample
CK - Chunk Sample
R - Ring Sample
N - Nuclear Gauge Test
∇ - Water Table

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SUBSURFACE EXPLORATION LOG
BORING NO. B-1

Project Name: Proposed Restaurant Pads and Building Renovation, 216 Brookside Avenue, Redlands, CA

Project No.	1151-A17.1	Date:	1/4/2018	Logged By:	AH
Type of Rig:	Hollow-Stem Auger	Drive Wt.:	140 lb	Elevation:	± 1346
Drill Hole Dia.:	8 in.	Drop:	30 in.	Depth of Boring (ft.):	42.0

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
1 2	R	21 37 38	SC	113.8	4.6	af		ARTIFICIAL FILL: Clayey fine to caorse sand, trace gravel, slightly porous; Red brown; Moist; Very dense.
3 4	S	6 6 9	SC					Clayey fine to medium sand trace coarse, trace silt, trace fine rootlets; Red brown; Moist; Medium dense.
5 6 7	R	12 19 19	SC	114.0	3.9			Clayey fine to coarse sand, trace silt, trace metal fragments; Red brown; Moist; Medium dense.
8 9	S	1 3 3	SM			Qvyw		VERY YOUNG WASH DEPOSITS: Silty fine sand, trace medium sand; Pale brown; Moist; Loose to medium dense.
10 11 12	R	4 8 9		115.0	5.4			Trace clay, slighty porous.
13 14	S	11 14 13	SM					Gravelly to silty fine to coarse sand; Gray brown; Moist; Medium dense. 3 fragments of rock larger than sampler.
15 16 17 18 19	R	14 11 12	SP/SM	105.7	3.7			Slightly silty fine to medium sand, trace coarse sand; Gray brown; Moist; Medium dense.
20 21 22	S	9 11 12						
23 24 25			SP					Gravelly fine to coarse sand, trace cobbles on flights; Gray brown; Moist; Dense.

S - SPT Sample R - Ring Sample B - Bulk Sample N - Nuclear Gauge Test D - Disturbed Sample

N.R. - No Recovery

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SUBSURFACE EXPLORATION LOG
BORING NO. B-1

Project Name: Proposed Restaurant Pads and Building Renovation, 216 Brookside Avenue, Redlands, CA

Project No.	1151-A17.1	Date:	1/4/2018	Logged By:	AH
Type of Rig:	Hollow-Stem Auger	Drive Wt.:	140 lb	Elevation:	± 1346
Drill Hole Dia.:	8 in.	Drop:	30 in.	Depth of Boring (ft.):	42.0

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SP			Qvyw		VERY YOUNG WASH DEPOSITS: Gravelly fine to coarse sand, trace cobbles on flights; Gray brown; Moist; Dense. Cobble encountered inside augers. No sample taken.
26								
27								
28			SP/SM					Slightly silty, fine to coarse sand, trace gravel; Gray orange brown; Moist; Dense to very dense.
29								
30	R	18 24 26						
31								
32								
33								
34								
35	R	50						
36								
37								
38								
39								
40	R	36 50/2"						
41								
42								Bottom of boring 42.0 feet due to refusal on cobbles. No groundwater encountered. Boring was backfilled with excavated materials.
43								
44								
45								
46								
47								
48								
49								
50								

S - SPT Sample R - Ring Sample B - Bulk Sample N - Nuclear Gauge Test D - Disturbed Sample

N.R. - No Recovery

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INCORPORATED

SUBSURFACE EXPLORATION LOG
BORING NO. B-2

Project Name: Proposed Restaurant Pads and Building Renovation, 216 Brookside Avenue, Redlands, CA

Project No.	1151-A17.1	Date:	1/4/2018	Logged By:	AH
Type of Rig:	Hollow-Stem Auger	Drive Wt.:	140 lb	Elevation:	± 1343
Drill Hole Dia.:	8 in.	Drop:	30 in.	Depth of Boring (ft.):	21.5

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
	S/B	9	SC			af		ARTIFICIAL FILL: Clayey fine to coarse sand; Red brown; Moist; Medium dense.
1		11 10						
2								
3	R	11 13						
4		13		101.8	14.8			
5	S	3	SM					Silty fine to medium sand, trace coarse sand; trace clay brick in sample; Dark red brown; Moist; Loose.
6		3 2						
7			SC			Qvyw		VERY YOUNG WASH DEPOSITS: Clayey fine to medium sand, a little silt; Red brown; Moist; Loose to medium dense.
8	R	3 3						
9		3		108.9	8.6			
10	S	4						
11		8 8						
12								
13			SM					Silty fine to medium sand, trace coarse sand, trace clay; Red brown; Moist; Medium dense.
14								
15	S	7						
16		10 13						
17								
18								
19			SP/SM					Slightly silty fine to coarse sand, trace gravel; Light reddish gray brown; Moist; Dense.
20	R	18						
21		24 25		115.3	4.2			
22								Bottom of boring 21.5 feet. No groundwater encountered. Boring backfilled with excavated materials.
23								
24								
25								

S - SPT Sample   R - Ring Sample   B - Bulk Sample   N - Nuclear Gauge Test   D - Disturbed Sample

N.R. - No Recovery

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SUBSURFACE EXPLORATION LOG
BORING NO. B-3

Project Name:	Proposed Restaurant Pads and Building Renovation, 216 Brookside Avenue, Redlands, CA				
Project No.	1151-A17.1	Date:	1/4/2018	Logged By:	AH
Type of Rig:	Hollow-Stem Auger	Drive Wt.:	140 lb	Elevation:	± 1342
Drill Hole Dia.:	8 in.	Drop:	30 in.	Depth of Boring (ft.):	26.5

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
	R	8	SM			af		ARTIFICIAL FILL: Silty fine to coarse sand, trace gravel; Brown; Moist; Medium dense.
1		17 17		122.8	3.7			
2			SC					Clayey fine to coarse sand, trace silt; Red brown; Moist; Medium dense.
3	S	5 13 13						
4								
5			SP/SM			Qvyw		VERY YOUNG WASH DEPOSITS: Slighty silty fine to medium sand; Dark brown; Moist; Medium dense.
6	R	9 11 12		114.6	3.8			
7			SP/SM					Slightly silty fine sand, trace medium sand; Gray brown; Moist; Loose.
8	S	4 5 5						
9								
10	R	15 22 25	SP	127.4	2.7			Fine to coarse sand, a little gravel, trace silt; Gray brown; Moist; Dense to medium dense.
11								
12								
13	S	8 5 5						
14								
15	R	4 8 9						
16								
17								
18								
19								
20	S	12 19 14						
21								
22								
23			SC					Clayey fine to coarse sand, trace gravel; Red brown; Moist; Dense.
24								
25								

S - SPT Sample R - Ring Sample B - Bulk Sample N - Nuclear Gauge Test D - Disturbed Sample

N.R. - No Recovery

Plate No. 5a

SUBSURFACE EXPLORATION LOG
BORING NO. B-3

Project Name:	Proposed Restaurant Pads and Building Renovation, 216 Brookside Avenue, Redlands, CA				
Project No.	1151-A17.1	Date:	1/4/2018	Logged By:	AH
Type of Rig:	Hollow-Stem Auger	Drive Wt.:	140 lb	Elevation:	± 1342
Drill Hole Dia.:	8 in.	Drop:	30 in.	Depth of Boring (ft.):	26.5

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
26	R	10 19 37	SC			Qvyw		VERY YOUNG WASH DEPOSITS: Clayey fine to coarse sand, trace gravel; Red brown; Moist; Dense.
27								Bottom of boring 26.5 feet. No groundwater encountered. Boring was backfilled with excavated materials.
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								

S - SPT Sample R - Ring Sample B - Bulk Sample N - Nuclear Gauge Test D - Disturbed Sample

N.R. - No Recovery

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SUBSURFACE EXPLORATION LOG
BORING NO. B-4

Project Name:	Proposed Restaurant Pads and Building Renovation, 216 Brookside Avenue, Redlands, CA				
Project No.	1151-A17.1	Date:	1/4/2018	Logged By:	AH
Type of Rig:	Hollow-Stem Auger	Drive Wt.:	140 lb	Elevation:	± 1344
Drill Hole Dia.:	8 in.	Drop:	30 in.	Depth of Boring (ft.):	21.5

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SM			af		3" Inches Hot Mix Asphalt (HMA) / 0 Base ARTIFICIAL FILL: Silty fine to medium sand, trace clay; Red brown; Moist; Very loose to loose.
1	R	2						
		1						
2								
		1						
3	R	2						
		2						
4		2		102.8	10.5			
5								
	S	2						
6		2						
		3						
7			SC			Qvoa3		VERY OLD AXIAL VALLEY DEPOSITS: Clayey fine to coarse sand; Red brown; Moist; Medium dense.
8	R	5						
		6						
9		10		116.0	9.5			
10								
	S	7						
11		8						
		7						
12			SP/SM					Slightly silty fine to medium sand, trace coarse sand; Gray red brown; Moist; Medium dense.
13	R	6						
		7						
14		7		113.9	5.5			
15								
	S	10						
16		17						
		12						
17								
18								
19			SP/SM					Slightly silty fine to coarse sand, trace gravel; Light reddish gray brown; Moist; Dense.
20								
	R	12						
21		11						
		12	SM					Silty fine sand, trace clay; Red brown; Moist; Medium dense.
22								Bottom of boring 21.5 feet. No groundwater encountered. Boring backfilled with excavated materials.
23								
24								
25								

S - SPT Sample R - Ring Sample B - Bulk Sample N - Nuclear Gauge Test D - Disturbed Sample

N.R. - No Recovery

SUMMARY OF LABORATORY TEST RESULTS

EXPANSION INDEX TEST RESULTS (ASTM D4829 Test Method)

SAMPLE NO.	MOISTURE CONTENT PRIOR TO TEST (to 0.1%)	DRY DENSITY PRIOR TO TEST (to 0.1 pcf)	SATURATION PRIOR TO TEST (to 0.1% between 48% & 52%)*	MOISTURE CONTENT AFTER TEST (to 0.1%)	EXPANSION INDEX	EXPANSION POTENTIAL**
B-2, 0-4.0'	7.4	119.7	49.0	13.0	5	Non-Expansive

* Assumes a 2.70 Specific Gravity for the earth material.

** As defined in Section 1803.5.3, 'Expansive Soil,' in the 2016 California Building Code (CBC) (i.e., Non-Expansive: EI ≤20; Expansive: EI >20).

SOLUBLE SULFATE TEST RESULTS (EPA 300.0 Test Procedure)*

SAMPLE	SOLUBLE SULFATE CONTENT (%)	CLASS**
B-2, 0-4.0'	<0.0021	S0

* Test performed by **A & R Laboratories**.

** Per Table 19.3.1.1, 'Exposure Categories and Classes,' in **American Concrete Institute** (ACI) 318-14.

PERCENT PASSING #200 SIEVE TEST RESULTS (ASTM D1140 Test Method)

SAMPLE	EARTH MATERIAL DESCRIPTION	PERCENT PASSING #200 SIEVE
B-2, 0-4.0'	Clayey, fine to coarse sand; Red brown (SC)	29.7

SUMMARY OF LABORATORY TEST RESULTS

CHEMICAL / MINIMUM ELECTRICAL RESISTIVITY TEST RESULTS

SAMPLE	RESISTIVITY Minimum (ohm-cm)	pH*	SULFIDE	CHLORIDE (ppm)*
B-2, 0-4.0'	5,561	8.21	Neg.**	23

* Test performed by **A & R Laboratories** in accordance with EPA 300.0 procedures.

** Neg. - Negative.

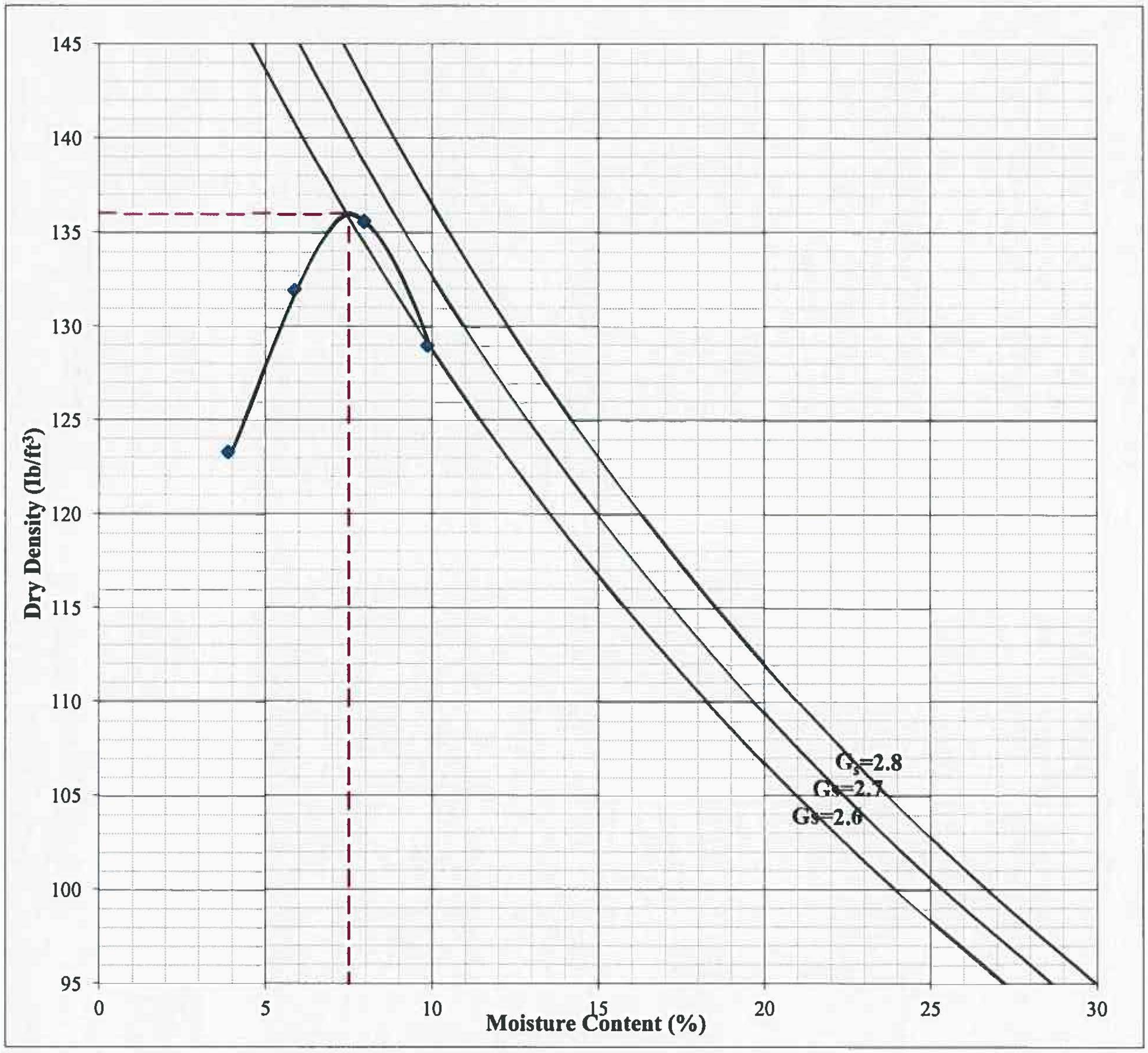
COLLAPSE POTENTIAL TEST RESULTS (ASTM D5333 Test Method)

SAMPLE	SETTLEMENT AT 1,600 PSF LOAD (%)	COLLAPSE / SWELL* (%)	COLLAPSE INDEX, (I_C), (%)	DEGREE OF COLLAPSE**
B-1, 10.0'	1.1	7.0	7.0	Moderately Severe
B-1, 10.0'	1.1	8.1	8.1	Moderately Severe
B-2, 2.5'	1.0	0.7	0.7	Slight

* Percent collapse (-) or swell (+) measured when water added at 1,600 psf load during test procedure.

** Per Table 1, 'Classification of Collapse Index, I_C,' in ASTM Standard Test Method D5333-03.

None - 0%
Slight - 0.1 - 2.0%
Moderate - 2.1 - 6.0%
Moderately Severe - 6.1 - 10.0%
Severe - >10.0%



Maximum Dry Density (lb/ft^3)	136.0
Optimum Moisture Content (%)	7.5
Procedure	B

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MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT RELATIONSHIP TEST RESULTS
(ASTM D1557 Test Method)

SAMPLE: B-2, 0-4.0'

SOIL DESCRIPTION:	Clayey, fine to coarse sand; Red brown (SC)

BY:	SS	DATE:	2/2018
JOB NO.:	1151-A17.1	PLATE NO.:	9

APPENDIX B

TECHNICAL REFERENCES

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APPENDIX C

HILLTOP GEOTECHNICAL
INCORPORATED

PERCOLATION SUBSURFACE EXPLORATION LOG
PERCOLATION NO. P-1

Project Name: Proposed Restaurant Pads and Building Renovation, 216 Brookside Avenue, Redlands, CA
Project No. 1151-A17.1 Date: 1/4/2018 Logged By: AH
Type of Rig: Hollow-Stem Auger Drive Wt.: 140 lb Elevation: ± 1338
Drill Hole Dia.: 8 in. Drop: 30 in. Depth of Boring (ft.): 5.7

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
1			SC			af		2.0 inches Hot Mix Asphalt (HMA) / 0 Base Clayey fine to medium sand, trace coarse sand; Red brown; Moist.
2 3 4 5			SC/SM			Qvoa3		OLD AXIAL VALLEY DEPOSITS: Slightly silty to clayey, fine to medium sand; Red brown; Moist.
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25								Bottom of boring at 5.7 feet. No groundwater encountered. Boring converted to percolation test, and backfilled with excavated material after testing.

S - SPT Sample R - Ring Sample B - Bulk Sample N - Nuclear Gauge Test D - Disturbed Sample

N.R. - No Recovery

Plate No. 10

Hilltop Geotechnical Incorporated

PERCOLATION SUBSURFACE EXPLORATION LOG
PERCOLATION NO. P-2

Project Name: Proposed Restaurant Pads and Building Renovation, 216 Brookside Avenue, Redlands, CA

Project No.	1151-A17.1	Date:	1/4/2018	Logged By:	AH
Type of Rig:	Hollow-Stem Auger	Drive Wt.:	140 lb	Elevation:	± 1339
Drill Hole Dia.:	8 in.	Drop:	30 in.	Depth of Boring (ft.):	5.7

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
1			SC			af		1.75 inches Hot Mix Asphalt (HMA), No base Clayey fine to medium sand, trace coarse sand; Red brown; Moist.
2 3 4 5			SC			Qvoa3		OLD AXIAL VALLEY DEPOSITS: Gravelly, fine to coarse sand; Red brown; Moist. Largest gravel sized 4".
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25								Bottom of boring at 5.7 feet. No groundwater encountered. Boring converted to percolation test, and backfilled with excavated material after testing.

S - SPT Sample R - Ring Sample B - Bulk Sample N - Nuclear Gauge Test D - Disturbed Sample

N.R. - No Recovery

Plate No. 11

HILLTOP GEOTECHNICAL
INCORPORATED

SHALLOW PERCOLATION DATA SHEET

Project Name: Proposed Restaurants and Building Renovations, Redlands
Test Hole Number: P-1
Depth of Boring in feet: 5.67
Diameter of Boring in inches: 0.67

Project Number: 1151-A17.1
Date Tested: 1/5/18
Tested By: AH
Hours Presaturation 16

Depth of Bottom (ft)	Time Initial	Time Final	Time Interval (minutes)	Depth of Water - Initial (ft)	Depth of Water - Final (ft)	Change in Water Level (ft)	$H_{average}$ (ft)	Rate, It (In/Hr)	Rate, It (Cm/Hr)
5.67	10:17	10:42	25.0	0.166	0.604	0.438	5.285	0.752	1.910
4.67	10:42	11:12	30.0	0.000	0.479	0.479	4.431	0.808	2.053
4.63	11:12	11:42	30.0	0.250	0.521	0.271	4.240	0.476	1.210
4.56	11:42	12:12	30.0	0.292	0.563	0.271	4.133	0.488	1.239
4.54	12:12	12:42	30.0	0.250	0.917	0.667	3.957	1.250	3.174
4.38	12:42	13:12	30.0	0.396	1.000	0.604	3.677	1.210	3.074
4.29	13:12	13:42	30.0	0.396	0.875	0.479	3.655	0.965	2.452
4.16	13:42	14:12	30.0	0.333	0.792	0.459	3.598	0.938	2.384
4.16	14:12	14:42	30.0	0.354	0.771	0.417	3.598	0.853	2.165
4.00	14:42	15:12	30.0	0.250	0.708	0.458	3.521	0.955	2.426
3.90	15:12	15:42	30.0	0.354	0.771	0.417	3.338	0.913	2.319
3.83	15:42	16:12	30.0	0.250	0.708	0.458	3.351	0.999	2.537

Average Steady State Rate (In/Hr): **0.930**
Average Steady State Rate (Cm/Hr): **2.362**
Average Rate (In/Hr): **0.896**
Average Rate (Cm/Hr): **2.276**

HILLTOP GEOTECHNICAL INCORPORATED

SHALLOW PERCOLATION DATA SHEET

Project Name:	Proposed Restaurants and Building Renovations, Redlands	Project Number:	1151-A17.1
Test Hole Number:	P-2	Date Tested:	1/5/18
Depth of Boring in feet:	5.67	Tested By:	AH
Diameter of Boring in inches:	0.67	Hours Presaturation	16

Depth of Bottom (ft)	Time Initial	Time Final	Time Interval (minutes)	Depth of Water - Initial (ft)	Depth of Water - Final (ft)	Change in Water Level (ft)	$H_{average}$ (ft)	Rate, It (In/Hr)	Rate, It (Cm/Hr)
5.58	10:21	10:46	25.0	0.250	4.458	4.208	3.226	11.401	28.958
5.58	10:46	11:11	25.0	0.146	3.040	2.894	3.987	6.460	16.409
4.38	11:11	11:21	10.0	0.229	1.875	1.646	3.323	10.853	27.567
4.38	11:22	11:32	10.0	0.313	1.646	1.333	3.396	8.619	21.891
4.33	11:32	11:42	10.0	0.208	1.333	1.125	3.560	6.968	17.697
4.33	11:42	11:52	10.0	0.188	1.188	1.000	3.642	6.065	15.405
4.29	11:52	12:02	10.0	0.167	1.125	0.958	3.644	5.807	14.750
4.29	12:02	12:12	10.0	0.188	1.021	0.833	3.686	4.997	12.693
4.27	12:12	12:22	10.0	0.208	1.000	0.792	3.666	4.775	12.127

Average Steady State Rate (In/Hr): **5.411**

Average Steady State Rate (Cm/Hr): **13.744**

Average Rate (In/Hr): **6.869**

Average Rate (Cm/Hr): **17.447**

Plate No. 13