Preliminary

Water Quality Management Plan

For:

Proposed Manufacturing / Warehousing Facility

County of San Bernardino

APN 0298-063-07

Prepared for:

800 Opal, LLC

Attn: Charles Walden

2618 San Miguel #487

Newport Beach, CA 92660

(909) 553-0970

Prepared by:

Thatcher Engineering and Assoicates, Inc.

1461 Ford Street, Suite 105

Redlands, CA 92373

(909) 748-7777

Approval Date:_____

Prepared: August 21, 2017

P201700298

LAND DEVELOPMENT DIVISION COMPLETED
BY BAD P. DATE 9-11-17
REPORT APPROVAL/ADDITIONAL REVIEW
YES ☒ NO ☐ YES ☐ NO ☒

Project Owner's Certification

This Water Quality Management Plan (WQMP) has been prepared for the proposed manufacturing / warehousing facility by Thatcher Engineering and Associates, Inc.. The WQMP is intended to comply with the requirements of the Santa Ana Regional Water Quality Control Board 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):		Grading Permit Number(s):	N/A
Tract/Parcel Map Number(s):	APN 0298-063-07	Building Permit Number(s):	N/A
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN 0298-063-07

Owner's Signature			
Owner Name: Charles Walden			
Title			
Company	800 Opal LLC		
Address	2618 San Miguel #487		
Email	charlesfwalden@gmail.com		
Telephone #	(909) 553-0970		
Signature		Date	

Preparer's Certification

Project Data			
Permit/Application Number(s):		Grading Permit Number(s):	N/A
Tract/Parcel Map Number(s):	APN 0298-063-07	Building Permit Number(s):	N/A
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN 0298-063-07

"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: Patrick C. Flanagan Jr.		PE Stamp Below
Title	Registered Professional Engineer	
Company	Thatcher Engineering and Associates, Inc.	
Address	1461 Ford Street, Suite 105, Redlands, CA 92373	
Email	patrickf@thatcherengineering.com	
Telephone #	(909) 748-7777	
Signature		
Date		

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Section 1 Discretionary Permit(s)

Form 1-1 Project Information					
Project Name	Proposed Manufacturing / Warehousing Facility				
Project Owner Contact Name:	800 Opal, LLC, Attn: Charles Walden				
Mailing Address:	2618 San Miguel #487	E-mail Address:	charlesfwalden@gmail.com	Telephone:	(909) 553-0970
Permit/Application Number(s):		Tract/Parcel Map Number(s):	APN 0298-063-07		
Additional Information/ Comments:					
Description of Project:	The project site is approximately 35 acres in size located along the west side of Opal Avenue between Nice Avenue, to the north, and Colton Avenue, to the south in the Mentone area of San Bernardino County. Proposed redevelopment of the site includes grading the easterly undeveloped portion of the site to have a uniform grade from east to west. Proposed permeable, dust-proof, gravel surface will be placed in this area for use as outdoor storage. The two existing buildings onsite will remain. In addition, the existing canopy in the proposed outdoor storage area will be removed. Minor pavement removals, replacements and additions within the existing parking lot along the west portion of the site will occur to provide for ADA access which is considered routine maintenance, and, is therefore not required or proposed to receive water quality treatment. A block wall for screening and landscape buffer is proposed on the north and south perimeter of the project site. Though the net area of the project site is approximately 35 acres, this Water Quality Management Plan only addresses treatment of the dustproof material, as the proposed redevelopment results in an increase of less than 50% of the impervious surfaces currently onsite. The dustproof material is proposed to be self treating as a hydrologic source control BMP. Any uninfiltrated flows will continue west to Opal as they do historically.				

Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	Not applicable at this time.

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):	1,532,208 SF Net; 819,341 new dustproof material	3 Number of Dwelling Units:	0	4 SIC Code:	4225

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 Owner is responsible for development of a report to the County on an annual basis. The Owner will complete a walk of the development and inspect the BMPs outlined in this WQMP. The Owner will report on the capacity and repair of facilities. Records shall be transmitted to the County for their use and keeping. These records must be kept on file by the Owner for at least 5 years from the date generated.

Project Owner:

800 Opal LLC

Attn: Charles Walden

2618 San Miguel #487

Newport Beach, CA 92660

(909) 553-0970

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 ☐	(Generated from landscape areas) Santa Ana River Reach 4 (Non-Point Source), Santa Ana River Reach 3 (Dairies), Santa Ana River Reach 2 (Non-Point Source)
Phosphorous	E ☒	N ☐	(Generated from landscaped areas and eroded soil from inorganic substances)
Nitrogen	E ☒	N ☐	(Generated from landscaped areas and eroded soil from inorganic substances)
Sediment	E ☒	N ☐	(Generated from landscape areas)
Metals	E ☒	N ☐	(Generated from brake pad and tire tread wear associated w/ driving) Santa Ana River Reach 3 (Non-Point Source)
Oil and Grease	E ☒	N ☐	(Generated from petroleum hydrocarbon producs, motor products from leaking vehicles, esters, oils, fats, waxes and high molecular-weight fatty acids)
Trash/Debris	E ☒	N ☐	(Generated from paper, plastic, polystyrene packing foam, and aluminum materials and biodegradable organic matter)
Pesticides / Herbicides	E ☒	N ☐	(Generated from landscape maintenance/pest control)
Organic Compounds	E ☒	N ☐	(Generated from solvents and hydrocarbons)
Other:	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]	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

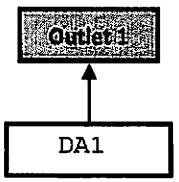
Describe the project site conditions that will facilitate the selection of BMP through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and 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 34.064581	Longitude -117.132014	Thomas Bros Map page 608

1 San Bernardino County climatic region: ☒ Valley ☐ Mountain

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



Example only – modify for project specific WQMP using additional form

Conveyance	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA
DA1 DMA C flows to DA1 DMA A	*Ex. Bioretention overflow to vegetated bioswale with 4' bottom width, 5:1 side slopes and bed slope of 0.01. Conveys runoff for 1000' through DMA 1 to existing catch basin on SE corner of property*

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)	226,076	229,126	324,289	211,702
2 Existing site impervious area (ft^2)	33,911	160,388	32,409	190,531
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	AMC II	AMC II	AMC II	AMC II
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	A	A	A	A
5 Longest flowpath length (ft)	621	636	695	925
6 Longest flowpath slope (ft/ft)	0.0324	0.0247	0.0448	0.0084
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	See Preliminary Drainage Study	See Preliminary Drainage Study	See Preliminary Drainage Study	See Preliminary Drainage Study
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*	Poor	Poor	Poor	Poor

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)	211,266	210,830	118,919	
2 Existing site impervious area (ft^2)	21,126	189,747	107,027	
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	AMC II	AMC II	AMC II	
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	A	A	A	
5 Longest flowpath length (ft)	679	629	217	
6 Longest flowpath slope (ft/ft)	0.0499	0.0083	0.0271	
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	See Preliminary Drainage Study	See Preliminary Drainage Study	See Preliminary Drainage Study	
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*	Poor	Poor	Poor	

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*	Santa Ana River Reach 5 (Primary Basin No. 801.52, Secondary Basin No. 801.57) Santa Ana River Reach 4 (Primary Basin No. 801.27, Secondary Basin No. 801.27 and No. 801.44) Santa Ana River Reach 3 (Primary Basin No. 801.21, Secondary Basin No. 801.27 and 801.25) Santa Ana River Reach 2 (Primary Basin No. 801.11 and Secondary Basin No. 801.12) Santa Ana River Reach 1 (Primary Basin No. 801.11) Pacific Ocean
Applicable TMDLs *Refer to Local Implementation Plan*	Santa Ana River Reach 4 for Pathogens still required Santa Ana River Reach 3 for Copper and Lead still required Santa Ana River Reach 3 for pathogens is being addressed by a U.S. EPA approved TMDL. Santa Ana River Reach 2 for Bacteria still required
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*	Santa Ana River Reaches 4, 3, and 2 are impaired by pathogens/bacteria. Santa Ana River Reach 3 is also impaired by 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*	Santa Ana River Reaches 5-1
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	☒	☐	Owners and tenants are to familiarize themselves with the BMP's inlcuded in this document.
N2	Activity Restrictions	☒	☐	Restrictions include: outdoor work or processing areas, outdoor food preparation air/water supply, and pesticide application by any other person than an applicator certified by the California Department of Pesticide Regulation.
N3	Landscape Management BMPs	☒	☐	All landscaping is native and drought tolerant trees and shrubs and groundcovers. Wood fiber is used in the landscaping design. Plants have been grouped with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Landscaping will correlate to the climate, soil, related natural resources and existing vegetation of the site, as well as the type of development proposed. Rain triggered shutoff devices and shutoff devices designed to limit water supply in the event of a broken sprinkler will be used in the landscape design for new landscape areas. Irrigation and landscaping will be coordinated to avoid overspray, etc. Wood fiber will be used to limit the area requiring irrigation.
N4	BMP Maintenance	☐	☒	No BMP's are proposed. Treatment is limited to Hydrologic Source Control.
N5	Title 22 CCR Compliance (How development will comply)	☒	☐	The Owner(s) will file a Business Emergency Contingency Plan as required based on the nature and quantities of hazardous materials stored.
N6	Local Water Quality Ordinances	☒	☐	The Owner(s) are reponsible to comply with all County of San Bernardino Water Quality Ordinances.
N7	Spill Contingency Plan	☒	☐	The Owner(s) are reponsible to comply with all County of San Bernardino Water Quality Ordinances.

Form 4.1-1 Non-Structural Source Control BMPs				
N8	Underground Storage Tank Compliance	☐	☒	No underground storage tanks.
N9	Hazardous Materials Disclosure Compliance	☒	☐	The Owner(s) will file a Business Emergency Contingency Plan as required based on the nature and quantities of hazardous materials stored.

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N10	Uniform Fire Code Implementation	☒	☐	The Owner(s) will file a Business Emergency Contingency Plan as required based on the nature and quantities of hazardous materials stored.
N11	Litter/Debris Control Program	☒	☐	The Owner will ensure that the overall site is trash free including the basins and trash enclosure. This will occur on a weekly basis or more frequently as dictated by the volume of trash.
N12	Employee Training	☒	☐	The Owner is to schedule an annual seminar and refresher course based on this document which can be conducted by a designated representative.
N13	Housekeeping of Loading Docks	☒	☐	A landscape maintenance company will be retained to provide housekeeping service for loading dock areas to include litter control and sweeping. This will occur on a monthly basis.
N14	Catch Basin Inspection Program	☐	☒	No catch basins are proposed.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	The owners will contract with a sweeping company to to complete this BMP. Sweeping will occur annually, prior to the rainy season.
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	This is not a public agency project.
N17	Comply with all other applicable NPDES permits	☐	☒	There are no other appliable NPDES permits at this time.

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)	☐	☒	No catch basins are proposed.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☒	☐	Outdoor storage area is proposed to be dustproof material, rather than paved, to allow for maximum infiltration opportunities.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☐	☐	Site drainage is designed to flow areound the enclosure and not through it. Bins are to be equipped with working covers. The enclosure will be roofed.
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)	☒	☐	Landscape planning has coupled considerations of land suitability for urban uses with consideration of projected growth. Project plan designs maximize natural water storage and infiltration opportunities, and protect slopes and channels. Plants have been grouped with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Landscaping correlates to the climate, soil, related natural resources and existing vegetation of the site, as well as the type of development proposed. Irrigation methods have been utilized to minimize runoff of excess irrigation water across impervious surfaces and into the stormwater conveyance system. Wood chip mulch has been used to minimize sediment run-off and maintain soil infiltration capacity. A programmable controller has been proposed that includes a weather sensor and flow sensor to eliminate irrigation during and immediately after rain events and in the event of a broken line. Scrap pipe and extra materials shall be recycled if possible. All non-recyclable wastes shall be landfilled. Hazardous wastes shall be disposed of per County hazardous material disposal regulations.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	The finished grade of newly created landscape areas will be 1-2" below adjacent surface.
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☒	☐	This BMP to protect slopes and channels is to be installed at the same time as the site grading and is to be maintained by the owner. It will be inspected annually and slope deterioration or damage is to be repaired within 30 days of inspection.

S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	See 'Loading Docks', above.
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	No maintenance bays are part of the project.
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No vehicle wash areas are part of the project.
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	No outdoor processing areas are part of the project.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No equipment wash areas are part of the project.
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	No fueling areas are part of the project.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	The project is not on a hillside.
S14	Wash water control for food preparation areas	☐	☒	No food preparation areas are part of the project.
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	No community car wash racks are part of the project.

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: Dustproof material will be placed in the proposed storage areas to maintain infiltration potential. Frontage landscaping is proposed in addition to existing landscaping which is proposed to remain.
Maximize natural infiltration capacity: Yes ☒ No ☐ Explanation: Dustproof material will provide natural treatment of runoff.
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: Existing drainage patterns are generally preserved. Emergency flows from large back to back storm events will exit the site as they have historically .Time of concentration is improved and peak flows reduced due to the addition of the basins.
Disconnect impervious areas: Yes ☐ No ☒ Explanation: The site is already developed. Dustproof material is self treating.
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation: Dustproof material is proposed over the area that is currently barren in order to provide for outdoor storage. There are no environmentally sensitive areas onsite.
Re-vegetate disturbed areas: Yes ☒ No ☐ Explanation: All areas that are not proposed hardscape or building will be planted and irrigated.
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: Construction documents will provide for provisions to minimize compaction during construction within gravel areas.
Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes ☐ No ☒ Explanation: The site is already developed. This is not feasible.
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☐ No ☒ Explanation: The site is already developed. This is not feasible.

4.2 Project Performance Criteria

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

Methods applied in the following forms include:

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

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

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

1 Project area DA 1 (ft^2): 819,341 SF	2 Imperviousness after applying preventative site design practices (Imp%): 20	3 Runoff Coefficient (Rc): _0.1705 *$R_c = 0.858(Imp\%)^{*3} - 0.78(Imp\%)^{*2} + 0.774(Imp\%) + 0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.495 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.733 *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): 16,750 CF *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	1 115,236 *Form 4.2-3 Item 12*	2 7.5 *Form 4.2-4 Item 13*	3 6.43 *Form 4.2-5 Item 10*
Post-developed	4 5,260 *Form 4.2-3 Item 13*	5 6.9 *Form 4.2-4 Item 14*	6 6.43 *Form 4.2-5 Item 14*
Difference	7 *-109,976* *Item 4 – Item 1*	8 *1.452* *Item 5 – Item 2*	9 *0* *Item 6 – Item 3*
Difference (as % of pre-developed)	10 *-95.44%* *Item 7 / Item 1*	11 *-8%* *Item 8 / Item 2*	12 *0%* *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	DMA E	DMA F	DMA G	DMA H
1a Land Cover type	Barren	Mixed	Barren	Commerc.	Barren	Commerc.	Commerc.	
2a Hydrologic Soil Group (HSG)	A	A	A	A	A	A	A	
3a DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	226,076	229,126	324,289	211,702	211,266	210,830	118,919	
4a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	78	81	78	98	78	98	98	
Weighted Curve Number Determination for: Post-developed DA	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H
1b Land Cover type	Slag	Mixed	Slag	Commerc.	Slag	Commerc.	Commerc.	
2b Hydrologic Soil Group (HSG)	A	A	A	A	A	A	A	
3b DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	226,076	229,126	324,289	211,702	211,266	210,830	118,919	
4b Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	32	43	32	98	32	98	98	

5 Pre-Developed area-weighted CN: 85	**7** Pre-developed soil storage capacity, S (in): 1.79 *S = (1000 / Item 5) - 10*	**9** Initial abstraction, I_a (in): 0.36 *I_a = 0.2 * Item 7*
6 Post-Developed area-weighted CN: 57	**8** Post-developed soil storage capacity, S (in): 7.86 *S = (1000 / Item 6) - 10*	**10** Initial abstraction, I_a (in): 1.57 *I_a = 0.2 * Item 8*

11 Precipitation for 2 yr, 24 hr storm (in): 2.16
Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

12 Pre-developed Volume (ft^3): 115,236
*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): 5,260
*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): -110,239
*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*	621	636	695	925	621	710	657	893
2 Change in elevation (ft)	20.11	15.73	31.11	7.8	20.53	15.9	19.53	20.0
3 Slope (ft/ft), S_o = *Item 2 / Item 1*	0.0324	0.0247	0.0448	0.0084	0.0244	0.0197	0.0165	0.0244
4 Land cover	Barren	Barren/Commercial	Barren	Commerical	Slag	Slag/Commerical	Slag	Commerical
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*	8.5	8.7	8.5	11.4	11.4	12.1	11.9	9.5
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*								
7 Cross-sectional area of channel (ft^2)								
8 Wetted perimeter of channel (ft)								
9 Manning's roughness of channel (n)								
10 Channel flow velocity (ft/sec) V_{fps} = *(1.49 / Item 9) * (Item 7/Item 8)*$^{0.67}$ * *(Item 3)*$^{0.5}$								
11 Travel time to outlet (min) T_t = *Item 6 / (Item 10 * 60)*								
12 Total time of concentration (min) T_c = *Item 5 + Item 11*	8.5	8.7	8.5	11.4	11.4	12.1	11.9	9.5

13 Pre-developed time of concentration (min): 7.5 *Minimum of Item 12 pre-developed DMA*

14 Post-developed time of concentration (min): 6.9 *Minimum of Item 12 post-developed DMA*

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

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 E	DMA F	DMA G	DMA H	DMA E	DMA F	DMA G	DMA H
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*	679	636	695		619	629	349	
2 Change in elevation (ft)	33.86	15.73	31.11		32.44	5.25	7.4	
3 Slope (ft/ft), S_o = *Item 2 / Item 1*	0.0499	0.0247	0.0448		0.0524	0.0083	0.0212	
4 Land cover	Barren	Commercial	Commercial		Slag	Commercial	Commercial	
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*	8.3	8.4	7.5		10.4	10.2	6.9	
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*								
7 Cross-sectional area of channel (ft^2)								
8 Wetted perimeter of channel (ft)								
9 Manning's roughness of channel (n)								
10 Channel flow velocity (ft/sec) V_{fps} = *(1.49 / Item 9) * (Item 7/Item 8)*$^{0.67}$ * *(Item 3)*$^{0.5}$								
11 Travel time to outlet (min) T_t = *Item 6 / (Item 10 * 60)*								
12 Total time of concentration (min) T_c = *Item 5 + Item 11*	8.3	8.4	7.5		10.4	10.2	6.9	
13 Pre-developed time of concentration (min): *Minimum of Item 12 pre-developed DMA*								
14 Post-developed time of concentration (min): *Minimum of Item 12 post-developed DMA*								
15 Additional time of concentration needed to meet HCOC requirement (min): $T_{C\text{-}HCOC}$ = *(Item 14 * 0.95) – Item 13*								

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)*		0.96	0.97	0.96	0.96	0.96	0.96
2 Drainage Area of each DMA (ft^2) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		5.19	5.26	7.44	5.19	5.26	7.44
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	0.2	0	0	0.2	0
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	0.36	0.42	0.98	0.87	0.98
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	0.072	0	0	0.174	0
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		4.48	4.25	6.43	4.48	3.72	6.43
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	n/a	*n/a*	n/a	n/a
	DMA B	n/a	*n/a*	n/a	n/a	*n/a*	n/a
	DMA C	n/a	n/a	*n/a*	n/a	n/a	*n/a*

8 Pre-developed Q_p at T_c for DMA A: 4.48 *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: 4.25 *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: 6.43 *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): 6.43 *Maximum of Item 8, 9, and 10 (including additional forms as needed)*

11 Post-developed Q_p at T_c for DMA A: 4.48 *Same as Item 8 for post-developed values*	12 Post-developed Q_p at T_c for DMA B: 3.72 *Same as Item 9 for post-developed values*	13 Post-developed Q_p at T_c for DMA C: 6.43 *Same as Item 10 for post-developed values*

14 Peak runoff from post-developed condition confluence analysis (cfs): 6.43 *Maximum of Item 11, 12, and 13 (including additional forms as needed)*

15 Peak runoff reduction needed to meet HCOC Requirement (cfs): -0.32 *$Q_{p\text{-}HCOC}$ = (Item 14 * 0.95) – Item 10*

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 D	DMA E	DMA F	DMA D	DMA E	DMA F
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)*		0.96	0.96	0.97	0.97	0.96	0.97
2 Drainage Area of each DMA (ft^2) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		4.86	4.85	4.84	4.86	4.85	4.84
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)*		1	0	1	1	0	1
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*		0.04	0.42	0.04	0.04	0.98	0.04
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)*		0.04	0	0.04	0.04	0	0.04
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		4.02	4.19	4.05	4.07	4.19	4.05
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	n/a	*n/a*	n/a	n/a
	DMA B	n/a	*n/a*	n/a	n/a	*n/a*	n/a
	DMA C	n/a	n/a	*n/a*	n/a	n/a	*n/a*

8 Pre-developed Q_p at T_c for DMA D: 4.02 *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 E: 4.19 *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 F: 4.05 *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): 6.43 *Maximum of Item 8, 9, and 10 (including additional forms as needed)*

11 Post-developed Q_p at T_c for DMA D: 4.07 *Same as Item 8 for post-developed values*	12 Post-developed Q_p at T_c for DMA E: 4.19 *Same as Item 9 for post-developed values*	13 Post-developed Q_p at T_c for DMA F: 4.05 *Same as Item 10 for post-developed values*

14 Peak runoff from post-developed condition confluence analysis (cfs): 6.43 *Maximum of Item 11, 12, and 13 (including additional forms as needed)*

15 Peak runoff reduction needed to meet HCOC Requirement (cfs): -0.32 *$Q_{p\text{-}HCOC}$ = (Item 14 * 0.95) – Item 10*

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 G	DMA H	DMA I	DMA G	DMA H	DMA I
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)*		0.97			0.97		
2 Drainage Area of each DMA (ft^2) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		2.73			2.73		
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)*		1			1		
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*		0.04			0.04		
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)*		0.04			0.04		
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		2.29			2.29		
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	n/a	*n/a*	n/a	n/a
	DMA B	n/a	*n/a*	n/a	n/a	*n/a*	n/a
	DMA C	n/a	n/a	*n/a*	n/a	n/a	*n/a*

8 Pre-developed Q_p at T_c for DMA G: 2.29 *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 H: *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 I: *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): 6.43 *Maximum of Item 8, 9, and 10 (including additional forms as needed)*

11 Post-developed Q_p at T_c for DMA G: 2.29 *Same as Item 8 for post-developed values*	12 Post-developed Q_p at T_c for DMA H: *Same as Item 9 for post-developed values*	13 Post-developed Q_p at T_c for DMA I: *Same as Item 10 for post-developed values*

14 Peak runoff from post-developed condition confluence analysis (cfs): 6.43 *Maximum of Item 11, 12, and 13 (including additional forms as needed)*

15 Peak runoff reduction needed to meet HCOC Requirement (cfs): -0.32 *$Q_{p\text{-}HCOC}$ = (Item 14 * 0.95) – Item 10*

4.3 Project Conformance Analysis

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

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

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

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

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

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

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

Form 4.3-1 Infiltration BMP Feasibility (DA 1)

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

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

Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach)

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

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

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

If Yes, Provide basis: (attach)

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

If Yes, Provide basis: (attach)

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

If Yes, Provide basis: (attach)

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

If Yes, Provide basis: (attach)

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

See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

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

If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 9 below.

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

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

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

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):		$V_{retention}$ *=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 1 DMA 1 BMP Type Dustproof Material	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
7 Ponding surface area (ft^2)	0		
8 Ponding depth (ft)	0		
9 Surface area of amended soil/gravel (ft^2)	819,341		
10 Average depth of amended soil/gravel (ft)	0.083		
11 Average porosity of amended soil/gravel	0.35		
12 Retention volume achieved from on-lot infiltration (ft^3) $V_{retention}$ *= (Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)*	23,802		
13 Runoff volume retention from on-lot infiltration (ft^3): 23,802 $V_{retention}$ *=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): *$V_{retention}$ =Sum of Item 19 for all BMPs*			
21 Implementation of Street Trees: Yes ☐ No ☒ *If yes, complete Items 20-2. If no, proceed to Item 24*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
22 Number of Street Trees			
23 Average canopy cover over impervious area (ft^2)			
24 Runoff volume retention from street trees (ft^3) *$V_{retention}$ = Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches*			
25 Runoff volume retention from street tree BMPs (ft^3): *$V_{retention}$ = Sum of Item 24 for all BMPs*			
26 Implementation of residential rain barrels/cisterns: Yes☐ No ☒ *If yes, complete Items 27-28; If no, proceed to Item 29*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
27 Number of rain barrels/cisterns			
28 Runoff volume retention from rain barrels/cisterns (ft^3) *$V_{retention}$ = Item 27 * 3*			
29 Runoff volume retention from residential rain barrels/Cisterns (ft3): *$V_{retention}$ =Sum of Item 28 for all BMPs*			
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: 23,802 *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): 0 CF *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30*			
BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type	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*			
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*			
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*			
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*			
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*			
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*			
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*			
10 Amended soil porosity			
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*			
12 Gravel porosity			
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
14 Above Ground Retention Volume (ft^3) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*			
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*			
16 Total Retention Volume from LID Infiltration BMPs: *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*			
17 Fraction of DCV achieved with infiltration BMP: % *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): *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16*			
BMP Type(s) *Compute runoff volume retention from proposed harvest and use BMP (Select BMPs from Table 5-4 of the TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Describe cistern or runoff detention facility			
3 Storage volume for proposed detention type (ft^3) *Volume of cistern*			
4 Landscaped area planned for use of harvested stormwater (ft^2)			
5 Average wet season daily irrigation demand (in/day) Use local values, typical ~ 0.1 in/day			
6 Daily water demand (ft^3/day) *Item 4 * (Item 5 / 12)*			
7 Drawdown time (hrs) *Copy Item 6 from Form 4.2-1*			
8 Retention Volume (ft^3) *$V_{retention}$ = Minimum of (Item 3) or (Item 6 * (Item 7 / 24))*			
9 Total Retention Volume (ft^3) from Harvest and Use BMP *Sum of Item 8 for all harvest and use BMP included in plan*			
10 Is the full DCV retained with a combination of LID HSC, retention and infiltration, and harvest 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): *Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9*	List pollutants of concern *Copy from Form 2.3-1.*	
2 Biotreatment BMP Selected *(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)*	Volume-based biotreatment *Use Forms 4.3-6 and 4.3-7 to compute treated volume*	Flow-based biotreatment *Use Form 4.3-8 to compute treated volume*
	☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention	☐ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment
3 Volume biotreated in volume based biotreatment BMP (ft^3): *Form 4.3-6 Item 15 + Form 4.3-7 Item 13*	4 Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft^3): *Item 1 – Item 3*	5 Remaining fraction of LID DCV for sizing flow based biotreatment BMP: % *Item 4 / Item 1*
6 Flow-based biotreatment BMP capacity provided (cfs): *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)*		
7 Metrics for MEP determination: • Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.*		

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

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

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

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

Form 4.3-8 Flow Based Biotreatment (DA 1)

Biotreatment BMP Type *Vegetated swale, vegetated filter strip, or other comparable proprietary BMP*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in TGD Table 5-5*			
2 Flow depth for water quality treatment (ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
3 Bed slope (ft/ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
4 Manning's roughness coefficient			
5 Bottom width (ft) b_w = (Form 4.3-5 Item 6 * Item 4) / (1.49 * Item 2$^{\wedge 1.67}$ * 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): 16,750 CF *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design hydrologic source control LID BMP (ft^3): 26,802 CF *Copy Item 30 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): 0 CF *Copy Item 16 in Form 4.3-3*

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

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

6 Flow capacity provided by flow based biotreatment BMP (cfs): 0 CF *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): 0 CF *(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): 0 *Sum of Form 4.3-9 Items 2, 3, and 4 Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving HCOC volume reduction*
3 Remaining volume for HCOC volume capture (ft^3): 0 *Item 1 – Item 2*	4 Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft^3): 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
N-1 Education of Property Owners, Tenants and occupants on storm-water BMPs	Owner	This BMP will begin at building occupancy. Practical informational materials are provided in this document in Section 6. These include BMPs that eliminate or reduce pollution during property improvements. The property owners are encouraged to implement the use of alternative building materials, drought resistant and native plant species in landscaping and pervious pavement in all additions and modifications to the property.	Within 6 months of employment of new employees and annually thereafter.
N-3 Landscape Manage-ment BMPs	Owner	This BMP will begin within 30 days of building occupancy and will occur on a monthly basis (or more frequently if desired). The owners will retain a landscape maintenance company or will have staff designated to service all site landscaping. Site trees and shrubs are to be trimmed as necessary and all wastes disposed of offsite. Wood fiber that has been disturbed is to be replaced. They are also to ensure that all areas are trash free. Trash is to be disposed of offsite. Ongoing maintenance shall be consistent with local guidelines, and fertilizer and pesticide usage shall be consistent with the instructions contained on product labels and with the regulations administered by the State	Monthly

		Department of Pesticide Regulation. Clippings and yard waste shall be composted. A landscape maintenance company will be retained to service all site irrigation. Any breaks or leaks in piping must be repaired within 2 business days of report to the landscaper.	
N-11 Litter/ Debris Control Program	Owner	This BMP will begin within 30 days of project completion and will occur on a weekly basis (or more frequently if dictated by volume of trash). A landscape maintenance company will be retained to provide litter control services. They are to ensure that overall site is trash free, including the inside of the trash enclosure. Trash in these areas is to be removed and placed inside the trash bins. They are also to report to the Owners if the trash bins or lids have become damaged so that they can be replaced.	Annually
N-12 Employee Training	Owner	This BMP will begin within 30 days of building occupancy and refresher course will occur annually thereafter. The owners shall insure that all employees are familiar with the contents of this plan and appendix.	Weekly
N-13 House-keeping of Loading Docks	Owner	This BMP will begin within 30 days of project completion and sweeping will occur monthly thereafter. All wastes shall be landfilled. There will be no loading dock cleaning with water.	Monthly
N-15 Vacuum Sweeping of Private Streets and Parking Lots	Owner	This BMP will begin within 1 year of project completion and sweeping will occur annually thereafter, prior to the rainy season. The owners will contract with a sweeping company to complete this BMP. All wastes shall be landfilled. The parking lots shall be swept. There will be no parking lot cleaning with water.	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

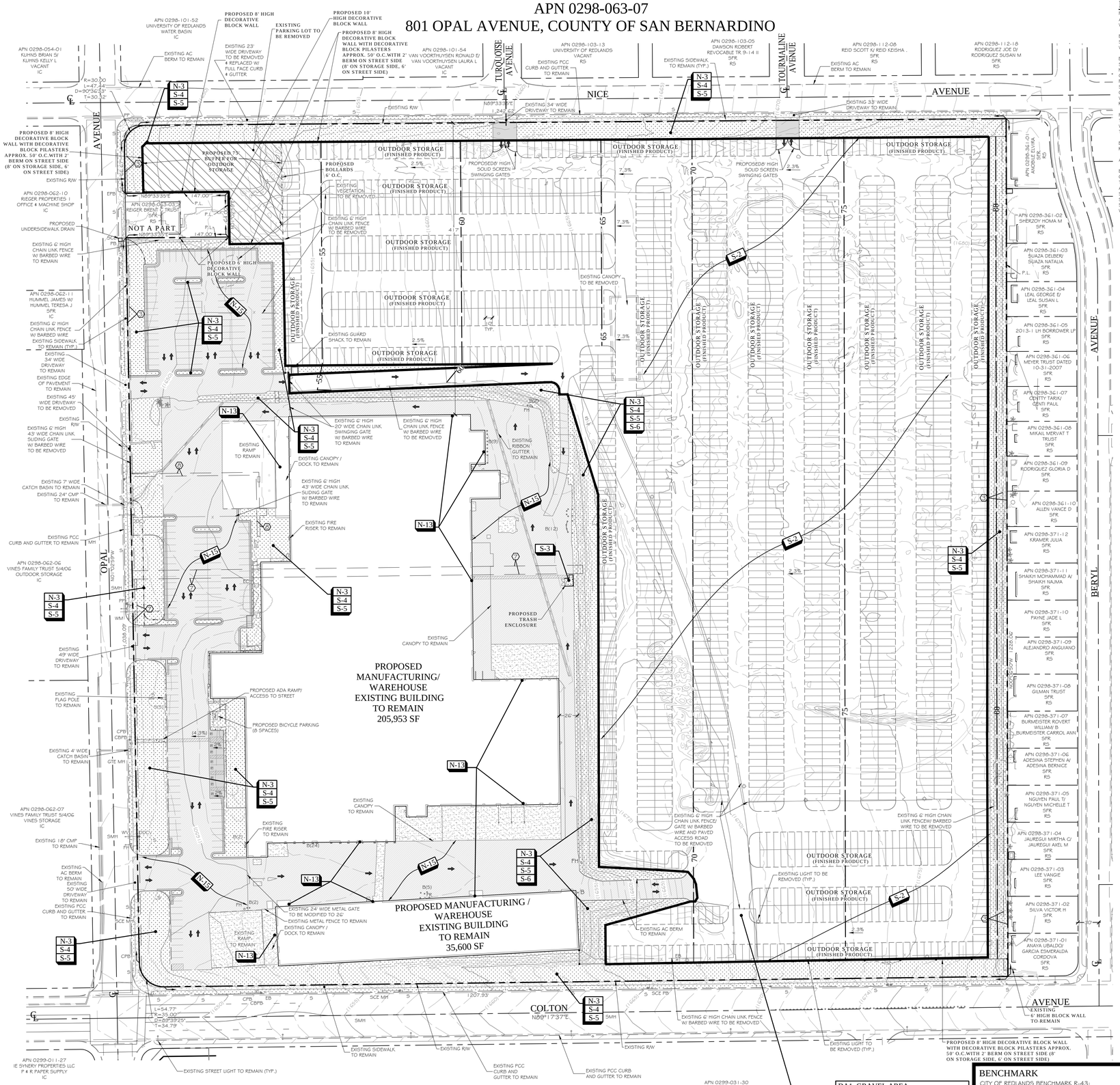
Attach all O&M Plans and Maintenance Agreements for BMP to the WQMP.

6.4 Other Supporting Documentation

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

PRELIMINARY WATER QUALITY MANAGEMENT PLAN

PROPOSED MANUFACTURING/ WAREHOUSING FACILITY
APN 0298-063-07
801 OPAL AVENUE, COUNTY OF SAN BERNARDINO



KEY NOTES:

BMP SYMBOL	DESCRIPTION	RESPONSIBLE PARTY
N-1	EDUCATION OF PROPERTY OWNERS TENANTS AND OCCUPANTS	OWNER
N-2	ACTIVITY RESTRICTIONS	OWNER
N-3	LANDSCAPE MANAGEMENT BMP'S	OWNER
N-5	TITLE 22 CCR COMPLIANCE	OWNER
N-6	LOCAL WATER QUALITY ORDINANCES	OWNER
N-7	SPILL CONTINGENCY PLAN	OWNER
N-8	HAZARDOUS MATERIALS STORAGE	OWNER
N-10	UNIFORM FIRE CODE IMPLEMENTATION	OWNER
N-11	LITTER/DEBRIS CONTROL PROGRAM	OWNER
N-12	EMPLOYEE TRAINING	OWNER
N-13	HOUSEKEEPING OF LOADING DOCKS	OWNER
N-15	VACUUM SWEEPING PARKING LOTS	OWNER
S-2	OUTDOOR MATERIALS STORAGE AREA	OWNER
S-3	DESIGN AND CONSTRUCT TRASH AND WASTE STORAGE AREAS	OWNER
S-4	EFFICIENT LANDSCAPE DESIGN	OWNER
S-5	FINISH GRADE LANDSCAPED AREAS 1/2" MIN BELOW CURB	OWNER
S-6	PROTECT SLOPES AND CHANNELS	OWNER

SEE TRIBUTARY AREA MAPS FOR DA DELINEATIONS RELATING TO HCOC CALCULATIONS.

SITE WIDE BMP'S

N-1, N-2, N-5, N-6, N-7, N-9, N-10, N-11, N-12

LEGAL DESCRIPTION

PARCEL A:
ALL THAT PORTION OF THE SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SECTION 19, TOWNSHIP 1 SOUTH, RANGE 2 WEST, SAN BERNARDINO MERIDIAN, DESCRIBED AS FOLLOWS:

BEING A STRIP OF LAND OF UNIFORM WIDTH OF 39 FEET ON AND ALONG THE SOUTH BOUNDARY LINE OF THE SOUTHEAST ONE QUARTER OF THE SOUTHWEST ONE QUARTER OF SECTION 19, TOWNSHIP 1 SOUTH, RANGE 2 WEST, SAN BERNARDINO MERIDIAN.

EXCEPTING AND RESERVING UNTO UNION PACIFIC RAILROAD COMPANY, A DELAWARE CORPORATION, ITS SUCCESSORS AND ASSIGNS, FOREVER, ALL MINERALS AND ALL MINERAL RIGHTS OF EVERY KIND AND CHARACTER NOW KNOWN TO EXIST OR HEREAFTER DISCOVERED UNDERLYING THE PROPERTY, INCLUDING, WITHOUT LIMITING THE GENERALITY OF THE FOREGOING, OIL AND GAS AND RIGHTS THERETO, TOGETHER WITH THE SOLE, EXCLUSIVE AND PERPETUAL RIGHT TO EXPLORE FOR, REMOVE AND DISPOSE OF SAID MINERALS BY ANY MEANS OR METHODS SUITABLE TO GRANTOR, ITS SUCCESSORS AND ASSIGNS, BUT WITHOUT ENTERING UPON OR USING THE SURFACE OF THE PROPERTY, AND IN SUCH MANNER AS NOT TO DAMAGE THE SURFACE OF THE PROPERTY, OR TO INTERFERE WITH THE USE THEREOF BY GRANTEE, ITS SUCCESSORS OR ASSIGNS, AS RESERVED ON QUITCLAIM DEED RECORDED APRIL 07, 2006, AS INSTRUMENT NO. 2006-0239406, OF OFFICIAL RECORDS.

PARCEL B:
THE SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER OF SECTION 19, TOWNSHIP 1 SOUTH, RANGE 2 WEST, SAN BERNARDINO MERIDIAN, IN THE COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO THE OFFICIAL PLAT THEREOF.

EXCEPTING THE SOUTHERLY 39 FEET THEREOF, AS CONVEYED TO THE SOUTHERN PACIFIC RAILROAD BY DEED RECORDED OCTOBER 09, 1891, IN BOOK 139, PAGE 225 OF DEEDS.

ALSO SAVING AND EXCEPTING THE FOLLOWING DESCRIBED PROPERTY:

BEGINNING AT A POINT ON THE WEST LINE OF AFORESAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER OF SECTION 19, DISTANT THEREON 130 FEET SOUTH OF THE NORTHWEST CORNER THEREOF; THENCE EAST PARALLEL TO THE NORTH LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER A DISTANCE OF 180 FEET; THENCE SOUTH PARALLEL TO THE WEST LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER A DISTANCE OF 64 FEET; THENCE WEST PARALLEL TO THE NORTH LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER A DISTANCE OF 180 FEET TO THE WEST LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER OF SECTION 19; THENCE NORTH ALONG SAID WEST LINE A DISTANCE OF 64 FEET TO THE POINT OF BEGINNING.

EASEMENTS

1 AN EASEMENT FOR CARRIAGE OF WATER TO DIG AND LAY WATER WAYS, ALSO THE RIGHT TO BUILD CONSTRUCT AND MAINTAIN UPON SAID DAMS AND RESERVOIRS AND INCIDENTAL PURPOSES IN FAVOR OF THE MENTONE IRRIGATION COMPANY RECORDED DECEMBER 01, 1887, IN BOOK 69 OF DEEDS, PAGE 144.

SAID EASEMENT IS NOT PLOTTABLE.

2 AN EASEMENT FOR HIGHWAY, ROADWAY AND INCIDENTAL PURPOSES IN FAVOR OF COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED JUNE 21, 2007 AS INSTRUMENT NO. 2007-0369493 OF OFFICIAL RECORDS.

SAID EASEMENT IN CONTAINED WITHIN THE COLTON AVENUE RIGHT OF WAY.

3 AN EASEMENT FOR POLE LINES AND INCIDENTAL PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA EDISON COMPANY RECORDED DECEMBER 30, 1953 IN BOOK 3302, PAGE 397 OF OFFICIAL RECORDS.

4 AN EASEMENT FOR STREET AND INCIDENTAL PURPOSES IN FAVOR OF LESTER C. ALBERTON, ET UX. RECORDED JULY 02, 1956 IN BOOK 3976, PAGE 359 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN APN 0298-063-03.

5 AN EASEMENT FOR THE DEDICATION FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED OCTOBER 26, 1977 IN BOOK 9294, PAGE 1750 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE NICE AVENUE RIGHT OF WAY.

6 AN EASEMENT FOR THE DEDICATION FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED OCTOBER 26, 1977 IN BOOK 9294, PAGE 1752 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE OPAL AVENUE RIGHT OF WAY.

7 AN EASEMENT FOR CONSTRUCT, USE, MAINTAIN, OPERATE, ALTER, AND TO REPAIR, REPLACE, RECONSTRUCT, INSPECT AND REMOVE AT ANY TIME AND FROM TIME TO TIME AND INCIDENTAL PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA EDISON, A CORPORATION, RECORDED OCTOBER 31, 1977 IN BOOK 9295, PAGE 1491 OF OFFICIAL RECORDS.

8 AN EASEMENT FOR PUBLIC UTILITIES AND INCIDENTAL PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA EDISON COMPANY, A CORPORATION, ITS SUCCESSORS AND ASSIGNS, RECORDED FEBRUARY 13, 1986 AS INSTRUMENT NO. 86-040551 OF OFFICIAL RECORDS.

9 AN EASEMENT FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED JUNE 21, 2007 AS INSTRUMENT NO. 2007-0369494 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE OPAL AVENUE RIGHT OF WAY.

10 AN EASEMENT FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED JUNE 21, 2007 AS INSTRUMENT NO. 2007-0362735 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE OPAL AVENUE AND NICE AVENUE RIGHT OF WAY.

UTILITIES

ELECTRIC:
SOUTHERN CALIFORNIA EDISON COMPANY
287 TENNESSEE STREET
REDLANDS, CA 92373
(909) 307-6731

CABLE:
SPECTRUM CABLE
1076 E. HOSPITALITY LANE, SUITE D
SAN BERNARDINO, CA 92408
(855) 897-2285

WATER & SEWER:
CITY OF REDLANDS
35 CAJON STREET
REDLANDS, CA 92373
(909) 798-7698

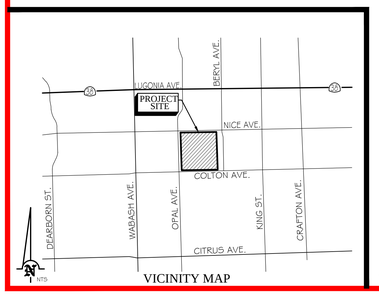
GAS:
SOUTHERN CALIFORNIA GAS COMPANY
1961 WEST LUGONIA AVENUE
REDLANDS, CA 92373
(909) 335-7750

TELEPHONE:
VERIZON
9 SOUTH 4TH STREET
REDLANDS, CA 92373
(909) 748-6676

LEGEND

- PROPOSED AC PAVING
- EXISTING AC PAVING TO REMAIN
- PROPOSED DUST PROOF MATERIAL
- EXISTING LANDSCAPING TO REMAIN / PROPOSED LANDSCAPING
- PROPOSED PCC PAVING
- EXISTING PCC PAVING TO REMAIN
- TRIBUTARY BOUNDARY

AC	ASPHALT CONCRETE
B	EXISTING BOLLARD TO REMAIN
BF	EXISTING BACKFLOW TO REMAIN
CBPB	CABLE PULL BOX
CPB	COMMUNICATIONS PULLBOX
DDCV	DOUBLE DETECTOR CHECK VALVE
EB	ELECTRICAL BOX
EPB	ELECTRICAL PULLBOX
EC	EXISTING ELECTRICAL CABINET TO REMAIN
EX.	EXISTING
EV	EXISTING EDISON VAULT
FH	EXISTING FIRE HYDRANT TO REMAIN
FR	EXISTING FIRE RISER TO REMAIN
MB	EXISTING MAILBOX TO REMAIN
MH	EXISTING MANHOLE TO REMAIN
OH	OVERHANG
PB	EXISTING PULLBOX TO REMAIN
PCC	PORTLAND CEMENT CONCRETE
PL	PROPERTY LINE
PP	POWER POLE
RW	RIGHT-OF-WAY
S	EXISTING SIGN TO REMAIN
SMH	EXISTING SEWER MANHOLE TO REMAIN
WM	WATER METER
WV	WATER VALVE
	EXISTING VEGETATION TO REMAIN UNLESS OTHERWISE SHOWN TO BE REMOVED



VICINITY MAP

SCALE: 1"=60'

SOURCE OF SURVEY

TOPOGRAPHIC SURVEY
DATED AUGUST 2013
AS CONDUCTED BY
ONPOINT LAND SURVEYING, INC.
1910 ORANGE TREE LANE, SUITE 344
REDLANDS, CALIFORNIA 92374
PHONE: (909) 792-2221

DA1: GRAVEL AREA
AREA= 819,314 SF
20% IMPERVIOUS
MIN. DEPTH TO PROVIDE TREATMENT = 1"
35% VOIDS
DCV = 16,750 CF
VOL. PROVIDED IN GRAVEL: 23,802 CF

BENCHMARK

CITY OF REDLANDS BENCHMARK R-43:
BRASS DISK IN THE TOP OF CURB @ NE COR. BERYL AVE. & COLTON AVE. EAST END OF RETURN.
ELEVATION= 1,683.679

BASIS OF BEARING

CENTERLINE OF OPAL AVENUE PER RS 55/28 BEING: N01°02'59"W.

APN 0298-063-07
PRELIMINARY WATER QUALITY MANAGEMENT PLAN
PROPOSED MANUFACTURING/ WAREHOUSING FACILITY

PROPERTY OWNER/APPLICANT:
800 OPAL, LLC ATTN: CHARLES WALDEN
2615 SAN MIGUEL #487, NEWPORT BEACH, CA 92660
PHONE: (909) 553-0970
REPRESENTATIVE:
THATCHER ENGINEERING & ASSOCIATES, INC
1461 FORD STREET, STE 105, REDLANDS, CA 92373
PHONE: (909) 748-7777, FAX: (909) 748-7776

• land planning
• civil engineering
• landscape architecture
phone 909.748.7777
fax 909.748.7776
thatcher engineering & associates, inc.
1461 ford street, suite 105, redlands, ca 92373
est. 1989

Job Number:	Date Prepared:	Drawn By:	Reference Number:
154801	8/22/17	PF	154801WQ2

154801WQ2

• land planning
• civil engineering
• landscape architecture
phone 909.748.7777
fax 909.748.7776
est. 1989
thatcher engineering & associates, inc.
1461 ford street, suite 105, redlands, ca 92373

Proposed Manufacturing /Warehousing Facility
Preliminary Drainage Study
APN 0298-063-07
County of San Bernardino
August 16, 2017

Prepared for:

800 Opal, LLC
Attn: Charles Walden
2618 San Miguel Drive, #487
Newport Beach, CA 92660

Description

The project site is approximately 35 acres in size and is located along the west side of Opal Avenue between Nice Avenue, to the north, and Colton Avenue, to the south, in the Mentone area of San Bernardino County. The west portion of the site is currently developed with two existing buildings and paved access. The east portion of the site is currently undeveloped with an existing canopy and minor paved access. The site currently drains from east to west at an approximate grade of 2%. The majority of the site's offsite flows enter Opal Avenue that borders the project to the west. From Opal, flows are directed north or south to two existing catch basins that direct flows west to an existing storm drain channel. Ultimately, all flows enter the Santa Ana River to the northwest.

The existing frontages along Nice Avenue, Opal Avenue and Colton Avenue are fully improved with curb and gutter and sidewalk. Therefore, there will be no anticipated flows from the north, west or south to the project area. Neighboring properties in the existing housing tract to the east direct flows east to Beryl Avenue, thus, there are no anticipated flows expected from the east to the subject site.

Proposed development of the site includes grading the easterly undeveloped portion of the site to have a uniform grade from east to west. Proposed permeable, dust-proof, gravel surfacing will be placed in this area for use as outdoor storage. This gravel area is self-treating for water quality treatment as described in the Water Quality Management Plan. The two existing buildings onsite will remain. Minor pavement removals within the existing parking lot along the west portion of the site will occur to provide for ADA access and construction of required landscaped areas. In addition, the existing canopy in the proposed outdoor storage area will be removed. A block wall for screening and landscape buffer is proposed on the north and south perimeter of the project site. Flows from the site will continue as they do historically from east to west. There will be no increase in volume or intensity of flows leaving the site from pre-development to post-development conditions.

Purpose

The purpose of this study is to analyze the flows to and through the site both pre-development and post-development and demonstrate that the post-development flows leaving the site will be less than pre-development flows.

Analysis

To achieve the desired goal the following steps will be taken:

1. Determine the 10, 25 and 100 year pre-development flows.
2. Determine the 10, 25 and 100 year post-development flows.
3. Determine if any onsite mitigation will have to occur in order to have post-development flows that leave the site be less than pre-development flows in both intensity and volume.

Results

1. The 10, 25 & 100 year pre-development flows were determined utilizing the Rational Method per San Bernardino County Hydrology Manual. AES 2015 Software was utilized for the calculations and they can be found in the appendix of this report. The variables used were:

   Rainfall Values (per NOAA Atlas 14, Volume 6, Version 2 Map, Figure 4.1):
   $Y_{10} = 0.816$
   $Y_{100} = 1.41$

   Soil Group (per reference Soil Group Map in appendix, Figure 4.2): A

   Pervious Cover Designations:
   Mobile Homes
   Condominiums
   0.4 Dwellings/Acre
   Commercial
   Public Park

Node 3:

10-year peak flows: Q_{10} = 14.55 CFS
10-year time of concentration: Tc_{10}= 12.56 min
10-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(14.55cfs)(12.56\min)(60\min)\left(\frac{3}{2}\right)$ **= 16,448 cubic feet**

25-year peak flows: Q_{25} = 19.54 CFS
25-year time of concentration: Tc_{25}= 12.56 min
25-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(19.54cfs)(12.56\min)(60\min)\left(\frac{3}{2}\right)$ **= 22,089 cubic feet**

100-year peak flows: Q_{100} = 29.88 CFS
100-year time of concentration: Tc_{100}= 12.56 min
100-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(29.88cfs)(12.56\min)(60\min)\left(\frac{3}{2}\right)$ **= 33,777 cubic feet**

Node 6:

10-year peak flows: Q_{10} = 17.17 CFS
10-year time of concentration: Tc_{10}= 12.42 min
10-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(17.17cfs)(12.42\min)(60\min)\left(\frac{3}{2}\right)$ **= 19,193 cubic feet**

25-year peak flows: Q_{25} = 23.08 CFS
25-year time of concentration: Tc_{25}= 12.42 min
25-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(23.08cfs)(12.42\min)(60\min)\left(\frac{3}{2}\right)$ **= 25,799 cubic feet**

100-year peak flows: Q_{100} = 35.36 CFS
100-year time of concentration: Tc_{100}= 12.42 min
100-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(35.36cfs)(12.42\min)(60\min)\left(\frac{3}{2}\right)$ **= 39,515 cubic feet**

Node 9:

10-year peak flows: Q_{10} = 14.58 CFS
10-year time of concentration: Tc_{10}= 12.04 min
10-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(14.58cfs)(12.04\min)(60\min)\left(\frac{3}{2}\right)$ **= 15,799 cubic feet**

25-year peak flows: Q_{25} = 19.33 CFS
25-year time of concentration: Tc_{25}= 12.04 min
25-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(19.33cfs)(12.04\min)(60\min)\left(\frac{3}{2}\right)$ **= 20,946 cubic feet**

100-year peak flows: Q_{100} = 28.99 CFS
100-year time of concentration: Tc_{100}= 12.04 min
100-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(28.99cfs)(12.04\min)(60\min)\left(\frac{3}{2}\right)$ **= 31,414 cubic feet**

Node 11:

10-year peak flows: Q_{10} = 8.36 CFS
10-year time of concentration: Tc_{10}= 5.38 min
10-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(8.36cfs)(5.38\min)(60\min)\left(\frac{3}{2}\right)$ **= 4,048 cubic feet**

25-year peak flows: Q_{25} = 10.53 CFS
25-year time of concentration: Tc_{25}= 5.38 min
25-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(10.53cfs)(5.38\min)(60\min)\left(\frac{3}{2}\right)$ **= 5,099 cubic feet**

100-year peak flows: Q_{100} = 14.54 CFS
100-year time of concentration: Tc_{100}= 5.38 min
100-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(14.54cfs)(5.38\min)(60\min)\left(\frac{3}{2}\right)$ **= 7,041 cubic feet**

Pre-development Total:

10-year peak flows: Q_{10} = 54.66 CFS
10-year volume produced = 55,488 cubic feet

25-year peak flows: Q_{25} = 72.48 CFS
25-year volume produced = 73,933 cubic feet

100-year peak flows: Q_{100} = 108.77 CFS
100-year volume produced = 111,747 cubic feet

2. The 10, 25 & 100 year post-development flows were determined utilizing the Rational Method per San Bernardino County Hydrology Manual at each individual basin. AES 2015 Software was utilized for the calculations and they can be found in the appendix of this report. The variables used were:

   Rainfall Values (per NOAA Atlas 14, Volume 6, Version 2 Map, Figure 4.1):
   Y_{10} = 0.816
   Y_{100} = 1.41

   Soil Group (per reference Soil Group Map in appendix, Figure 4.2): B

   Pervious Cover Designations:
   1 Dwelling/Acre
   3-4 Dwellings/Acre
   Commercial

Node 3:

10-year peak flows: Q_{10} = 13.80 CFS
10-year time of concentration: Tc_{10}= 12.15 min
10-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(13.80cfs)(12.15\min)(60\min)\left(\frac{3}{2}\right)$ **= 15,091 cubic feet**

25-year peak flows: Q_{25} = 18.89 CFS
25-year time of concentration: Tc_{25}= 12.15 min
25-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(18.89cfs)(12.15\min)(60\min)\left(\frac{3}{2}\right)$ **= 20,657 cubic feet**

100-year peak flows: Q_{100} = 29.69 CFS
100-year time of concentration: Tc_{100}= 12.15 min
100-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(29.69cfs)(12.15\min)(60\min)\left(\frac{3}{2}\right)$ **= 32,467 cubic feet**

Node 6:

10-year peak flows: Q_{10} = 22.42 CFS
10-year time of concentration: Tc_{10}= 12.69 min
10-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(22.42cfs)(12.69\min)(60\min)\left(\frac{3}{2}\right)$ **= 25,606 cubic feet**

25-year peak flows: Q_{25} = 29.56 CFS
25-year time of concentration: Tc_{25}= 12.69 min
25-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(29.56cfs)(12.69\min)(60\min)\left(\frac{3}{2}\right)$ **= 33,761 cubic feet**

100-year peak flows: Q_{100} = 43.95 CFS
100-year time of concentration: Tc_{100}= 12.69 min
100-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(43.95cfs)(12.69\min)(60\min)\left(\frac{3}{2}\right)$ **= 50,196 cubic feet**

Node 9:

10-year peak flows: Q_{10} = 15.99 CFS
10-year time of concentration: Tc_{10}= 11.07 min
10-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(15.99cfs)(11.07\min)(60\min)\left(\frac{3}{2}\right)$ **= 15,931 cubic feet**

25-year peak flows: Q_{25} = 20.98 CFS
25-year time of concentration: Tc_{25}= 11.07 min
25-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(20.98cfs)(11.07\min)(60\min)\left(\frac{3}{2}\right)$ **= 20,903 cubic feet**

100-year peak flows: Q_{100} = 30.99 CFS
100-year time of concentration: Tc_{100}= 11.07 min
100-year volume produced = $(Q)(Tc)(60\min)\left(\frac{3}{2}\right)$

= $(30.99cfs)(11.07\min)(60\min)\left(\frac{3}{2}\right)$ **= 30,876 cubic feet**

Post-development Total:

10-year peak flows: Q_{10} = 52.21 CFS
10-year volume produced = 56,628 cubic feet

25-year peak flows: Q_{25} = 69.43 CFS
25-year volume produced = 75,321 cubic feet

100-year peak flows: Q_{100} = 104.63 CFS
100-year volume produced = 113,509 cubic feet

3. All post-development flows will be less then pre-developmetn flows leaving the site in both intensity and volume. There will be no need to provide any mitigation for increase onsite.

	Pre-development	Post-development	% Decreased
10-year flows	54.66 cfs	52.21 cfs	4.5
10-year volume	55,488 cubic feet	54,533 cubic feet	1.7
25-year flows	72.48 cfs	69.43 cfs	4.2
25-year volume	73.933 cubic feet	73,226 cubic feet	0.9
100-year flows	108.77 cfs	104.63 cfs	3.8
100-year volume	111,747 cubic feet	111,414 cubic feet	0.3

Conclusion

There will be no increase in post-development flows leaving the site from pre-development conditions. All onsite flows will continue as they have historically from the east portion of the site to Opal Avenue to the west.

Prepared By: Reviewed By:

_____ _____

Patrick C. Flanagan, Jr., P.E. M.W. "Bud" Thatcher III, P.E.
RCE 86046 Exp 9/30/18 RCE 39964 Exp 12/31/17

APPENDIX

Figure 1.1 PRE-DEVELOPMENT FLOW CALCULATIONS – 10-YEAR STORM

Figure 1.2 PRE-DEVELOPMENT FLOW CALCULATIONS – 25-YEAR STORM

Figure 1.3 PRE-DEVELOPMENT FLOW CALCULATIONS – 100-YEAR STORM

Figure 2.1 POST DEVELOPMENT FLOW CALCULATIONS – 10-YEAR STORM

Figure 2.2 POST DEVELOPMENT FLOW CALCULATIONS – 25-YEAR STORM

Figure 2.3 POST DEVELOPMENT FLOW CALCULATIONS – 100-YEAR STORM

Figure 3.1 ISOHYETAL MAP

Figure 3.2 SOIL GROUP

Figure 4.1 PRE-DEVELOPMENT TRIBUTARY MAP

Figure 4.2 POST-DEVELOPMENT TRIBUTARY MAP

```
****************************************************************************
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            Ver. 22.0  Release Date: 07/01/2015  License ID 1533

                          Analysis prepared by:

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                            REDLANDS, CA 92373
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 ************************** DESCRIPTION OF STUDY **************************
* 154801 - APN 0298-063-07                                                 *
* PRE-DEVELOPMENT DRAINAGE STUDY                                           *
* 10-YEAR STORM EVENT                                                      *
 ***************************************************************************

  FILE NAME: 154801PR.DAT
  TIME/DATE OF STUDY: 11:53 04/04/2017
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =   10.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   4.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.816
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.410
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =   10.00   1-HOUR INTENSITY(INCH/HOUR) = 0.8242
  SLOPE OF INTENSITY DURATION CURVE = 0.6000

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

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

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

```
****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   621.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     64.42

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.564
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.106
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  PUBLIC PARK                 A        5.19      0.98     0.850    32   12.56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.850
  SUBAREA RUNOFF(CFS) =       5.97
  TOTAL AREA(ACRES) =       5.19   PEAK FLOW RATE(CFS) =      5.97

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   636.00
  ELEVATION DATA: UPSTREAM(FEET) =     64.42  DOWNSTREAM(FEET) =     48.69

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.313
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.520
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  MOBILE HOME PARK            A        2.63      0.98     0.250    32    9.31
  CONDOMINIUMS                A        2.63      0.98     0.350    32    9.98
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.300
  SUBAREA AREA(ACRES) =     5.26   INITIAL SUBAREA RUNOFF(CFS) =   10.55

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.56
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.106
  SUBAREA AREA(ACRES) =     5.26      SUBAREA RUNOFF(CFS) =     8.58
  EFFECTIVE AREA(ACRES) =      10.45   AREA-AVERAGED Fm(INCH/HR) =  0.56
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.57
  TOTAL AREA(ACRES) =        10.5       PEAK FLOW RATE(CFS) =      14.55

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
```

```
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   695.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     53.42

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.421
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.120
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  ".4 DWELLING/ACRE"         A        7.44      0.98     0.900    32   12.42
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.900
  SUBAREA RUNOFF(CFS) =      8.32
  TOTAL AREA(ACRES) =      7.44   PEAK FLOW RATE(CFS) =      8.32

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   925.00
  ELEVATION DATA: UPSTREAM(FEET) =     53.42  DOWNSTREAM(FEET) =     45.62

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.138
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.150
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 A        4.86      0.98     0.100    32   12.14
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    4.86   INITIAL SUBAREA RUNOFF(CFS) =    8.98

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.42
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.120
  SUBAREA AREA(ACRES) =    4.86      SUBAREA RUNOFF(CFS) =    8.85
  EFFECTIVE AREA(ACRES) =     12.30   AREA-AVERAGED Fm(INCH/HR) =  0.57
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.58
  TOTAL AREA(ACRES) =       12.3       PEAK FLOW RATE(CFS) =      17.17

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   679.00
  ELEVATION DATA: UPSTREAM(FEET) =     86.62  DOWNSTREAM(FEET) =     52.76
```

```
Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.042
*  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.160
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
RESIDENTIAL
".4 DWELLING/ACRE"          A        4.85      0.98     0.900    32   12.04
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.900
SUBAREA RUNOFF(CFS) =      5.60
TOTAL AREA(ACRES) =      4.85   PEAK FLOW RATE(CFS) =      5.60

****************************************************************************
FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  82
----------------------------------------------------------------------------
>>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
>>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
INITIAL SUBAREA FLOW-LENGTH(FEET) =   629.00
ELEVATION DATA: UPSTREAM(FEET) =     52.76  DOWNSTREAM(FEET) =     47.51

Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.424
*  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.356
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
COMMERCIAL                  A        4.84      0.98     0.100    32   10.42
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
SUBAREA AREA(ACRES) =    4.84   INITIAL SUBAREA RUNOFF(CFS) =    9.84

** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
MAINLINE Tc(MIN.) =   12.04
*  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.160
SUBAREA AREA(ACRES) =    4.84      SUBAREA RUNOFF(CFS) =    8.98
EFFECTIVE AREA(ACRES) =      9.69   AREA-AVERAGED Fm(INCH/HR) =  0.49
AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.50
TOTAL AREA(ACRES) =        9.7       PEAK FLOW RATE(CFS) =      14.58

****************************************************************************
FLOW PROCESS FROM NODE     10.00 TO NODE     11.00 IS CODE =  21
----------------------------------------------------------------------------
>>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
INITIAL SUBAREA FLOW-LENGTH(FEET) =   217.00
ELEVATION DATA: UPSTREAM(FEET) =     52.40  DOWNSTREAM(FEET) =     46.53

Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.383
*  10 YEAR RAINFALL INTENSITY(INCH/HR) =  3.502
```

```
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
COMMERCIAL                  A        2.73      0.98     0.100    32    5.38
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
SUBAREA RUNOFF(CFS) =      8.36
TOTAL AREA(ACRES) =      2.73   PEAK FLOW RATE(CFS) =      8.36
==============================================================================
END OF STUDY SUMMARY:
TOTAL AREA(ACRES)      =        2.7  TC(MIN.) =      5.38
EFFECTIVE AREA(ACRES) =      2.73  AREA-AVERAGED Fm(INCH/HR)=  0.10
AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap = 0.100
PEAK FLOW RATE(CFS)   =       8.36
==============================================================================
==============================================================================
END OF RATIONAL METHOD ANALYSIS
```

```
****************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
         (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
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            Ver. 22.0  Release Date: 07/01/2015  License ID 1533

                          Analysis prepared by:

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                       1461 FORD STREET, SUITE 105
                            REDLANDS, CA 92373
               PHONE: (909) 748-7777   FAX: (909) 748-7776

 ************************** DESCRIPTION OF STUDY **************************
* 154801 - APN 0298-063-07                                                 *
* PRE-DEVELOPMENT DRAINAGE STUDY                                           *
* 25-YEAR STORM EVENT                                                      *
 ***************************************************************************

  FILE NAME: 154801PR.DAT
  TIME/DATE OF STUDY: 11:52 04/04/2017
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =   25.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   4.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.816
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.410
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =   25.00   1-HOUR INTENSITY(INCH/HOUR) = 1.0318
  SLOPE OF INTENSITY DURATION CURVE = 0.6000

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

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

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

```
****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   621.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     64.42

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.564
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.636
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  PUBLIC PARK                 A        5.19      0.98     0.850    32   12.56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.850
  SUBAREA RUNOFF(CFS) =       8.44
  TOTAL AREA(ACRES) =       5.19   PEAK FLOW RATE(CFS) =      8.44

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   636.00
  ELEVATION DATA: UPSTREAM(FEET) =     64.42  DOWNSTREAM(FEET) =     48.69

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.313
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.155
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  MOBILE HOME PARK            A        2.63      0.98     0.250    32    9.31
  CONDOMINIUMS                A        2.63      0.98     0.350    32    9.98
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.300
  SUBAREA AREA(ACRES) =     5.26   INITIAL SUBAREA RUNOFF(CFS) =   13.55

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.56
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.636
  SUBAREA AREA(ACRES) =     5.26      SUBAREA RUNOFF(CFS) =   11.10
  EFFECTIVE AREA(ACRES) =      10.45   AREA-AVERAGED Fm(INCH/HR) =  0.56
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.57
  TOTAL AREA(ACRES) =        10.5       PEAK FLOW RATE(CFS) =      19.54

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
```

```
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   695.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     53.42

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.421
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.655
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  ".4 DWELLING/ACRE"          A        7.44      0.98     0.900    32   12.42
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.900
  SUBAREA RUNOFF(CFS) =     11.90
  TOTAL AREA(ACRES) =      7.44   PEAK FLOW RATE(CFS) =     11.90

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   925.00
  ELEVATION DATA: UPSTREAM(FEET) =     53.42  DOWNSTREAM(FEET) =     45.62

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.138
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.692
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        4.86      0.98     0.100    32   12.14
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    4.86   INITIAL SUBAREA RUNOFF(CFS) =   11.35

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.42
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.655
  SUBAREA AREA(ACRES) =    4.86      SUBAREA RUNOFF(CFS) =   11.18
  EFFECTIVE AREA(ACRES) =     12.30   AREA-AVERAGED Fm(INCH/HR) =  0.57
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.58
  TOTAL AREA(ACRES) =       12.3       PEAK FLOW RATE(CFS) =      23.08

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   679.00
  ELEVATION DATA: UPSTREAM(FEET) =     86.62  DOWNSTREAM(FEET) =     52.76
```

```
Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.042
*  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.704
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
RESIDENTIAL
".4 DWELLING/ACRE"          A        4.85      0.98     0.900    32   12.04
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.900
SUBAREA RUNOFF(CFS) =      7.97
TOTAL AREA(ACRES) =      4.85   PEAK FLOW RATE(CFS) =      7.97

****************************************************************************
FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  82
----------------------------------------------------------------------------
>>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
>>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
INITIAL SUBAREA FLOW-LENGTH(FEET) =   629.00
ELEVATION DATA: UPSTREAM(FEET) =     52.76  DOWNSTREAM(FEET) =     47.51

Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.424
*  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.949
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
COMMERCIAL                  A        4.84      0.98     0.100    32   10.42
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
SUBAREA AREA(ACRES) =    4.84   INITIAL SUBAREA RUNOFF(CFS) =   12.42

** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
MAINLINE Tc(MIN.) =   12.04
*  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.704
SUBAREA AREA(ACRES) =    4.84      SUBAREA RUNOFF(CFS) =   11.36
EFFECTIVE AREA(ACRES) =      9.69   AREA-AVERAGED Fm(INCH/HR) =  0.49
AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.50
TOTAL AREA(ACRES) =        9.7       PEAK FLOW RATE(CFS) =      19.33

****************************************************************************
FLOW PROCESS FROM NODE     10.00 TO NODE     11.00 IS CODE =  21
----------------------------------------------------------------------------
>>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
INITIAL SUBAREA FLOW-LENGTH(FEET) =   217.00
ELEVATION DATA: UPSTREAM(FEET) =     52.40  DOWNSTREAM(FEET) =     46.53

Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.383
*  25 YEAR RAINFALL INTENSITY(INCH/HR) =  4.384
```

```
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
COMMERCIAL                  A       2.73      0.98     0.100    32    5.38
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
SUBAREA RUNOFF(CFS) =     10.53
TOTAL AREA(ACRES) =      2.73   PEAK FLOW RATE(CFS) =     10.53
============================================================================
END OF STUDY SUMMARY:
TOTAL AREA(ACRES)      =        2.7  TC(MIN.) =      5.38
EFFECTIVE AREA(ACRES) =      2.73  AREA-AVERAGED Fm(INCH/HR)=  0.10
AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap = 0.100
PEAK FLOW RATE(CFS)    =      10.53
============================================================================
============================================================================
END OF RATIONAL METHOD ANALYSIS
```

```
****************************************************************************
              RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
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                          Analysis prepared by:

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 ************************** DESCRIPTION OF STUDY **************************
* 154801 - APN 0298-063-07                                                 *
* PRE-DEVELOPMENT DRAINAGE STUDY                                           *
* 100-YEAR STORM EVENT                                                     *
 ***************************************************************************

  FILE NAME: 154801PR.DAT
  TIME/DATE OF STUDY: 11:52 04/04/2017
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                     --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   4.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.816
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.410
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =  100.00   1-HOUR INTENSITY(INCH/HOUR) = 1.4100
  SLOPE OF INTENSITY DURATION CURVE = 0.6000

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

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

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

```
****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   621.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     64.42

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.564
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.603
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  PUBLIC PARK                 A        5.19      0.74     0.850    52   12.56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.850
  SUBAREA RUNOFF(CFS) =     13.88
  TOTAL AREA(ACRES) =       5.19   PEAK FLOW RATE(CFS) =     13.88

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   636.00
  ELEVATION DATA: UPSTREAM(FEET) =     64.42  DOWNSTREAM(FEET) =     48.69

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.313
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.312
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  MOBILE HOME PARK            A        2.63      0.74     0.250    52    9.31
  CONDOMINIUMS                A        2.63      0.74     0.350    52    9.98
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.300
  SUBAREA AREA(ACRES) =     5.26   INITIAL SUBAREA RUNOFF(CFS) =   19.36

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.56
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.603
  SUBAREA AREA(ACRES) =     5.26      SUBAREA RUNOFF(CFS) =   16.00
  EFFECTIVE AREA(ACRES) =     10.45   AREA-AVERAGED Fm(INCH/HR) =  0.43
  AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap =  0.57
  TOTAL AREA(ACRES) =       10.5       PEAK FLOW RATE(CFS) =      29.88

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
```

```
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   695.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     53.42

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.421
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.628
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  ".4 DWELLING/ACRE"          A        7.44      0.74     0.900    52   12.42
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.900
  SUBAREA RUNOFF(CFS) =     19.82
  TOTAL AREA(ACRES) =      7.44   PEAK FLOW RATE(CFS) =     19.82

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   925.00
  ELEVATION DATA: UPSTREAM(FEET) =     53.42  DOWNSTREAM(FEET) =     45.62

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.138
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.678
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        4.86      0.74     0.100    52   12.14
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    4.86   INITIAL SUBAREA RUNOFF(CFS) =   15.76

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.42
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.628
  SUBAREA AREA(ACRES) =    4.86      SUBAREA RUNOFF(CFS) =   15.54
  EFFECTIVE AREA(ACRES) =     12.30   AREA-AVERAGED Fm(INCH/HR) =  0.43
  AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap =  0.58
  TOTAL AREA(ACRES) =       12.3       PEAK FLOW RATE(CFS) =      35.36

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   679.00
  ELEVATION DATA: UPSTREAM(FEET) =     86.62  DOWNSTREAM(FEET) =     52.76
```

```
Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.042
* 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.696
SUBAREA Tc AND LOSS RATE DATA(AMC III):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
RESIDENTIAL
".4 DWELLING/ACRE"          A        4.85      0.74     0.900    52   12.04
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.900
SUBAREA RUNOFF(CFS) =     13.22
TOTAL AREA(ACRES) =      4.85   PEAK FLOW RATE(CFS) =     13.22

****************************************************************************
FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  82
----------------------------------------------------------------------------
>>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
>>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
INITIAL SUBAREA FLOW-LENGTH(FEET) =   629.00
ELEVATION DATA: UPSTREAM(FEET) =     52.76  DOWNSTREAM(FEET) =     47.51

Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.424
* 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.030
SUBAREA Tc AND LOSS RATE DATA(AMC III):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
COMMERCIAL                  A        4.84      0.74     0.100    52   10.42
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
SUBAREA AREA(ACRES) =    4.84   INITIAL SUBAREA RUNOFF(CFS) =   17.23

** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
MAINLINE Tc(MIN.) =   12.04
* 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.696
SUBAREA AREA(ACRES) =    4.84      SUBAREA RUNOFF(CFS) =   15.77
EFFECTIVE AREA(ACRES) =      9.69   AREA-AVERAGED Fm(INCH/HR) =  0.37
AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap =  0.50
TOTAL AREA(ACRES) =        9.7       PEAK FLOW RATE(CFS) =      28.99

****************************************************************************
FLOW PROCESS FROM NODE     10.00 TO NODE     11.00 IS CODE =  21
----------------------------------------------------------------------------
>>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
INITIAL SUBAREA FLOW-LENGTH(FEET) =   217.00
ELEVATION DATA: UPSTREAM(FEET) =     52.40  DOWNSTREAM(FEET) =     46.53

Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.383
* 100 YEAR RAINFALL INTENSITY(INCH/HR) =  5.991
```

```
SUBAREA Tc AND LOSS RATE DATA(AMC III):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
COMMERCIAL                 A        2.73      0.74     0.100    52    5.38
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
SUBAREA RUNOFF(CFS) =     14.54
TOTAL AREA(ACRES) =      2.73   PEAK FLOW RATE(CFS) =     14.54
============================================================================
END OF STUDY SUMMARY:
TOTAL AREA(ACRES)      =        2.7  TC(MIN.) =      5.38
EFFECTIVE AREA(ACRES) =      2.73  AREA-AVERAGED Fm(INCH/HR)=  0.07
AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap = 0.100
PEAK FLOW RATE(CFS)    =      14.54
============================================================================
============================================================================
END OF RATIONAL METHOD ANALYSIS
```

```
****************************************************************************
              RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
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                          Analysis prepared by:

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                            REDLANDS, CA 92373
               PHONE: (909) 748-7777   FAX: (909) 748-7776

 ************************* DESCRIPTION OF STUDY *************************
* 154801 - APN 0298-063-07                                               *
* POST-DEVELOPMENT DRAINAGE STUDY                                        *
* 10-YEAR STORM EVENT                                                    *
 ************************************************************************

  FILE NAME: 154801PO.DAT
  TIME/DATE OF STUDY: 13:27 04/04/2017
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =   10.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   4.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.816
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.410
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =   10.00   1-HOUR INTENSITY(INCH/HOUR) = 0.8242
  SLOPE OF INTENSITY DURATION CURVE = 0.6000

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

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

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

```
****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   621.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     64.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.149
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.149
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "1 DWELLING/ACRE"           A        5.19      0.98     0.800    32   12.15
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.800
  SUBAREA RUNOFF(CFS) =      6.39
  TOTAL AREA(ACRES) =      5.19   PEAK FLOW RATE(CFS) =      6.39

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   710.00
  ELEVATION DATA: UPSTREAM(FEET) =     64.00  DOWNSTREAM(FEET) =     48.10

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.172
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.146
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"        A        5.26      0.98     0.600    32   12.17
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.97
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
  SUBAREA AREA(ACRES) =    5.26   INITIAL SUBAREA RUNOFF(CFS) =    7.39

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.15
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.149
  SUBAREA AREA(ACRES) =    5.26      SUBAREA RUNOFF(CFS) =    7.40
  EFFECTIVE AREA(ACRES) =     10.45   AREA-AVERAGED Fm(INCH/HR) =  0.68
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.70
  TOTAL AREA(ACRES) =       10.5       PEAK FLOW RATE(CFS) =      13.80

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  21
----------------------------------------------------------------------------
```

```
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   657.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     65.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.693
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.093
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "1 DWELLING/ACRE"           A        7.44      0.98     0.800    32   12.69
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.800
  SUBAREA RUNOFF(CFS) =      8.79
  TOTAL AREA(ACRES) =      7.44   PEAK FLOW RATE(CFS) =      8.79

******************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  82
------------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   893.00
  ELEVATION DATA: UPSTREAM(FEET) =     65.00  DOWNSTREAM(FEET) =     45.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.844
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.438
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        4.86      0.98     0.100    32    9.84
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    4.86   INITIAL SUBAREA RUNOFF(CFS) =   10.24

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.69
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.093
  SUBAREA AREA(ACRES) =    4.86      SUBAREA RUNOFF(CFS) =    8.73
  EFFECTIVE AREA(ACRES) =     12.30   AREA-AVERAGED Fm(INCH/HR) =  0.51
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.52
  TOTAL AREA(ACRES) =       12.3       PEAK FLOW RATE(CFS) =      17.52

******************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      6.00 IS CODE =   1
------------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
==============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
```

```
  TIME OF CONCENTRATION(MIN.) =   12.69
  RAINFALL INTENSITY(INCH/HR) =   2.09
  AREA-AVERAGED Fm(INCH/HR) =  0.51
  AREA-AVERAGED Fp(INCH/HR) =  0.98
  AREA-AVERAGED Ap =  0.52
  EFFECTIVE STREAM AREA(ACRES) =      12.30
  TOTAL STREAM AREA(ACRES) =      12.30
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      17.52

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   619.00
  ELEVATION DATA: UPSTREAM(FEET) =     85.20  DOWNSTREAM(FEET) =     52.76

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.066
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.273
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "1 DWELLING/ACRE"           A        4.85      0.98     0.800    32   11.07
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.800
  SUBAREA RUNOFF(CFS) =      6.52
  TOTAL AREA(ACRES) =      4.85   PEAK FLOW RATE(CFS) =      6.52

****************************************************************************
  FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   629.00
  ELEVATION DATA: UPSTREAM(FEET) =     52.76  DOWNSTREAM(FEET) =     47.51

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.424
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.356
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        4.84      0.98     0.100    32   10.42
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    4.84   INITIAL SUBAREA RUNOFF(CFS) =    9.84

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   11.07
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.273
```

```
  SUBAREA AREA(ACRES) =     4.84      SUBAREA RUNOFF(CFS) =     9.47
  EFFECTIVE AREA(ACRES) =       9.69   AREA-AVERAGED Fm(INCH/HR) =  0.44
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.45
  TOTAL AREA(ACRES) =         9.7       PEAK FLOW RATE(CFS) =      15.99

****************************************************************************
  FLOW PROCESS FROM NODE     10.00 TO NODE      6.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   349.00
  ELEVATION DATA: UPSTREAM(FEET) =     52.40  DOWNSTREAM(FEET) =     45.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    6.835
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  3.034
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        2.73      0.98     0.100    32    6.83
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =       7.22
  TOTAL AREA(ACRES) =       2.73   PEAK FLOW RATE(CFS) =      7.22

****************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      6.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.83
  RAINFALL INTENSITY(INCH/HR) =   3.03
  AREA-AVERAGED Fm(INCH/HR) =  0.10
  AREA-AVERAGED Fp(INCH/HR) =  0.98
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       2.73
  TOTAL STREAM AREA(ACRES) =       2.73
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       7.22

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       17.52   12.69    2.093  0.98( 0.51) 0.52      12.3       4.00
      2        7.22    6.83    3.034  0.98( 0.10) 0.10       2.7      10.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
```

```
 NUMBER      (CFS)   (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
    1        22.26    6.83    3.034  0.98( 0.39) 0.40       9.4      10.00
    2        22.42   12.69    2.093  0.97( 0.44) 0.45      15.0       4.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      22.42    Tc(MIN.) =    12.69
 EFFECTIVE AREA(ACRES) =      15.03   AREA-AVERAGED Fm(INCH/HR) =  0.44
 AREA-AVERAGED Fp(INCH/HR) =  0.97  AREA-AVERAGED Ap =  0.45
 TOTAL AREA(ACRES) =       15.0
 LONGEST FLOWPATH FROM NODE      4.00 TO NODE      6.00 =     657.00 FEET.
============================================================================
 END OF STUDY SUMMARY:
 TOTAL AREA(ACRES)      =       15.0  TC(MIN.) =     12.69
 EFFECTIVE AREA(ACRES) =     15.03  AREA-AVERAGED Fm(INCH/HR)=  0.44
 AREA-AVERAGED Fp(INCH/HR) =  0.97  AREA-AVERAGED Ap = 0.447
 PEAK FLOW RATE(CFS)    =      22.42

 ** PEAK FLOW RATE TABLE **
  STREAM       Q       Tc   Intensity   Fp(Fm)      Ap      Ae     HEADWATER
  NUMBER     (CFS)   (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
    1        22.26    6.83    3.034  0.98( 0.39) 0.40       9.4      10.00
    2        22.42   12.69    2.093  0.97( 0.44) 0.45      15.0       4.00
============================================================================
============================================================================
 END OF RATIONAL METHOD ANALYSIS
```

```
****************************************************************************
              RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
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                          Analysis prepared by:

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 ************************** DESCRIPTION OF STUDY **************************
* 154801 - APN 0298-063-07                                                 *
* POST-DEVELOPMENT DRAINAGE STUDY                                          *
* 25-YEAR STORM EVENT                                                      *
 ***************************************************************************

  FILE NAME: 154801PO.DAT
  TIME/DATE OF STUDY: 13:26 04/04/2017
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                     --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =   25.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   4.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.816
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.410
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =   25.00   1-HOUR INTENSITY(INCH/HOUR) = 1.0318
  SLOPE OF INTENSITY DURATION CURVE = 0.6000

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

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

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

```
****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   621.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     64.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.149
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.690
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "1 DWELLING/ACRE"          A        5.19      0.98     0.800    32   12.15
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.800
  SUBAREA RUNOFF(CFS) =      8.92
  TOTAL AREA(ACRES) =      5.19   PEAK FLOW RATE(CFS) =      8.92

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   710.00
  ELEVATION DATA: UPSTREAM(FEET) =     64.00  DOWNSTREAM(FEET) =     48.10

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.172
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.687
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"       A        5.26      0.98     0.600    32   12.17
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.97
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
  SUBAREA AREA(ACRES) =    5.26   INITIAL SUBAREA RUNOFF(CFS) =    9.95

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.15
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.690
  SUBAREA AREA(ACRES) =    5.26      SUBAREA RUNOFF(CFS) =    9.97
  EFFECTIVE AREA(ACRES) =     10.45   AREA-AVERAGED Fm(INCH/HR) =  0.68
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.70
  TOTAL AREA(ACRES) =       10.5       PEAK FLOW RATE(CFS) =      18.89

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  21
----------------------------------------------------------------------------
```

```
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   657.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     65.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.693
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.620
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "1 DWELLING/ACRE"           A        7.44      0.98     0.800    32   12.69
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.800
  SUBAREA RUNOFF(CFS) =     12.32
  TOTAL AREA(ACRES) =      7.44   PEAK FLOW RATE(CFS) =     12.32

******************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  82
------------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   893.00
  ELEVATION DATA: UPSTREAM(FEET) =     65.00  DOWNSTREAM(FEET) =     45.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.844
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.052
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        4.86      0.98     0.100    32    9.84
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    4.86   INITIAL SUBAREA RUNOFF(CFS) =   12.92

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.69
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.620
  SUBAREA AREA(ACRES) =    4.86      SUBAREA RUNOFF(CFS) =   11.03
  EFFECTIVE AREA(ACRES) =     12.30   AREA-AVERAGED Fm(INCH/HR) =  0.51
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.52
  TOTAL AREA(ACRES) =       12.3       PEAK FLOW RATE(CFS) =      23.36

******************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      6.00 IS CODE =   1
------------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
==============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
```

```
  TIME OF CONCENTRATION(MIN.) =   12.69
  RAINFALL INTENSITY(INCH/HR) =   2.62
  AREA-AVERAGED Fm(INCH/HR) =  0.51
  AREA-AVERAGED Fp(INCH/HR) =  0.98
  AREA-AVERAGED Ap =  0.52
  EFFECTIVE STREAM AREA(ACRES) =      12.30
  TOTAL STREAM AREA(ACRES) =      12.30
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      23.36

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   619.00
  ELEVATION DATA: UPSTREAM(FEET) =     85.20  DOWNSTREAM(FEET) =     52.76

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.066
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.845
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "1 DWELLING/ACRE"           A        4.85      0.98     0.800    32   11.07
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.800
  SUBAREA RUNOFF(CFS) =       9.01
  TOTAL AREA(ACRES) =       4.85   PEAK FLOW RATE(CFS) =      9.01

****************************************************************************
  FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   629.00
  ELEVATION DATA: UPSTREAM(FEET) =     52.76  DOWNSTREAM(FEET) =     47.51

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.424
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.949
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        4.84      0.98     0.100    32   10.42
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =     4.84   INITIAL SUBAREA RUNOFF(CFS) =   12.42

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   11.07
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.845
```

```
  SUBAREA AREA(ACRES) =     4.84       SUBAREA RUNOFF(CFS) =    11.97
  EFFECTIVE AREA(ACRES) =       9.69   AREA-AVERAGED Fm(INCH/HR) =  0.44
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.45
  TOTAL AREA(ACRES) =         9.7        PEAK FLOW RATE(CFS) =       20.98

****************************************************************************
  FLOW PROCESS FROM NODE     10.00 TO NODE      6.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   349.00
  ELEVATION DATA: UPSTREAM(FEET) =     52.40  DOWNSTREAM(FEET) =     45.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    6.835
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.799
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        2.73      0.98     0.100    32    6.83
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =       9.09
  TOTAL AREA(ACRES) =       2.73   PEAK FLOW RATE(CFS) =      9.09

****************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      6.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.83
  RAINFALL INTENSITY(INCH/HR) =   3.80
  AREA-AVERAGED Fm(INCH/HR) =  0.10
  AREA-AVERAGED Fp(INCH/HR) =  0.98
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       2.73
  TOTAL STREAM AREA(ACRES) =       2.73
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       9.09

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       23.36   12.69    2.620  0.98( 0.51) 0.52      12.3       4.00
      2        9.09    6.83    3.799  0.98( 0.10) 0.10       2.7      10.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
```

NUMBER	(CFS)	(MIN.)	(INCH/HR)	(INCH/HR)		(ACRES)	NODE
1	28.70	6.83	3.799	0.98(0.39)	0.40	9.4	10.00
2	29.56	12.69	2.620	0.97(0.44)	0.45	15.0	4.00

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
PEAK FLOW RATE(CFS) = 29.56 Tc(MIN.) = 12.69
EFFECTIVE AREA(ACRES) = 15.03 AREA-AVERAGED Fm(INCH/HR) = 0.44
AREA-AVERAGED Fp(INCH/HR) = 0.97 AREA-AVERAGED Ap = 0.45
TOTAL AREA(ACRES) = 15.0
LONGEST FLOWPATH FROM NODE 4.00 TO NODE 6.00 = 657.00 FEET.

==========

END OF STUDY SUMMARY:
TOTAL AREA(ACRES) = 15.0 TC(MIN.) = 12.69
EFFECTIVE AREA(ACRES) = 15.03 AREA-AVERAGED Fm(INCH/HR)= 0.44
AREA-AVERAGED Fp(INCH/HR) = 0.97 AREA-AVERAGED Ap = 0.447
PEAK FLOW RATE(CFS) = 29.56

** PEAK FLOW RATE TABLE **

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	28.70	6.83	3.799	0.98(0.39)	0.40	9.4	10.00
2	29.56	12.69	2.620	0.97(0.44)	0.45	15.0	4.00

==========

==========

END OF RATIONAL METHOD ANALYSIS

```
****************************************************************************
              RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
         (c) Copyright 1983-2015 Advanced Engineering Software (aes)
             Ver. 22.0  Release Date: 07/01/2015  License ID 1533

                              Analysis prepared by:

                   THATCHER ENGINEERING & ASSOCIATES, INC.
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                              REDLANDS, CA 92373
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 ************************** DESCRIPTION OF STUDY **************************
* 154801 - APN 0298-063-07                                                 *
* POST-DEVELOPMENT DRAINAGE STUDY                                          *
* 100-YEAR STORM EVENT                                                     *
 ***************************************************************************

  FILE NAME: 154801PO.DAT
  TIME/DATE OF STUDY: 13:26 04/04/2017
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                     --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   4.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.816
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.410
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =  100.00   1-HOUR INTENSITY(INCH/HOUR) = 1.4100
  SLOPE OF INTENSITY DURATION CURVE = 0.6000

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

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

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

```
****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   621.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     64.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.149
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.676
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "1 DWELLING/ACRE"           A        5.19      0.74     0.800    52   12.15
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.800
  SUBAREA RUNOFF(CFS) =     14.40
  TOTAL AREA(ACRES) =      5.19   PEAK FLOW RATE(CFS) =     14.40

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   710.00
  ELEVATION DATA: UPSTREAM(FEET) =     64.00  DOWNSTREAM(FEET) =     48.10

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.172
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.672
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "3-4 DWELLINGS/ACRE"        A        5.26      0.74     0.600    52   12.17
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.600
  SUBAREA AREA(ACRES) =    5.26   INITIAL SUBAREA RUNOFF(CFS) =   15.28

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.15
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.676
  SUBAREA AREA(ACRES) =    5.26      SUBAREA RUNOFF(CFS) =   15.29
  EFFECTIVE AREA(ACRES) =     10.45   AREA-AVERAGED Fm(INCH/HR) =  0.52
  AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap =  0.70
  TOTAL AREA(ACRES) =       10.5       PEAK FLOW RATE(CFS) =      29.69

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  21
----------------------------------------------------------------------------
```

Figure 2.3

```
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   657.00
  ELEVATION DATA: UPSTREAM(FEET) =     84.53  DOWNSTREAM(FEET) =     65.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.693
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.581
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "1 DWELLING/ACRE"           A        7.44      0.74     0.800    52   12.69
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.800
  SUBAREA RUNOFF(CFS) =     20.00
  TOTAL AREA(ACRES) =      7.44   PEAK FLOW RATE(CFS) =     20.00

******************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  82
------------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   893.00
  ELEVATION DATA: UPSTREAM(FEET) =     65.00  DOWNSTREAM(FEET) =     45.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.844
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.171
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        4.86      0.74     0.100    52    9.84
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    4.86   INITIAL SUBAREA RUNOFF(CFS) =   17.92

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   12.69
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.581
  SUBAREA AREA(ACRES) =    4.86      SUBAREA RUNOFF(CFS) =   15.34
  EFFECTIVE AREA(ACRES) =     12.30   AREA-AVERAGED Fm(INCH/HR) =  0.39
  AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap =  0.52
  TOTAL AREA(ACRES) =       12.3       PEAK FLOW RATE(CFS) =      35.34

******************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      6.00 IS CODE =   1
------------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
==============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
```

```
  TIME OF CONCENTRATION(MIN.) =   12.69
  RAINFALL INTENSITY(INCH/HR) =   3.58
  AREA-AVERAGED Fm(INCH/HR) =  0.39
  AREA-AVERAGED Fp(INCH/HR) =  0.74
  AREA-AVERAGED Ap =  0.52
  EFFECTIVE STREAM AREA(ACRES) =      12.30
  TOTAL STREAM AREA(ACRES) =      12.30
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      35.34

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   619.00
  ELEVATION DATA: UPSTREAM(FEET) =     85.20  DOWNSTREAM(FEET) =     52.76

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.066
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.888
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "1 DWELLING/ACRE"           A        4.85      0.74     0.800    52   11.07
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.800
  SUBAREA RUNOFF(CFS) =      14.38
  TOTAL AREA(ACRES) =       4.85   PEAK FLOW RATE(CFS) =     14.38

****************************************************************************
  FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  82
----------------------------------------------------------------------------
  >>>>>ADD SUBAREA RUNOFF TO MAINLINE, AT MAINLINE Tc,<<<<<
  >>>>>(AND COMPUTE INITIAL SUBAREA RUNOFF)<<<<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   629.00
  ELEVATION DATA: UPSTREAM(FEET) =     52.76  DOWNSTREAM(FEET) =     47.51

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.424
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.030
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        4.84      0.74     0.100    52   10.42
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =     4.84   INITIAL SUBAREA RUNOFF(CFS) =   17.23

  ** ADD SUBAREA RUNOFF TO MAINLINE AT MAINLINE Tc:
  MAINLINE Tc(MIN.) =   11.07
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.888
```

```
  SUBAREA AREA(ACRES) =     4.84      SUBAREA RUNOFF(CFS) =    16.61
  EFFECTIVE AREA(ACRES) =       9.69   AREA-AVERAGED Fm(INCH/HR) =  0.33
  AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap =  0.45
  TOTAL AREA(ACRES) =         9.7       PEAK FLOW RATE(CFS) =      30.99

****************************************************************************
  FLOW PROCESS FROM NODE     10.00 TO NODE      6.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   349.00
  ELEVATION DATA: UPSTREAM(FEET) =     52.40  DOWNSTREAM(FEET) =     45.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    6.835
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  5.191
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        2.73      0.74     0.100    52    6.83
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =     12.57
  TOTAL AREA(ACRES) =      2.73   PEAK FLOW RATE(CFS) =     12.57

****************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      6.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.83
  RAINFALL INTENSITY(INCH/HR) =   5.19
  AREA-AVERAGED Fm(INCH/HR) =  0.07
  AREA-AVERAGED Fp(INCH/HR) =  0.74
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       2.73
  TOTAL STREAM AREA(ACRES) =       2.73
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      12.57

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       35.34   12.69    3.581  0.74( 0.39) 0.52      12.3       4.00
      2       12.57    6.83    5.191  0.74( 0.07) 0.10       2.7      10.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
```

NUMBER	(CFS)	(MIN.)	(INCH/HR)	(INCH/HR)		(ACRES)	NODE
1	41.20	6.83	5.191	0.74(0.30)	0.40	9.4	10.00
2	43.95	12.69	3.581	0.74(0.33)	0.45	15.0	4.00

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
PEAK FLOW RATE(CFS) = 43.95 Tc(MIN.) = 12.69
EFFECTIVE AREA(ACRES) = 15.03 AREA-AVERAGED Fm(INCH/HR) = 0.33
AREA-AVERAGED Fp(INCH/HR) = 0.74 AREA-AVERAGED Ap = 0.45
TOTAL AREA(ACRES) = 15.0
LONGEST FLOWPATH FROM NODE 4.00 TO NODE 6.00 = 657.00 FEET.

==========

END OF STUDY SUMMARY:
TOTAL AREA(ACRES) = 15.0 TC(MIN.) = 12.69
EFFECTIVE AREA(ACRES) = 15.03 AREA-AVERAGED Fm(INCH/HR)= 0.33
AREA-AVERAGED Fp(INCH/HR) = 0.74 AREA-AVERAGED Ap = 0.447
PEAK FLOW RATE(CFS) = 43.95

** PEAK FLOW RATE TABLE **

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	41.20	6.83	5.191	0.74(0.30)	0.40	9.4	10.00
2	43.95	12.69	3.581	0.74(0.33)	0.45	15.0	4.00

==========

==========

END OF RATIONAL METHOD ANALYSIS

NOAA Atlas 14, Volume 6, Version 2
Location name: Mentone, California, US*
Coordinates: 34.0648, -117.1323
Elevation: 1666 ft*
* source: Google Maps

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	**0.105** (0.087-0.127)	**0.139** (0.115-0.169)	**0.187** (0.155-0.228)	**0.229** (0.188-0.282)	**0.291** (0.231-0.370)	**0.341** (0.265-0.443)	**0.396** (0.300-0.528)	**0.456** (0.336-0.625)	**0.544** (0.384-0.778)	**0.617** (0.420-0.914)
10-min	**0.150** (0.125-0.182)	**0.199** (0.166-0.242)	**0.268** (0.222-0.327)	**0.329** (0.270-0.404)	**0.416** (0.331-0.530)	**0.489** (0.380-0.636)	**0.568** (0.430-0.756)	**0.654** (0.481-0.896)	**0.779** (0.550-1.11)	**0.884** (0.602-1.31)
15-min	**0.181** (0.151-0.220)	**0.241** (0.200-0.293)	**0.325** (0.269-0.396)	**0.397** (0.327-0.488)	**0.504** (0.400-0.641)	**0.591** (0.460-0.769)	**0.686** (0.520-0.915)	**0.790** (0.582-1.08)	**0.942** (0.665-1.35)	**1.07** (0.729-1.58)
30-min	**0.266** (0.221-0.323)	**0.353** (0.293-0.429)	**0.476** (0.394-0.580)	**0.582** (0.479-0.716)	**0.738** (0.586-0.939)	**0.867** (0.674-1.13)	**1.01** (0.762-1.34)	**1.16** (0.853-1.59)	**1.38** (0.975-1.98)	**1.57** (1.07-2.32)
60-min	**0.373** (0.310-0.452)	**0.495** (0.411-0.601)	**0.666** (0.552-0.812)	**0.816** (0.670-1.00)	**1.03** (0.821-1.31)	**1.21** (0.943-1.58)	**1.41** (1.07-1.88)	**1.62** (1.20-2.23)	**1.93** (1.36-2.77)	**2.19** (1.50-3.25)
2-hr	**0.536** (0.446-0.651)	**0.696** (0.579-0.846)	**0.919** (0.761-1.12)	**1.11** (0.912-1.36)	**1.38** (1.10-1.76)	**1.61** (1.25-2.09)	**1.85** (1.40-2.46)	**2.10** (1.55-2.89)	**2.48** (1.75-3.54)	**2.78** (1.90-4.12)
3-hr	**0.657** (0.547-0.798)	**0.846** (0.703-1.03)	**1.10** (0.916-1.35)	**1.33** (1.09-1.63)	**1.64** (1.30-2.09)	**1.90** (1.47-2.46)	**2.17** (1.64-2.89)	**2.46** (1.81-3.37)	**2.87** (2.03-4.11)	**3.21** (2.19-4.75)
6-hr	**0.919** (0.765-1.12)	**1.17** (0.974-1.42)	**1.51** (1.25-1.85)	**1.80** (1.48-2.22)	**2.21** (1.75-2.81)	**2.53** (1.97-3.29)	**2.87** (2.18-3.83)	**3.23** (2.38-4.43)	**3.73** (2.63-5.34)	**4.14** (2.82-6.13)
12-hr	**1.25** (1.04-1.51)	**1.59** (1.32-1.93)	**2.05** (1.70-2.50)	**2.43** (1.99-2.98)	**2.95** (2.35-3.76)	**3.36** (2.62-4.37)	**3.79** (2.87-5.05)	**4.23** (3.12-5.80)	**4.84** (3.42-6.93)	**5.33** (3.63-7.90)
24-hr	**1.68** (1.49-1.93)	**2.16** (1.91-2.49)	**2.79** (2.46-3.23)	**3.31** (2.90-3.86)	**4.03** (3.41-4.85)	**4.58** (3.80-5.63)	**5.14** (4.16-6.47)	**5.72** (4.51-7.41)	**6.52** (4.93-8.79)	**7.14** (5.22-9.95)
2-day	**2.04** (1.80-2.35)	**2.66** (2.35-3.07)	**3.49** (3.08-4.04)	**4.17** (3.65-4.87)	**5.11** (4.33-6.16)	**5.84** (4.85-7.18)	**6.59** (5.34-8.30)	**7.37** (5.81-9.54)	**8.44** (6.39-11.4)	**9.28** (6.79-12.9)
3-day	**2.18** (1.93-2.51)	**2.88** (2.55-3.33)	**3.83** (3.38-4.43)	**4.61** (4.03-5.37)	**5.69** (4.82-6.86)	**6.54** (5.43-8.04)	**7.42** (6.01-9.34)	**8.33** (6.57-10.8)	**9.60** (7.27-12.9)	**10.6** (7.76-14.8)
4-day	**2.35** (2.08-2.70)	**3.13** (2.77-3.61)	**4.18** (3.69-4.84)	**5.06** (4.42-5.90)	**6.27** (5.31-7.56)	**7.23** (6.00-8.89)	**8.22** (6.66-10.4)	**9.26** (7.30-12.0)	**10.7** (8.10-14.4)	**11.9** (8.67-16.5)
7-day	**2.70** (2.39-3.11)	**3.65** (3.23-4.21)	**4.93** (4.35-5.71)	**6.00** (5.25-6.99)	**7.48** (6.33-9.01)	**8.64** (7.17-10.6)	**9.85** (7.98-12.4)	**11.1** (8.77-14.4)	**12.9** (9.75-17.4)	**14.3** (10.4-19.9)
10-day	**2.92** (2.59-3.37)	**3.98** (3.52-4.59)	**5.41** (4.77-6.26)	**6.60** (5.77-7.69)	**8.25** (6.99-9.94)	**9.56** (7.93-11.8)	**10.9** (8.84-13.7)	**12.3** (9.72-16.0)	**14.3** (10.8-19.3)	**15.9** (11.6-22.1)
20-day	**3.64** (3.22-4.19)	**5.01** (4.43-5.78)	**6.86** (6.05-7.94)	**8.41** (7.36-9.80)	**10.6** (8.95-12.7)	**12.3** (10.2-15.1)	**14.0** (11.4-17.7)	**15.9** (12.5-20.6)	**18.5** (14.0-24.9)	**20.5** (15.0-28.6)
30-day	**4.33** (3.83-4.99)	**5.96** (5.27-6.88)	**8.16** (7.20-9.44)	**10.0** (8.76-11.7)	**12.6** (10.7-15.2)	**14.6** (12.1-18.0)	**16.7** (13.6-21.1)	**19.0** (15.0-24.6)	**22.1** (16.7-29.8)	**24.5** (18.0-34.2)
45-day	**5.23** (4.63-6.03)	**7.14** (6.32-8.24)	**9.73** (8.58-11.3)	**11.9** (10.4-13.9)	**14.9** (12.6-18.0)	**17.3** (14.4-21.3)	**19.8** (16.1-25.0)	**22.5** (17.7-29.1)	**26.1** (19.8-35.3)	**29.1** (21.3-40.5)
60-day	**6.21** (5.50-7.15)	**8.37** (7.40-9.65)	**11.3** (9.96-13.1)	**13.7** (12.0-16.0)	**17.2** (14.6-20.7)	**19.9** (16.5-24.5)	**22.8** (18.4-28.7)	**25.8** (20.3-33.4)	**30.0** (22.7-40.4)	**33.3** (24.4-46.4)

[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.

Back to Top

SOURCE: GEOLOGY MAP

SOURCE: GEOLOGY MAP
SOURCE: 1971 SCS SURVEY

PROJECT SITE

LEGEND

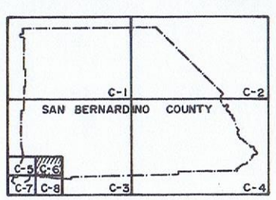
SOIL GROUP BOUNDARY

A SOIL GROUP DESIGNATION

BOUNDARY OF INDICATED SOURCE

SCALE 1:48,000

SCALE REDUCED BY 1/2



INDEX MAP

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

HYDROLOGIC SOILS GROUP MAP
FOR
SOUTHWEST-B AREA

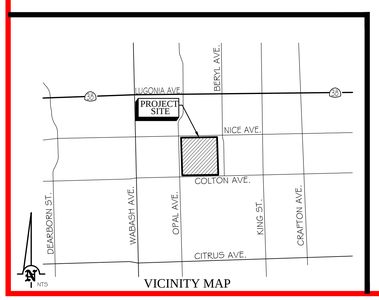
FIGURE C-14

PRE DEVELOPMENT TRIBUTARY AREA MAP

PROPOSED MANUFACTURING/ WAREHOUSING FACILITY

APN 0298-063-07

801 OPAL AVENUE, COUNTY OF SAN BERNARDINO



VICINITY MAP

SCALE: 1"=60'

0 60 120 180

SOURCE OF SURVEY

TOPOGRAPHIC SURVEY
DATED AUGUST 2013
AS CONDUCTED BY
ONPOINT LAND SURVEYING, INC.
1910 ORANGE TREE LANE, SUITE 344
REDLANDS, CALIFORNIA 92374
PHONE: (909) 792-2221

LEGEND

- EXISTING AC PAVING
- EXISTING PCC PAVING TO REMAIN

AC	ASPHALT CONCRETE
B	EXISTING BOLLARD TO REMAIN
BF	EXISTING BACKFLOW TO REMAIN
CBPB	CABLE PULL BOX
CPB	COMMUNICATIONS PULLBOX
DDCV	DOUBLE DETECTOR CHECK VALVE
EB	ELECTRICAL BOX
EPB	ELECTRICAL PULLBOX
EC	EXISTING ELECTRICAL CABINET TO REMAIN
EX.	EXISTING
EV	EXISTING EDISON VAULT
FH	EXISTING FIRE HYDRANT TO REMAIN
FR	EXISTING FIRE RISER TO REMAIN
MB	EXISTING MAILBOX TO REMAIN
MH	EXISTING MANHOLE TO REMAIN
OH	OVERHANG
PB	EXISTING PULLBOX TO REMAIN
PCC	PORTLAND CEMENT CONCRETE
PL	PROPERTY LINE
PP	POWER POLE
R/W	RIGHT-OF-WAY
S	EXISTING SIGN TO REMAIN
SMH	EXISTING SEWER MANHOLE TO REMAIN
WM	WATER METER
WV	WATER VALVE

EXISTING VEGETATION TO REMAIN UNLESS OTHERWISE SHOWN TO BE REMOVED

LEGEND

A=4.33 AC	SUB AREA
# 60.00	NODE # & ELEVATIONS
L=655'	FLOWLINE LENGTH
— · · · —	FLOWLINE

BENCHMARK

CITY OF REDLANDS BENCHMARK R-43:
BRASS DISK IN THE TOP OF CURB @ NE COR. BERYL AVE. & COLTON AVE. EAST END OF RETURN.
ELEVATION= 1,683.679

BASIS OF BEARING

CENTERLINE OF OPAL AVENUE PER RS 55/28 BEING: N01°02'59"W.

APN 0298-063-07

PRE DEVELOPMENT TRIBUTARY AREA MAP
PROPOSED MANUFACTURING/
WAREHOUSING FACILITY

PROPERTY OWNER/APPLICANT:
800 OPAL, LLC ATTN: CHARLES WALDEN
2615 SAN MIGUEL #487, NEWPORT BEACH, CA 92660
PHONE: (909) 553-0970
REPRESENTATIVE:
THATCHER ENGINEERING & ASSOCIATES, INC
1461 FORD STREET, STE 105, REDLANDS, CA 92373
PHONE: (909) 748-7777, FAX: (909) 748-7776

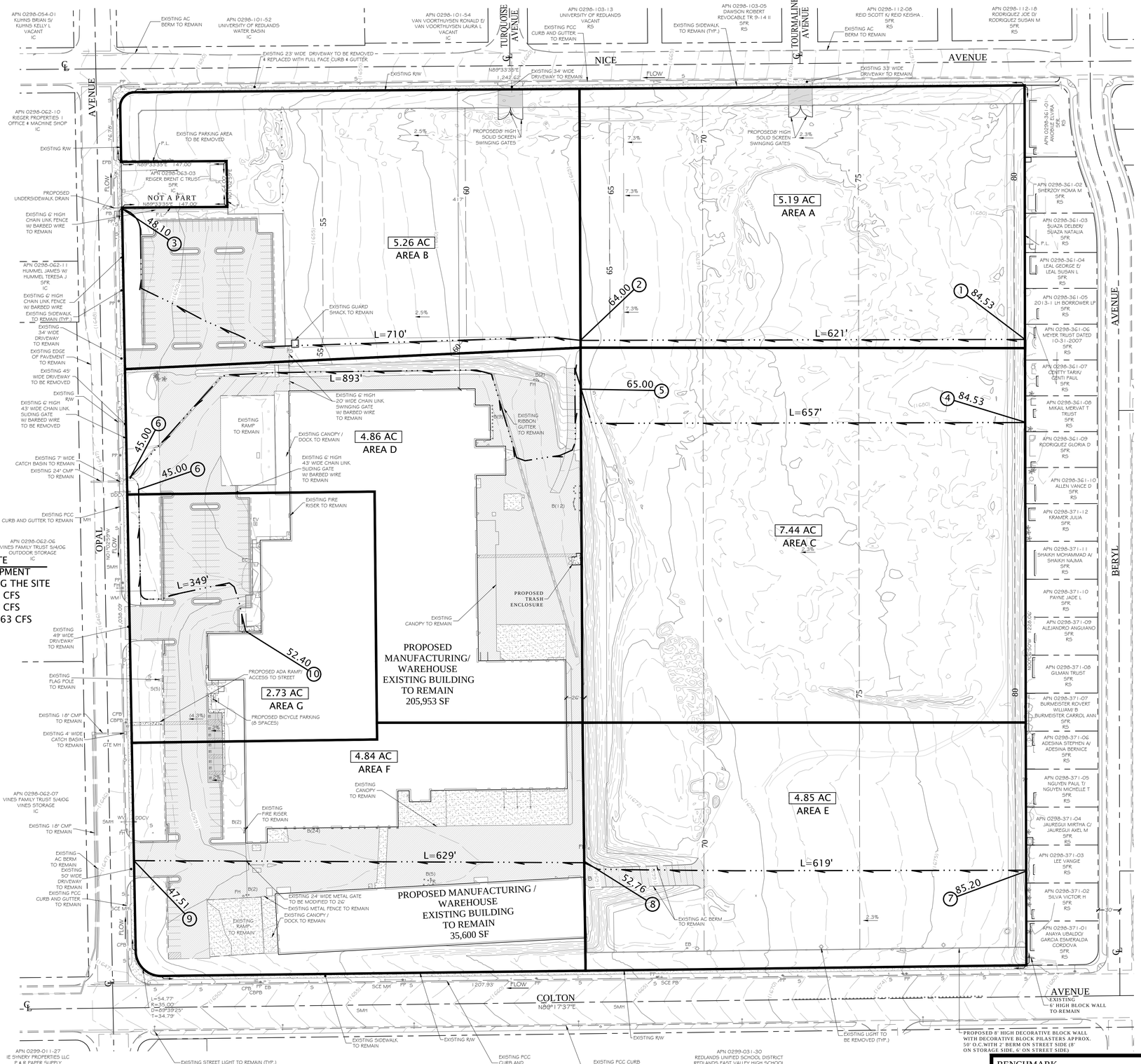
• land planning
• civil engineering
• landscape architecture
phone 909.748.7777
fax 909.748.7776
thatcher engineering & associates, inc.
1461 ford street, suite 105, redlands, ca 92373
est. 1992

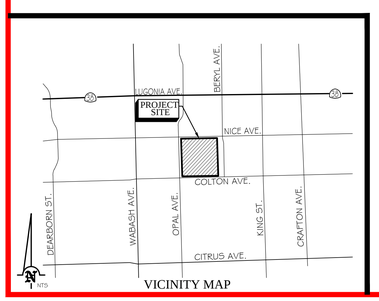
Job Number:	Date Prepared:	Drawn By:	Reference Number:
154801	8/16/17	PF	154801TAM2

154801TAM2

POST DEVELOPMENT TRIBUTARY AREA MAP

PROPOSED MANUFACTURING/ WAREHOUSING FACILITY
APN 0298-063-07
801 OPAL AVENUE, COUNTY OF SAN BERNARDINO





LEGEND

- PROPOSED AC PAVING
- EXISTING AC PAVING TO REMAIN
- PROPOSED DUST PROOF MATERIAL / LANDSCAPING
- PROPOSED PCC PAVING
- EXISTING PCC PAVING TO REMAIN

AC	ASPHALT CONCRETE
B	EXISTING BOLLARD TO REMAIN
BF	EXISTING BACKFLOW TO REMAIN
CBPB	CABLE PULL BOX
CPB	COMMUNICATIONS PULLBOX
DDCV	DOUBLE DETECTOR CHECK VALVE
EB	ELECTRICAL BOX
EPB	ELECTRICAL PULLBOX
EC	EXISTING ELECTRICAL CABINET TO REMAIN
EX.	EXISTING
EV	EXISTING EDISON VAULT
FH	EXISTING FIRE HYDRANT TO REMAIN
FR	EXISTING FIRE RISER TO REMAIN
MB	EXISTING MAILBOX TO REMAIN
MH	EXISTING MANHOLE TO REMAIN
OH	OVERHANG
PB	EXISTING PULLBOX TO REMAIN
PCC	PORTLAND CEMENT CONCRETE
PL	PROPERTY LINE
PP	POWER POLE
R/W	RIGHT-OF-WAY
S	EXISTING SIGN TO REMAIN
SMH	EXISTING SEWER MANHOLE TO REMAIN
WM	WATER METER
WV	WATER VALVE
	EXISTING VEGETATION TO REMAIN

LEGEND

A=4.33 AC	SUB AREA
# 60.00	NODE # & ELEVATIONS
L=655'	FLOWLINE LENGTH
	FLOWLINE

SOURCE OF SURVEY

TOPOGRAPHIC SURVEY
DATED AUGUST 2013
AS CONDUCTED BY
ONPOINT LAND SURVEYING, INC.
1910 ORANGE TREE LANE, SUITE 344
REDLANDS, CALIFORNIA 92374
PHONE: (909) 792-2221

BENCHMARK

CITY OF REDLANDS BENCHMARK R-43:
BRASS DISK IN THE TOP OF CURB @ NE COR. BERYL AVE. & COLTON AVE. EAST END OF RETURN.
ELEVATION= 1,683.679

BASIS OF BEARING

CENTERLINE OF OPAL AVENUE PER RS 55/28 BEING: N01°02'59"W.

APN 0298-063-07

POST DEVELOPMENT TRIBUTARY AREA MAP
PROPOSED MANUFACTURING/
WAREHOUSING FACILITY

PROPERTY OWNER/APPLICANT:
800 OPAL, LLC ATTN: CHARLES WALDEN
2615 SAN MIGUEL #467, NEWPORT BEACH, CA 92660
PHONE: (909) 553-0970

REPRESENTATIVE:
THATCHER ENGINEERING & ASSOCIATES, INC
1461 FORD STREET, STE 105, REDLANDS, CA 92373
PHONE: (909) 748-7777, FAX: (909) 748-7776

• land planning
• civil engineering
• landscape architecture
est. 1980
thatcher engineering & associates, inc.
1461 ford street, suite 105, redlands, ca 92373
phone 909.748.7777
fax 909.748.7776

Job Number:	Date Prepared:	Drawn By:	Reference Number:
154801	8/16/17	PF	154801TAM2

154801TAM2

REPORT OF LIMITED GEOTECHNICAL STUDY AND INFILTROMETER TESTING PROPOSED MANUFACTURING / WAREHOUSING FACILITY NORTHEAST CORNER OF COLTON AVENUE AND OPAL AVENUE IN THE MENTONE AREA OF SAN BERNARDINO COUNTY, CALIFORNIA

PROJECT NO.: 1100-A17
REPORT NO.: 1

JUNE 5, 2017

SUBMITTED TO:

800 OPAL LLC c/o
THATCHER ENGINEERING & ASSOCIATES, INC.
1461 FORD STREET
REDLANDS, CA 92373

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**

June 6, 2017

800 Opal LLC c/o
Thatcher Engineering & Associates, Inc.
1461 Ford Street, Suite 105
Redlands, CA 92373

Project No.: 1100-A17
Report No.: 1

Attention: Ms. Kayla Jordan

Subject: **Report of Limited Geotechnical Study and Infiltrometer Testing, Proposed Manufacturing / Warehousing Facility, Northeast Corner of Colton Avenue and Opal Avenue in the Mentone Area of San Bernardino County, California.**

References:

1. **Hilltop Geotechnical, Inc.**, February 20, 2014, *Report of Preliminary Geotechnical / Geologic Study, Proposed 132 Lot Subdivision, Tentative Tract 18952, Northeast Corner of Colton Avenue and Opal Avenue in the Mentone Area of San Bernardino County, California*, Project No.: 950-A14, Report No. 1.

2. **Thatcher Engineering & Associates, Inc.**, April 6, 2017, Minor Use Permit Site Plan for proposed Manufacturing / Warehousing Facility, Job No.: 154801, Reference Number: 154801CUP.

3. Technical References - See Appendix 'B.'

Gentlemen:

According to your request, we have completed a limited geotechnical study and infiltrometer testing for the design and construction of the proposed manufacturing

The findings of this study indicate that the project site is suitable for the proposed development 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 the 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, along with the CD containing a pdf copy of this report, 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.

REGISTERED PROFESSIONAL ENGINEER
SUNDARAMOORTHY SRIRAJAN
2871
EXP 9/30/17
GEOTECHNICAL
STATE OF CALIFORNIA

Mark Hulett, CEG No. 1623
President

Sundaramoorthy Srirajan, GE No. 2871
Senior Engineer
Date Signed: 6-5-17

Ashley Hulett, GIT No. 574
Staff Geologist

MH/SS/AH/dh

Distribution: (4) Addressee
Via U.S. Hand Delivery
(1) Addressee
pdf Copy Via E-Mail (kaylaj@thatcherengineering.com)

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Hilltop Geotechnical, Inc., February 20, 2014, *Report of Preliminary Geotechnical / Geologic Study, Proposed 132 Lot Subdivision, Tentative Tract 18952, Northeast Corner of Colton Avenue and Opal Avenue in the Mentone Area of San Bernardino County, California*, Project No.: 950-A14, Report No. 1.

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REPORT OF LIMITED GEOTECHNICAL STUDY AND INFILTROMETER TESTING PROPOSED MANUFACTURING / WAREHOUSING FACILITY NORTHEAST CORNER OF COLTON AVENUE AND OPAL AVENUE IN THE MENTONE AREA OF SAN BERNARDINO COUNTY, CALIFORNIA

PROJECT NO.: 1100-A17
REPORT NO.: 1

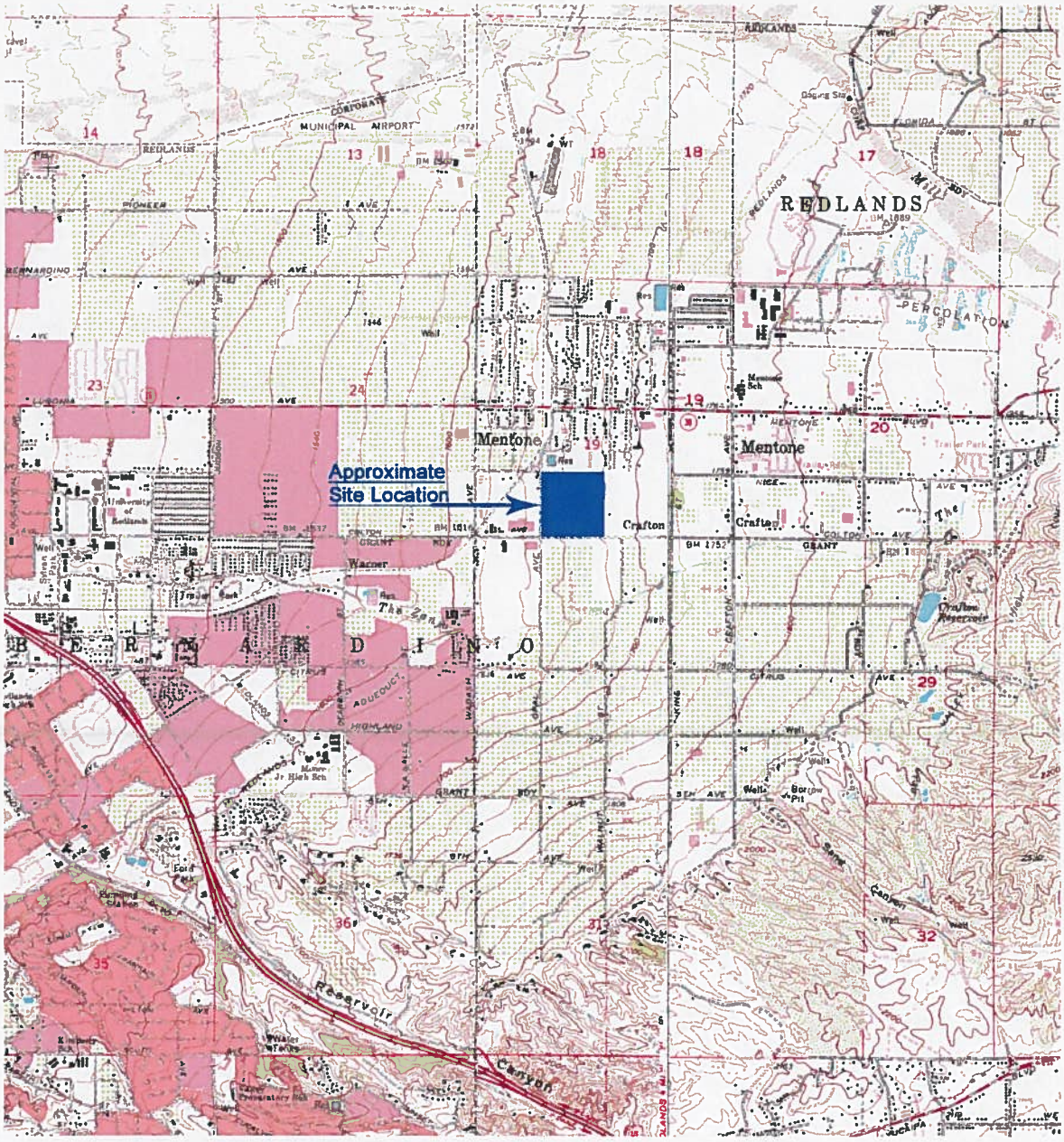
JUNE 5, 2017

INTRODUCTION

AUTHORIZATION

This report presents results of the limited geotechnical / geologic study conducted on the subject site for the proposed manufacturing / warehousing facility to be located north of Colton Avenue between Opel Avenue to the west and Beryl Avenue to the east in the Mentone area of 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 **Hilltop Geotechnical, Inc. (HGI)** (Geotechnical / Geologic Consultant) to **800 Opal LLC** (Client), dated April 7, 2017, Proposal Number: P17057 and signed by Mr. Charles Walden on April 25, 2017.



0 3500 7000

Approximate Scale in Feet

N

Reference: **United States Department of the Interior, Geologic Survey**, 1967, Photorevised 1988, *Redlands Quadrangle, California,* 7.5 Minute Topographic Series, Scale: 1:24,000.
United States Department of the Interior, Geologic Survey, 1967, Photorevised 1988, *Yucaipa Quadrangle, California,* 7.5 Minute Topographic Series, Scale: 1:24,000.

HILLTOP GEOTECHNICAL INCORPORATED

SITE LOCATION MAP	
By: AH	Date: 5/2017
Project No.: 1100-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 in the vicinity of the proposed improvements on the subject site with respect to geotechnical characteristics 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 site improvements. 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'), including geotechnical and geologic reports prepared by HGI (Reference No. 1 noted on the cover sheet of this report), etc. to ascertain earth material, geologic, and hydrologic conditions of the area.
- Telephone conversations with the client and/or representatives of the client.
- Engineering analysis of field and laboratory data to provide a basis for geotechnical conclusions and recommendations regarding retention basins and pavement design parameters.
- Preparation of this report to present the geotechnical conclusions and recommendations for the proposed site development.

This report presents our conclusions and/or recommendations regarding:

- Preliminary pavement section recommendations.
- Infiltrometer rates for the design of the proposed on-site retention basins.

The scope of work performed for this report did <u>not</u> 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.

This study was prepared for the exclusive use of **800 Opal LLC** and their consultants for specific application to the development of the proposed project in accordance with generally accepted standards of the geotechnical and geologic professions and generally accepted geotechnical engineering 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

Prior to this report, a previous preliminary Geotechnical / Geologic Study was performed on the subject site. The results of those studies were presented in the Reference No.1 noted on the first page of the cover letter for this report.

PROJECT DESCRIPTION / PROPOSED DEVELOPMENT

As part of our study, we have discussed the project with Mrs. Kayla Jordan and Kristin Tissot of Thatcher Engineering, the Civil Engineer for the project. We have also been provided with the Reference No. 2 'Site Plan,' for the project noted on the first page of the cover letter for this report. In addition, we have reviewed the Reference No. 1 report which was previously prepared for 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.

SITE DESCRIPTION

The subject property comprises approximately 42.37 acres, is rectangular in shape, and approximately 1,230 feet by 1,245 feet in plan dimension as shown on the Reference No. 2 'Site Plan' noted on the first page of the cover letter for this report. The subject property is located in the northeast quadrant of the intersection of Opal Avenue and Colton Avenue in the Mentone area of San Bernardino County, California. The subject property is located in the southwest portion of Section 19,

T1S, R2W of the San Bernardino Principle Meridian at Latitude: 34.0647° North, Longitude: 117.1320° West.

The subject property is bounded by Colton Avenue to the south, Opal Avenue to the west, and Nice Avenue to the north. A wall and housing community bounds the proposed site to the east, as shown on the 'Exploratory Excavation Location Plan,' Plate No. 1, presented in Appendix 'A.'

Walden Structures Construction occupies the west portion of the site. Grading reports and/or compaction reports were not made available at the time of this study, nor were/or they available at the County of San Bernardino Building and Safety Department. The west portion of the site contains office buildings, equipment buildings, trailers, storage areas, rock roadways, several parking lots, and concrete curbs. Surrounding Walden Structures Construction facility were various fenced areas and open areas that allow access to the eastern portion of the site.

Total on-site relief in was approximately 40 feet. The minimum and maximum elevations within the immediate area of the proposed development was approximately 1647 and 1687 Mean Sea Level (MSL), respectively.

At the time of the field study, buildings or other type structures were present on the site. 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 in the existing street right-of-way. Some of the utilities were noted on the referenced plans and are adjacent to the site. Due to the ages of the structures and the locations on the site, it is anticipated that cisterns, leach lines, and septic tanks also may still be present on the site. In the location of

infiltration test P-1, a leach line was exposed at a depth of approximately three feet.

Several end dumped piles of construction debris, miscellaneous debris and refuse, soil, etc. were observed at various locations throughout the subject property, mainly on the undeveloped portion of the site. Vegetation across the east portion of the site was light and consisted of seasonal native grasses, weeds, forbs, and brush. The west portion of the site was developed and consisted of one area of grass and a few open areas with light brush, curbs, gutters and pavement.

FIELD EXPLORATION AND LABORATORY TESTING

Field study and laboratory testing that were performed on January 20, 2014 and January 23, 2014 for the previous 'Geotechnical Study' (Reference No. 1).

A more detailed explanation of the field study and laboratory tests are presented in Appendix 'A' of this report.

FINDINGS

LOCAL SUBSURFACE CONDITIONS

Presented as follows are brief descriptions of the earth materials encountered in the exploratory excavations performed for the Reference No. 1 'Geotechnical Study,' noted on the second page of the cover letter for this report. More detailed descriptions of encountered earth materials are presented on the 'Subsurface Exploration Log,' Nos. 3 through 9, 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 man-made fill (af) and young axial valley deposits (alluvium) (Qya_3).

Man made fill was encountered at the location of trench T-2, T-3, T-5, and T-6. The fill extended to a depth of approximately 1.5 to 4.5 feet at the locations of the exploratory excavations. The fill generally consisted of silty fine to coarse sand with a trace to some gravel, a little cobbles, and a trace boulders. The fill encountered was orange-brown, light brown, and brown in color and dry at the surface to moist with depth. Additionally, numerous end-dumped piles of soil, concrete, and other hard construction materials were also observed in various areas on the site. The fill is considered to be undocumented and unsuitable for support of structural fill and/or a building structure. Where easily visible, the approximate location of the fill materials is shown on the Exploratory Excavation Location Plan, Plate No. 1, presented in Appendix 'A.'

Alluvium was encountered below the fill materials and at the surface at the locations of trench T-1, T-4, and T-7. The alluvium generally consisted of silty fine to coarse sands with varying amounts of gravel, cobbles, and boulders (SM), gravelly, fine to coarse sands with traces of silt, gravels, and cobbles (SP), fine to coarse, sandy gravel with a little to some cobbles and a trace to a little boulders (GP), gravel with some cobbles and a trace boulders (GP), cobbles with a little gravel, a little fine to coarse sand, and a trace boulders (GP), and gravel with a

trace silt and a trace fine to coarse sand (GP). The alluvium was light brown, brown, dark brown, orange-brown, gray-brown, and gray in color and dry near the surface to moist with depth. Locally, the alluvium extended to depths in excess of 12 feet below the existing ground surfaces at the excavation locations on the subject site. A distinct coarsening of the materials with was noted with depth. The excavations were terminated in the alluvial deposit.

Groundwater

Groundwater was not encountered in the exploratory excavations, performed for Reference No. 1 'Preliminary Geotechncial Report' to the maximum depth explored of approximately 12 feet below existing ground surface.

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.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

The conclusions and recommendations presented in this report are, in part, based on information provided to this firm, the results of the field and laboratory data on

the subject property from reference No. 1 "Preliminary Geotechnical Study', 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 impact onto or from adjoining properties providing the recommendations contained within this report are adhered to during project design and construction.

Per the Reference No. 1 report, the average in-situ moisture contents and in-situ dry densities of the upper 5.0 to 7.0 feet of the near-surface alluvial materials on the subject site suggests that the soils have an average relative compaction of approximately 85 percent. Additionally, up to 4.5 feet of material present in some areas 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 hardscape, and/or pavement.

Some remedial grading consisting of removals and replacement will have to be performed within loose, compressible, artificial fill and 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.

Recommendations for site grading, foundations, slab support, pavement design, etc., are presented in the subsequent paragraphs.

SITE PREPARATION RECOMMENDATIONS

General

Since mass grading is not anticipated for the development of the project, the grading recommendations presented in this report are intended for the rework of unsuitable, near-surface, undocumented fill and alluvial earth materials to create satisfactory support for exterior hardscape (i.e., sidewalks, etc.) and pavement.

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 County of San Bernardino, 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, grasses, weeds, brush, trees, and other deleterious materials should be removed from the 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. It is 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 existing fill materials and the near-surface 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 for reference No. 1 report was below the average 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. Some over-size material is anticipated to be encountered within the near-surface soils on the subject site which will require special handling.

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

Unsuitable, loose, or disturbed near-surface undocumented fill and/or alluvial earth material in proposed areas which will support structural fills, exterior hardscape (i.e., sidewalks, curb / gutters, etc.), and pavement should be prepared

in accordance with the following recommendations for grading in such areas. If over-excavation and total removal of undocumented fill materials is elected not to be performed in hardscape, curb / gutter, and pavement 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 pavement structure needs to be evaluated by the project owner.

- The near-surface undocumented fill and the loose, near-surface alluvial materials on the site are recommended to be overexcavated and recompacted. Based upon our exploratory excavations borings and laboratory test results frpm Reference No. 1 report, we anticipate that the overexcavation will extend to a depth of approximately 3 to 4 feet below existing ground surface in the areas which will receive structural fill. 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. It is noted that fill placed to support sidewalks, 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.

- 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 processing or over-excavation 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 over-excavation beneath the finish subgrade elevation, whichever is greater.

- Where the exploratory backhoe trenches are located within the limits of the proposed overexcavations for the proposed structural fills, structures, decorative walls, trash enclosure walls, retaining walls, exterior hardscape, and/or pavement areas, the trenches should be overexcavated to the width and depth of the trench.

- 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 not have been located during the field study. 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.

- 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 no more expansive than the on-site soils as determined by current ASTM D4829 procedures and have strength parameters (i.e., R-Value) equivalent to or greater than the on-site earth materials. Import fill material should be approved by the project Geotechnical Consultant prior to it being brought on-site.

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., 12 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 5.0 to 7.0 feet of the site which will be removed and replaced will be approximately 6.0 to 12 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 6.0 percent shrinkage factor would mean that it would take 1.06 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. Oversize rock removal and export will also result in additional shrinkage.

A subsidence factor (loss of elevation due to compaction of existing undocumented fill and/or the near-surface alluvial earth materials in-place) of 0.06 to 0.11 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 10 feet of fill (not including the depth of overexcavation and replacement) during the planned grading operation or rebound of the underlying alluvium due to unloading 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

SIEVE SIZE	PERCENT PASSING
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.

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.

PRELIMINARY PAVEMENT RECOMMENDATIONS

The following are preliminary recommendations for the structural pavement sections for the proposed streets, parking areas, and driveway areas for the subject development on the subject project site. 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 assumed Traffic Indexes 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 number as the recommended HMA pavement sections 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**
Streets, Driveway and Parking Areas for Autos and Light Weight Vehicles Only.	≤5.5	≥40	4.0" Hot Mix Asphaltic (HMA) Concrete over 4.0" Aggregate Base (AB) or 5.6" PCC @ 2,500 psi over properly prepared subgrade.
Streets, Driveway and Parking Areas for Delivery Trucks	≤6.0	≤40	4.0" HMA over 5.0" AB or 6.0" PCC @ 2,500 psi over properly prepared subgrade.

RECOMMENDED PAVEMENT SECTIONS			
Site Area	**Traffic Index***	**Subgrade R-Value****	**Pavement Section**
Streets, Driveway and Parking Areas for Heavy Trucks	≤7.0	≥40	4.0" HMA over 7.0" AB or 6.8" PCC @ 2,500 psi over properly prepared subgrade.
* Traffic Index was assumed for the project.			
** R-Values were assumed for the project.			

The San Bernardino County minimum guidelines may override the above pavement recommendations without prior County review and approval.

The pavement section for individual lot driveways should be according to current San Bernardino County, California standards.

HMA concrete pavement materials should be as specified in Section 39, 'Hot Mix Asphalt,' in the current CALTRANS Standard Specifications with the July 27, 2012 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 26-1.02A, 'General,' in the current, 2010 CALTRANS Standard Specifications with the July 27, 2012 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 1.0 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 6.0 inches 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 HMA 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 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 streets in a development or 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 2013 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 26-1.02A, 'General,' of the current 2010 CALTRANS 'Standard Specifications,' 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 2010 CALTRANS 'Standard Specifications.' 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 2013 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 2010 CALTRANS 'Standard Specifications,' 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 San Bernardino County, California.

RECHARGE BASIN RECOMMENDATIONS

LOCATION OF INFILTROMETER TESTING

This report presents the results of our infiltrometer testing conducted on the subject site at three (3) locations within the proposed retention basin areas provided by **Thatcher Engineering and Associates, Inc**. The three tests were conducted along the west portion of the site paralleling Opal Avenue. Infiltrometer testing was conducted at the locations and depths specified on the attached Plate No. 15, Infiltration Test Location Plan. Infiltration test P-1 was conducted at a depth of 3.5 feet, Infiltration test P-2 was conducted at a depth of 4.4 feet and Infiltration test P-3 was conducted at a depth of 1.4 feet beneath existing site grades. In the bottom of Trench P-1, a perforated pipe and encompassing gravel was encountered at a depth of 3.0 feet. The area was presumed to be a leach field. Infiltration testing P-1 and P-2 were conducted in planter areas in the front of the existing building. Infiltration test P-3, was performed in a paved area. A backhoe was used to excavate each test pit to the appropriate depths. The approximate infiltrometer test locations are shown on the 'Infiltration Test Location Plan', Plate No. 1.

SOIL CHARACTERISTICS OF THE SUBJECT SITE

- The soil characteristics for the subject site are defined as favorable.
- There was no visible evidence of shallow groundwater or impervious bedrock materials.

- Groundwater was not encountered in the exploratory excavations, performed for Reference No. 1 'Preliminary Geotechncial Report" to the maximum depth explored of approximately 12 feet below existing ground surface. 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. 01S02W30C001S, located approximately 300 feet west, (just south of Colton Avenue), of the subject site was approximately 120 feet on December 4, 1990. The surface elevation of this well is 1651 feet, generally lower (topographically) than that of the site

- Tests performed agreed with visual evidence.

- The natural slope of the ground surface above the proposed water infiltration areas are less than a 2.0 percent gradient.

- Soil conditions for the on-site, water infiltration systems were acceptable in the tested areas.

Soil Profile

- Percolation Hole No. 1: Infiltrometer test (P-1) was located in southwestern portion of the site and tested at the base of artificial fills. The fill encountered was a silty fine to coarse grained sand with various amounts of gravels, a trace of cobbles and 2-3 boulders (SM). At a depth of 3.0 feet, a perforated pipe encompassed by gravels was encountered. The tested depth was 0.5 feet lower than the pipe. Native alluvial soils were found under the fill and consisted of light brown, moist, silty, fine to coarse grained sand, with various amounts of gravels and a trace of cobbles. The excavation bottom was slightly compacted. The test hole was classified in general accordance with the Unified Soil Classification System as an SM.

- Percolation Hole No. 2: Infiltrometer test (P-2) was conducted in the middle west portion of the site at a depth of 4.4 feet beneath existing site grade. The materials encountered were native alluvial soils and generally finer grained in nature. The native alluvium was classified as a brown, moist, silty, fine to coarse sand (SM). The test hole was classified in general accordance with the Unified Soil Classification System to be an SM.

- Percolation Hole No. 3: Infiltrometer test (P-3) was conducted in the northwestern portion of the site at approximately 1.4 feet beneath existing site grade. A backhoe was used to excavate the test pit beneath 1.5 inches of asphalt to 1.4 feet. Materials encountered were classified as a silty, fine to coarse sand, with a trace of gravel (SM). The test hole was classified in general accordance with the Unified Soil Classification System to be an SM.

- No large plants or roots were encountered in the infiltrometer test areas.

- There were no wet or saturated soils encountered in the infiltrometer test areas.

- No groundwater was encountered within our infiltrometer test areas.

INFILTROMETER TEST PROCEDURES

Testing was performed in general accordance with ASTM D 3385 procedures. This method consists of driving two (2) open cylinders, one inside the other, into the ground, partially filling the rings with water, maintaining the water at a constant level, and measuring the volume of water required to maintain the constant level. The steel rings used for this project had nominal inside diameters of 11.75 inches and 23.75 inches. The volume of water added to the inner ring to maintain a

constant liquid level was the measure of the volume of liquid that infiltrates into the soil and is shown on Plate Nos. 16 through 18. The volume infiltrated during timed intervals was converted to an incremental infiltration velocity expressed in centimeters per hour, and the results were plotted on a graph versus elapsed time, as shown on Plate Nos. 19 through 21 attached to the rear of this report.

Test locations were chosen along the west portion of the site. A backhoe was used to excavate a small area of similar diameter of the rings at each of the infiltration test locations to a depth of approximately 3.5, 4.4, and 1.4 feet below existing grade. The outer and inner infiltrometer rings were then pressed into place to a depth of approximately 6.0 inches. Upon excavation, hand tools were used to prepare a smooth, flat test site free of loose, disturbed, and smeared soils.

Clear municipal water, was poured into the rings while using protective cardboard sheeting to prevent splashing and disturbance of the soil boundary. The pre-selected water test depth was approximately 6.0 inches (15.24cm). Initially, water levels were maintained within 5.0 millimeters of this depth during the test by periodic additions from 1000 milliliter graduated cylinder. However, the rates were fast and additions by use of 5 gallon water bottles were used for measurements. The apparatus was covered with cardboard sheeting to minimize evaporative losses from the sun. No significant wind occurred on the days of testing.

A tally of water added to the inner ring and annular space was made at periodic time intervals ranging from 15 to 60 minutes.

INFILTROMETER TEST RESULTS

The infiltration rates were moderate to fast and constant between the test pits. The Infiltration rates obtained are discussed below in Tables 1 and 2:

Table 1: Average Infiltration Rates

Ring (Inner / Outer)	Infiltration Rate (cm/hr)	Infiltration Rate (in/hr)
P-1, Inner	11.50	4.53
P-1, Outer	9.70	3.82
P-2, Inner	18.17	7.16
P-2, Outer	19.52	7.69
P-3, Inner	7.00	2.76
P-3, Outer	8.00	3.15

Table 2: Steady State Infiltration Rates

Ring (Inner / Outer)	Infiltration Rate (cm/hr)	Infiltration Rate (in/hr)
P-1, Inner	7.22	2.84
P-1, Outer	6.87	2.71
P-2, Inner	12.65	4.98
P-2, Outer	13.92	5.48
P-3, Inner	6.43	2.53
P-3, Outer	6.28	2.48

DISCUSSION

This area of Mentone is underlain by alluvial deposits that primarily consist of moderately consolidated silts, sand and gravel deposits. The rates presented above are generally consistent with the soil classifications in each area tested. Fast infiltrometer rates were obtained in percolation test P-2. Percolation tests P-1 and P-3 were similar in soils classification and tested infiltration rates.

Infiltration test P-2 was conducted in sands with a slight amount of silt. The sands were loose in nature and moist, contributing to faster infiltration results. Infiltration tests P-1 and P-3 were conducted in areas classified as a moderately compacted silty, fine to coarse grained sand with varying amounts of gravels and cobbles.

Field infiltration tests are subject to many factors that affect the infiltration rate, including soil texture, the condition of the soil surface, soil-moisture tension or the degree of saturation, the temperature of the water and soil, the percentage of entrapped air in the soil, and the head of the applied water.

INFILTRATION BASIN RECOMMENDATIONS

Infiltration testing in the proposed infiltration areas indicated percolation rates that appear to be consistent with respect to there respective on-site soil classification. The Project Civil Engineer should evaluate this information for final infiltration design.

Caution should be used in determining a percolation rate for any proposed infiltration basin or structure. Eventual siltation, water-borne silt from irrigation and precipitation runoff, and the accumulation of organic material in surface soils due to landscape grass and plant growth, can drastically reduce percolation rates

over time. We recommend that suitable methods to prevent siltation be considered 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 20, 2014 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 the map pocket in this Appendix.

A study of the property's subsurface condition was performed to evaluate underlying earth strata and the presence of groundwater. Seven (7) exploratory backhoe excavations were performed on the subject site on January 20, 2014. Locations of the exploratory excavations were determined in the field by sighting from the adjacent existing streets, adjacent structures, and topographic features as shown on the Reference No. 1 'Tract Map,' noted on the first page of the cover letter for this report. Approximate locations of the exploratory excavations are denoted on the 'Exploratory Excavation Location Plan' presented in the map pocket in this Appendix. Approximate elevations at the locations of the exploratory excavations were determined by interpolation to the closest 1.0 foot from a 1.0 foot contour interval topographic plot of the site (Reference No. 1 noted on the first page of the cover letter for this report). 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 trenches were excavated by using a rubber tired, tractor-mounted backhoe. The depths explored in the trenches was approximately 9.5 to 12 feet below the existing land surface at the excavation locations. Bulk and relatively undisturbed chunk samples were obtained from cuttings developed during the

backhoe excavation process and represent the earth materials within the depth indicated. In-place dry density and moisture content tests were also performed at various depths in the backhoe exploratory excavations. The tests were performed in general accordance with current Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) - ASTM D6938 test method. The dry density and moisture content test results are presented on the 'Summary of Field In-Place Density Test Results,' Plate No. 3 through 9, presented in this Appendix.

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 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 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.

Four (4) infiltrometer tests were also performed on the subject site as part of this study. The infiltrometer tests were performed in the proposed retention basin / storm water storage areas.

The exploratory backhoe 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. Recompaction of the exploratory backhoe excavation backfill, if located within proposed structural fill, building, hardscape, and/or pavement areas, should be addressed during site grading operations. In an area as small and deep as a backhoe 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.

LABORATORY TESTING PROGRAM

Laboratory tests were performed on selected, 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. 3 through 9, 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. 10, presented in this Appendix.

SOLUBLE SULFATE TEST

The concentration of soluble sulfate was determined on selected samples of near-surface earth materials in general accordance with current EPA 300.0 procedures. The test results are summarized in the 'Summary of Laboratory Test Results,' Plate No. 10, presented in this Appendix.

SIEVE ANALYSIS

The percent by weight finer than a No. 200 sieve (silt and clay content) was determined for selected samples of earth materials 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. 11, presented in this Appendix.

MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT RELATIONSHIP TEST

Maximum dry density / optimum moisture content relationship determinations were performed on samples of near-surface earth materials in general accordance with current ASTM D1557 procedures using a 4-inch and 6-inch diameter molds

for Methods 'B' and 'C,' respectively. Samples were prepared at various moisture contents and compacted in five (5) layers using a 10-pound weight dropping 18 inches and with 25 and 56 blows per layer for Methods 'B' and 'C,' respectively. 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 Nos. 12 and 13, presented in this Appendix.

DIRECT SHEAR TEST

A direct shear test was performed on a selected remolded sample of near-surface earth material obtained from the borings in general accordance with current ASTM D3080 procedures. The shear machine is of the constant strain type. The shear machine is designed to receive a 1-inch high, 2.416-inch diameter ring sample. Three (3) specimens from the selected bulk sample of earth material were remolded at approximately 90 percent relative compaction and at optimum moisture content based on the maximum dry density and optimum moisture content of the earth material as determined by current ASTM D1557 procedures. Specimens from the remolded samples were sheared at various pressures normal to the face of the specimens. The specimens were tested in a submerged condition. The peak and ultimate shear stresses were plotted verses the normal confining stresses to determine the shear strength (cohesion and angle of internal friction). The test results are summarized in the 'Direct Shear Test Results,' Plate No. 14, presented in this Appendix.

REPORT OF PRELIMINARY GEOTECHNICAL / GEOLOGIC STUDY PROPOSED 132 LOT SUBDIVISION TENTATIVE TRACT MAP 18952 NORTHEAST CORNER OF COLTON AVENUE AND OPAL AVENUE IN THE MENTONE AREA OF SAN BERNARDINO COUNTY, CALIFORNIA

PROJECT NO.: 950-A14
REPORT NO.: 1

FEBRUARY 20, 2014

SUBMITTED TO:

WALDEN STRUCTURES c/o
THATCHER ENGINEERING & ASSOCIATES, INC.
1461 FORD STREET, SUITE 105
REDLANDS, CA 92373

PREPARED BY:

HILLTOP GEOTECHNICAL, INC.
786 SOUTH GIFFORD AVENUE
SAN BERNARDINO, CA 92408

IN THE COUNTY OF SAN BERNARDINO

TENTATIVE TRACT MAP NO. 18952

LEGAL DESCRIPTION

PARCEL A:

ALL THAT PORTION OF THE SOUTHEAST 1/4 OF THE SOUTHWEST 1/4 OF SECTION 19, TOWNSHIP 1 SOUTH, RANGE 2 WEST, SAN BERNARDINO MERIDIAN, DESCRIBED AS FOLLOWS:

BEING A STRIP OF LAND OF UNIFORM WIDTH OF 39 FEET ON AND ALONG THE SOUTH BOUNDARY LINE OF THE SOUTHEAST ONE QUARTER OF THE SOUTHWEST ONE QUARTER OF SECTION 19, TOWNSHIP 1 SOUTH, RANGE 2 WEST, SAN BERNARDINO MERIDIAN.

EXCEPTING AND RESERVING UNTO UNION PACIFIC RAILROAD COMPANY, A DELAWARE CORPORATION, ITS SUCCESSORS AND ASSIGNS, FOREVER, ALL MINERALS AND ALL MINERAL RIGHTS OF EVERY KIND AND CHARACTER NOW KNOWN TO EXIST OR HEREAFTER DISCOVERED UNDERLYING THE PROPERTY, INCLUDING, WITHOUT LIMITING THE GENERALITY OF THE FOREGOING, OIL AND GAS AND RIGHTS THERETO, TOGETHER WITH THE SOLE, EXCLUSIVE AND PERPETUAL RIGHT TO EXPLORE FOR, REMOVE AND DISPOSE OF SAID MINERALS BY ANY MEANS OR METHODS SUITABLE TO GRANTOR, ITS SUCCESSORS AND ASSIGNS, BUT WITHOUT ENTERING UPON OR USING THE SURFACE OF THE PROPERTY, AND IN SUCH MANNER AS NOT TO DAMAGE THE SURFACE OF THE PROPERTY, OR TO INTERFERE WITH THE USE THEREOF BY GRANTEE, ITS SUCCESSORS OR ASSIGNS, AS RESERVED ON QUITCLAIM DEED RECORDED APRIL 07, 2006, AS INSTRUMENT NO. 2006-0235408, OF OFFICIAL RECORDS.

PARCEL B:

THE SOUTHEAST ONE QUARTER OF THE SOUTHWEST ONE-QUARTER OF SECTION 19, TOWNSHIP 1 SOUTH, RANGE 2 WEST, SAN BERNARDINO MERIDIAN, IN THE COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO THE OFFICIAL PLAT THEREOF.

EXCEPTING THE SOUTHERLY 39 FEET THEREOF, AS CONVEYED TO THE SOUTHERN PACIFIC RAILROAD BY DEED RECORDED OCTOBER 09, 1891, IN BOOK 139, PAGE 225 OF DEEDS.

ALSO SAVING AND EXCEPTING THE FOLLOWING DESCRIBED PROPERTY:

BEGINNING AT A POINT ON THE WEST LINE OF AFORESAID SOUTHEAST ONE QUARTER OF THE SOUTHWEST ONE-QUARTER OF SECTION 19, DISTANT THEREON 130 FEET SOUTH OF THE NORTHWEST CORNER THEREOF, THENCE EAST PARALLEL TO THE NORTH LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER, A DISTANCE OF 180 FEET, THENCE SOUTH PARALLEL TO THE WEST LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER A DISTANCE OF 64 FEET, THENCE WEST PARALLEL TO THE NORTH LINE OF SAID SOUTHEAST ONE QUARTER OF THE SOUTHWEST ONE-QUARTER, A DISTANCE OF 180 FEET TO THE WEST LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER OF SECTION 19; THENCE NORTH ALONG SAID WEST LINE A DISTANCE OF 64 FEET TO THE POINT OF BEGINNING.

EASEMENTS

1 AN EASEMENT FOR CARRIAGE OF WATER TO DIG AND LAY WATER WAYS, ALSO THE RIGHT TO BUILD CONSTRUCT AND MAINTAIN UPON SAID DAMS AND RESERVOIRS AND INCIDENTAL PURPOSES IN FAVOR OF THE MENTONE IRRIGATION COMPANY RECORDED DECEMBER 01, 1887, IN BOOK 69 OF DEEDS, PAGE 144.

SAID EASEMENT IS NOT PLOTTABLE.

2 AN EASEMENT FOR HIGHWAY, ROADWAY AND INCIDENTAL PURPOSES IN FAVOR OF COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED JUNE 21, 2007 AS INSTRUMENT NO. 2007-0369493 OF OFFICIAL RECORDS.

SAID EASEMENT IN CONTAINED WITHIN THE COLTON AVENUE RIGHT OF WAY.

(3) AN EASEMENT FOR POLE LINES AND INCIDENTAL PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA EDISON COMPANY RECORDED DECEMBER 30, 1953 IN BOOK 3302, PAGE 397 OF OFFICIAL RECORDS.

4 AN EASEMENT FOR STREET AND INCIDENTAL PURPOSES IN FAVOR OF LESTER C. ALBERTON, ET UX. RECORDED JULY 02, 1956 IN BOOK 3976, PAGE 359 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN APN 0298-063-03.

5 AN EASEMENT FOR THE DEDICATION FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED OCTOBER 28, 1977 IN BOOK 9294, PAGE 1750 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE NICE AVENUE RIGHT OF WAY.

(6) AN EASEMENT FOR THE DEDICATION FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED OCTOBER 28, 1977 IN BOOK 9294, PAGE 1752 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE OPAL AVENUE RIGHT OF WAY.

(7) AN EASEMENT FOR CONSTRUCT, USE, MAINTAIN, OPERATE, ALTER, AND TO REPAIR REPLACE, RECONSTRUCT, INSPECT AND REMOVE AT ANY TIME AND FROM TIME TO TIME AND INCIDENTAL PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA EDISON, A CORPORATION, RECORDED OCTOBER 31, 1977 IN BOOK 9295, PAGE 1491 OF OFFICIAL RECORDS.

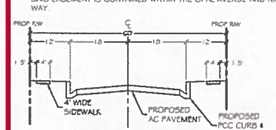
(8) AN EASEMENT FOR PUBLIC UTILITIES AND INCIDENTAL PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA EDISON COMPANY, A CORPORATION, ITS SUCCESSORS AND ASSIGNS, RECORDED FEBRUARY 13, 1986 AS INSTRUMENT NO. 86-040551 OF OFFICIAL RECORDS.

9 AN EASEMENT FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED JUNE 21, 2007 AS INSTRUMENT NO. 2007-0369494 OF OFFICIAL RECORDS.

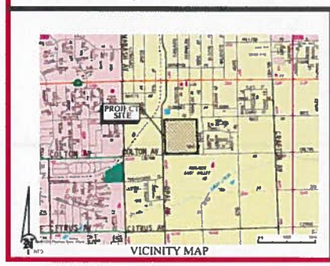
SAID EASEMENT IS CONTAINED WITHIN THE OPAL AVENUE RIGHT OF WAY.

10 AN EASEMENT FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED JUNE 21, 2007 AS INSTRUMENT NO. 2007-0352735 OF OFFICIAL RECORDS.

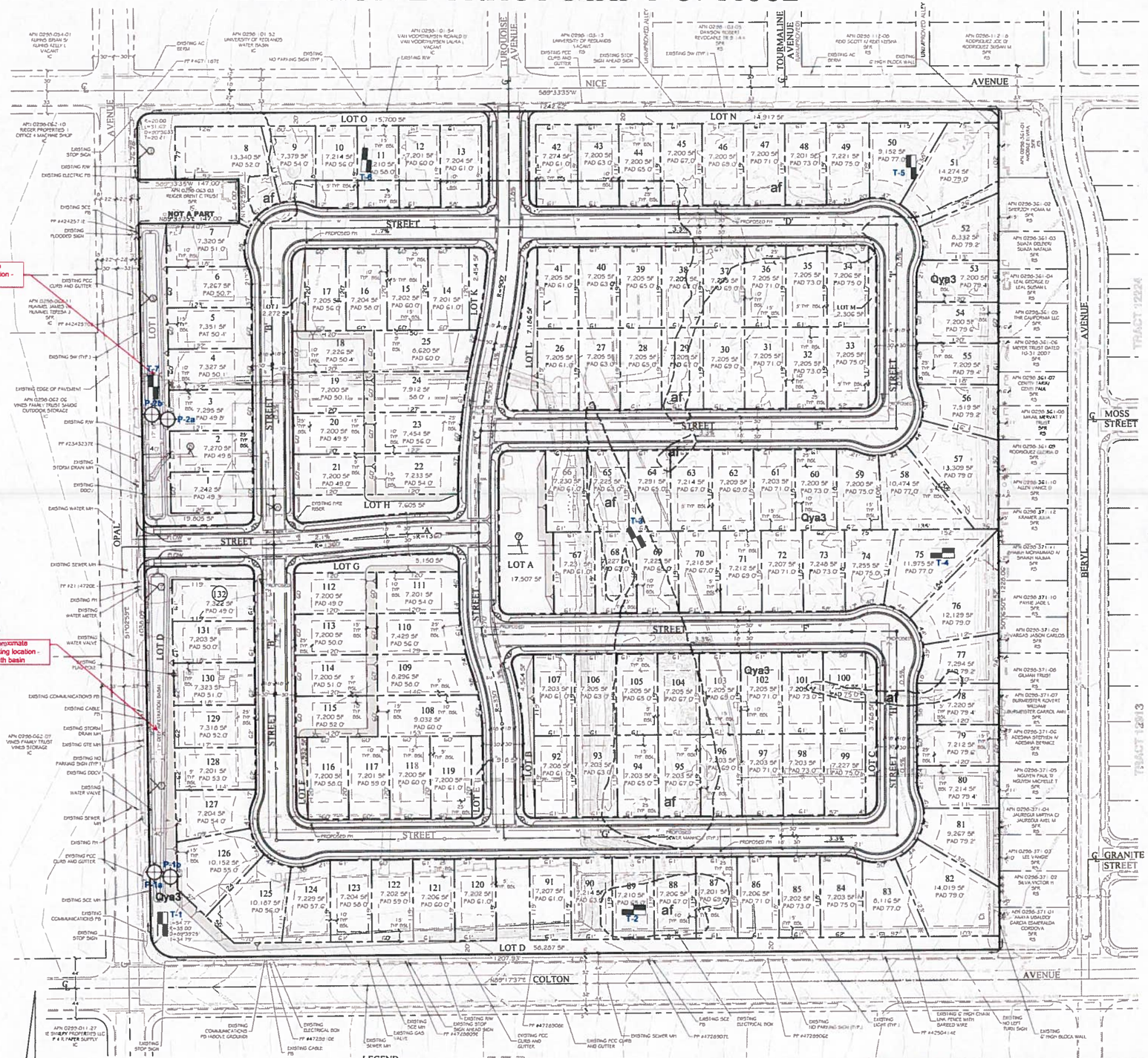
SAID EASEMENT IS CONTAINED WITHIN THE OPAL AVENUE AND NICE AVENUE RIGHT OF WAY.



TYPICAL X-SECTION INTERIOR STREET
NTS



VICINITY MAP



SOURCE OF SURVEY:
TOPOGRAPHIC SURVEY BY:
ONPOINT LAND SURVEYING, INC.
DATED 6/2013
412 WILBAR CIRCLE
REDLANDS, CA 92374

SCALE: 1"=60'
0 60 120 180

LEGEND

BSL BUILDING SET BACK LINE
DDCV DOUBLE DETECTOR CHECK VALVE
FH FIRE HYDRANT
MH MANHOLE
PP ELECTRIC POWER POLE
PL PROPERTY LINE
PB PULL BOX
PCC PORTLAND CEMENT CONCRETE
P.L. PROPERTY LINE
SFR SINGLE FAMILY RESIDENCE
STL STREET LIGHT
SW SIDEWALK

EXISTING BUILDING
PROPOSED PCC SIDEWALK
EXISTING PCC SIDEWALK
2:1 SLOPE (OVER 2' HEIGHT)

ZONING LEGEND

IC COMMUNITY INDUSTRIAL (COUNTY)
RS3 SINGLE RESIDENTIAL (COUNTY)
IN INSTITUTIONAL (COUNTY)

APN 0299-031-30
REDLANDS UNIFIED SCHOOL DISTRICT
REDLANDS EAST VALLEY HIGH SCHOOL
IN

BENCHMARK

CITY OF REDLANDS BENCHMARK R-43:
BRASS DISK IN THE TOP OF CURB @ NE COR. BERYL AVE. & COLTON AVE. EAST END OF RETURN
ELEVATION = 1,683.679

BASIS OF BEARING

CENTERLINE OF OPAL AVENUE PER RS 55/28 BEING N01°02'59"W

PREPARED FOR:

WALDEN STRUCTURES
ATTN: CHARLES WALDEN & JOEL MINER
801 OPAL AVENUE
MENTONE, CA 92359
PHONE: (909) 389-9102

Hilltop Geotechnical Inc. Legend

Approximate Double Ring Infiltrometer Test Location P-2b
Approximate Geologic Contact
Approximate Trench Location T-7
af Artificial Fill
Qya3 Young Axial Valley Deposit

OFFICIAL USE ONLY

Exploratory Excavation Location Plan
By: AH | Date: 2/14
Project No. 950-A14.1 | Plate No. 1

HILLTOP GEOTECHNICAL

PROJECT NOTES:

1. ASSESSOR'S PARCEL NUMBER: 0298-063-07
2. GROSS AREA: 42.37 AC
3. EXISTING NET AREA: 35.17 AC
4. 6,159 LF OF NEW STREETS ARE PROPOSED
5. EXISTING NUMBER OF LOTS: 1
6. PROPOSED NUMBER OF LOTS: 132 SINGLE FAMILY LOTS + 15 LETTERED LOTS
7. PROPOSED DENSITY: 4.69 DU/NET ACRE
8. EXISTING ZONING DESIGNATION: COMMUNITY INDUSTRIAL (IC)
9. PROPOSED COUNTY ZONING AND GENERAL PLAN DESIGNATION: SINGLE RESIDENTIAL (RS)
10. PROPOSED GENERAL PLAN DESIGNATION FOR CITY OF REDLANDS: LOW MEDIUM DENSITY (0 TO 6 DU/GROSS AC)
11. EXISTING GENERAL PLAN DESIGNATION FOR CITY OF REDLANDS: LIGHT INDUSTRIAL
12. NO CONTIGUOUS OWNERSHIP
13. GRADING & DRAINAGE SHOWN ON THIS PLAN IS CONCEPTUAL ONLY.
14. EXISTING USE: WALDEN STRUCTURES INDUSTRIAL USE
15. PROPOSED USE: SINGLE FAMILY RESIDENTIAL LOTS
16. SITE IS NOT SUBJECT TO FLOOD WATERS, OVERFLOW OR INUNDATION
17. NO REGULATED TREES OR PLANTS KNOWN TO EXIST ON SITE.
18. NO ADJACENT STRUCTURES WITHIN 15' OF PROJECT PROPERTY LINE, UNLESS OTHERWISE SHOWN
19. PROJECT SITE IS LOCATED WITHIN ZONE 'X' (AREAS DETERMINED TO BE OUTSIDE THE 0.2% ANNUAL CHANCE FLOOD PER FIRM NO.6717 OF 8400, DATED AUGUST 28, 2008.)
20. A RAIN GARDEN ON EACH SINGLE FAMILY LOT WILL PROVIDE WATER QUALITY TREATMENT OF STORMWATER FOR EACH LOT. RUNOFF FROM STREETS, SIDEWALKS AND OPEN SPACE WILL BE DIRECTED TO ONE OF TWO INFILTRATION BASINS (MAXIMUM 17" DEEP) LOCATED IN LOTS D & I FOR WATER QUALITY TREATMENT OF STORMWATER.
21. PRELIMINARY GRADING QUANTITIES:
    RAW CUT: 84,000 CY
    RAW FILL: 62,000 CY
    SITE TO BALANCE
22. ALL SLOPES 2:1 UNLESS OTHERWISE DESIGNATED. SLOPES 2' HIGH OR LESS ARE NOT SHOWN.
23. THIS PROJECT IS DESIGNED FOR DEVELOPER BUILD OUT.
24. ALL EXISTING FEATURES ONSITE WILL BE REMOVED. SEE PRE DEVELOPEMENT TRIBUTARY AREA MAP FOR LOCATION AND IDENTIFICATION OF EXISTING FEATURES.

UTILITIES

ELECTRIC:
SOUTHERN CALIFORNIA EDISON COMPANY 257 TENNESSEE STREET
REDLANDS, CA 92373
(909) 307-6731

GAS:
SOUTHERN CALIFORNIA GAS COMPANY 1981 WEST LUGONIA AVENUE
REDLANDS, CA 92373
(909) 335-7750

CABLE:
TIME WARNER CABLE
1971 W REDLANDS BLVD.
REDLANDS, CA 92374
(800) 892-2253

TELEPHONE:
VERIZON
9 SOUTH 4TH STREET
REDLANDS, CA 92373
(909) 748-6676

WATER & SEWER:
CITY OF REDLANDS
35 CAJON STREET
REDLANDS, CA 92373
(909) 798-7698

APN 0298-063-07

TENTATIVE TRACT MAP NO. 18952

APPLICANT/REPRESENTATIVE:
WALDEN STRUCTURES
ATTN: CHARLES WALDEN & JOEL MINER
801 OPAL AVENUE, MENTONE, CA 92359

PROPERTY OWNER:
800 OPAL LLC
C/O WALDEN STRUCTURES
ATTN: CHARLES WALDEN & JOEL MINER
801 OPAL AVENUE MENTONE, CA 92359

MAP PREPARER:
THATCHER ENGINEERING AND ASSOCIATES, INC.
1461 FORD STREET SUITE 105, REDLANDS CA 92373

DATE PREPARED: 1/13/2014

thatcher engineering & associates, inc.
• land planning
• civil engineering
• landscape architecture
phone 909 748 7777
fax 909 748 7778
1461 ford street suite 105, redlands, ca 92373

REGISTERED PROFESSIONAL ENGINEER
MELVIN W. THATCHER, III
No. 39964
Exp. 12/31/15
CIVIL
STATE OF CALIFORNIA

Melvin W. Thatcher, III R.C.E. 39964 Exp. Dec. 31, 2015

Job Number:	Date Prepared:	Drawn By:	Reference Number:
154601	1/15/14	PP	154601TM2014.1.2

SUBSURFACE EXPLORATION LEGEND

UNIFIED SOIL CLASSIFICATION SYSTEM Visual-Manual Procedure (ASTM D2488-09a)					CONSISTENCY / RELATIVE DENSITY
MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES	CRITERIA
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	Reference: 'Foundation Engineering'. Peck, Hansen, Thornburn. 2nd Edition.
			GP	Poorly Graded Gravels and Gravel-Sand Mixtures. Little or no Fines	Standard Penetration Test Granular Soils
		Gravels with Fines	GM	Silty Gravels, Gravel-Sand-Silt Mixtures**	Penetration Resistance, N, (Blows / Foot) — Relative Density
			GC	Clayey Gravel, Gravel-Sand-Clay Mixtures**	0 - 4 — Very Loose
	Sands More than 50 % of Coarse Fraction Passes No. 4 Sieve	Clean Sands	SW	Well Graded Sands and Gravely Sands, Little or no Fines	5 - 10 — Loose
			SP	Poorly Graded Sands and Gravelly Sands, Little or no Fines	11 - 30 — Medium Dense 31 - 50 — Dense
		Sands with Fines	SM	Silty Sands, Sand-Silt Mixtures**	> 50 — Very Dense
			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	Standard Penetration Test Cohesive Soils
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays	Penetration Resistance, N, (Blows / Foot) — Consistency — Unconfined Compressive Strength, (Tons / Sq. Ft.)
			OL	Organic Silts and Organic silty Clays of Low Plasticity	< 2 — Very Soft — < 0.25
	Silts and Clays Liquid Limits Greater than 50 %		MH	Inorganic Silts, Micaceous or Diatomaceous silts, Plastic Silts	2 - 4 — Soft — 0.25 - 0.5
			CH	Inorganic Clays of High Plasticity, Fat Clays	5 - 8 — Firm (Medium Stiff) — 0.5 - 1.0 9 - 15 — Stiff — 1.0 - 2.0
			OH	Organic Clays of Medium to High Plasticity	16 - 30 — Very Stiff — 2.0 - 4.0
Highly Organic Soils			PT	Peat, Muck, or Other Highly Organic Soils	> 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 (Few)	< 5 %
Slight	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

HILLTOP GEOTECHNICAL INCORPORATED

(Revised 7-10-2013)

SUBSURFACE EXPLORATION LOG
TRENCH NO. T-1

HILLTOP GEOTECHNICAL INCORPORATED

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.
Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH
Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1649

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SM			Qya_3		YOUNG AXIAL VALLEY DEPOSIT: Silty, fine to coarse sand, a little gravel, a little cobbles; Light brown to orange-brown; Moist.
1	B/N			120.1	5.8			
2								
3	N			99.4	5.7			
4			SP					Gravelly, fine to coarse sand, trace boulders, trace silt; Brown; Moist.
5	B		GP					Fine to coarse, sandy gravel, some cobbles, trace boulders; Light gray-brown; Moist.
6								
7								
8								
9								
10								
11								
12								Bottom of trench at 11.5 feet. No groundwater encountered. Trench backfilled with excavated material.
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

HILLTOP GEOTECHNICAL INCORPORATED

SUBSURFACE EXPLORATION LOG
TRENCH NO. T-2

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.
Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH
Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1668

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
1			SM			af		ARTIFICIAL FILL: Silty, fine to coarse sand, some gravel, a little cobbles, trace boulders, trace roots, trace asphalt particles and plastic pieces; Light brown; Moist.
2	N			114.6	3.3			
3	B							4 to 5 Large Boulders.
4	N		SM	110.0	6.9	Qya_3		YOUNG AXIAL VALLEY DESPOSIT: Silty, fine to coarse sand, a little gravel, a little cobbles; Light brown to orange-brown; Moist.
5								
6								
7			GP					Fine to coarse, sandy gravel, a little cobbles, trace boulders; Light gray-brown; Moist.
8								
9								
10								
11	B							
12								Bottom of trench at 11.5 feet. No groundwater encountered. Trench backfilled with excavated material.
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

SUBSURFACE EXPLORATION LOG
TRENCH NO. T-3

HILLTOP GEOTECHNICAL INCORPORATED

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.
Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH
Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1668

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SM			af		ARTIFICIAL FILL:
1	N			128.8	2.9			Silty, fine to coarse sand, a little gravel, a little cobbles; Light brown; Moist.
2								Asphalt pieces found at 2'
3	B N			126.1	4.5			
4								
5			SP			Qya_3		YOUNG AXIAL VALLEY DESPOSIT: Fine to coarse sand, a little gravel; Gray; Moist.
6			SM					Silty, fine to coarse sand, some gravel, trace cobble, trace boulders; Dark orange-brown; Moist.
7			GP					Fine to coarse, sandy gravel, some cobbles, a little boulders; Light gray-brown; Moist.
8								
9								
10								
11								
12								Bottom of trench at 11.5 feet. No groundwater encountered. Trench backfilled with excavated material.
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

SUBSURFACE EXPLORATION LOG
TRENCH NO. T-4

HILLTOP GEOTECHNICAL INCORPORATED

Project Name:	Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.				
Project No.:	950-A14.1	Date:	1/20/2014	Logged By:	AH
Equipment Used:	Rubber tired, tractor-mounted backhoe			Elevation:	± 1677

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SM			Qya_3		YOUNG AXIAL VALLEY DEPOSIT: Silty, fine to coarse sand, a little gravel, a little cobbles, trace boulders; Light brown to orange-brown; Moist
1								
2	N			104.6	2.7			
3			GP					5 Large boulders.
4	B/N		GP	116.4	4.2			Gravel, some fine to coarse sand, some cobbles, trace boulders; Gray-brown; Moist.
5								
6								
7								
8								
9								
10								Bottom of trench at 9.5 feet. No groundwater encountered. Trench backfilled with excavated material.
11								
12								
13								
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15								
16								
17								
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20								
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23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

HILLTOP GEOTECHNICAL INCORPORATED

SUBSURFACE EXPLORATION LOG
TRENCH NO. T-5

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.
Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH
Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1678

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SM			af		ARTIFICIAL FILL: Silty, fine to coarse sand, trace gravel, trace cobbles; Orange-brown; Moist.
1	N			109.9	3.3			
2	B		SM			Qya_3		YOUNG AXIAL VALLEY DEPOSIT: Silty, fine to coarse sand, trace gravel, trace cobbles; Orange-brown; Moist.
3	N			112.0	4.6			
4								
5			GP					Cobbles, a little gravel, a little fine to coarse sand, trace boulders; Gray; Moist.
6								
7			GP					Gravel, trace silt, trace fine to coarse sand; Gray; Moist.
8			GP					Cobbles, a little gravel, a little fine to coarse sand, trace boulders; Gray; Moist.
9								
10			GP					Gravel, trace silt, trace fine to coarse sand; Gray; Moist.
			GP					Cobbles, a little gravel, a little fine to coarse sand, trace boulders; Gray; Moist.
11								Bottom of trench at 10.5 feet. No groundwater encountered. Trench backfilled with excavated material.
12								
13								
14								
15								
16								
17								
18								
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20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

SUBSURFACE EXPLORATION LOG
TRENCH NO. T-6

HILLTOP GEOTECHNICAL INCORPORATED

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.
Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH
Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1659

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
1	B		SM			af		ARTIFICIAL FILL: Silty, fine to coarse sand, a little gravel, trace cobbles, trace boulders, trace asphalt and plastics; Brown; Moist.
2			SM			Qya_3		YOUNG AXIAL VALLEY DEPOSIT:
3	N			108.8	4.8			Silty, fine to coarse sand, a little gravel, trace cobbles, trace boulders; Orange-brown; Moist;.
4								
5	B/N			102.5	5.8			
6			GP					Boulders, some cobbles, a little gravel, a little fine to coarse sand; Orange-brown to Gray-brown.
7			GP					Gravel, trace silt, trace fine to coarse sand; Gray; Moist.
8			GP					Boulders, some cobbles, a little gravel, a little fine to coarse sand; Orange-brown to Gray-brown.
9								
10								
11								
12								Bottom of trench at 12.0 feet. No groundwater encountered. Trench backfilled with excavated material.
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

SUBSURFACE EXPLORATION LOG
TRENCH NO. T-7

HILLTOP GEOTECHNICAL INCORPORATED

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.
Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH
Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1651

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SM			Qya_3		YOUNG AXIAL VALLEY DEPOSIT:
1	N			112.2	14.4			Silty, fine to coarse sand, a little gravel, trace cobbles, trace boulders; Dark brown; Very moist.
2	B							
3	N			113.6	9.5			
4			SP					Fine to coarse sand, a little gravel, trace silt, trace cobbles; Dark brown; Moist.
5			GP					Cobbley, gravel, a little fine to coarse sand, trace silt, trace boulders; Dark brown; Moist.
6								
7								
8								
9								Bottom of trench at 9.0 feet due to sidewalll caving.
10								No groundwater encountered.
11								Trench backfilled with excavated material.
12								
13								
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23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

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 **
T-5, 1.5'-2.0'	8.1	116.2	48.6	13.6	0	Non-Expansive

* Assumes a 2.70 Specific Gravity for the earth material.
** As defined in Section 1803.5.3, 'Expansive Soil,' in the 2013 California Building Code (CBC) (i.e., Non-Expansive: EI ≤20; Expansive: EI >20).

SOLUBLE SULFATE TEST RESULTS (EPA 300.0 Test Procedure)*			
SAMPLE NO.	SOLUBLE SULFATE CONTENT (%)	SULFATE EXPOSURE**	
		CLASS	SEVERITY
T-2, 2.5'-3.0'	0.0019	S0	Not Applicable
T-5, 1.5'-2.0'	<0.0005	S0	Not Applicable

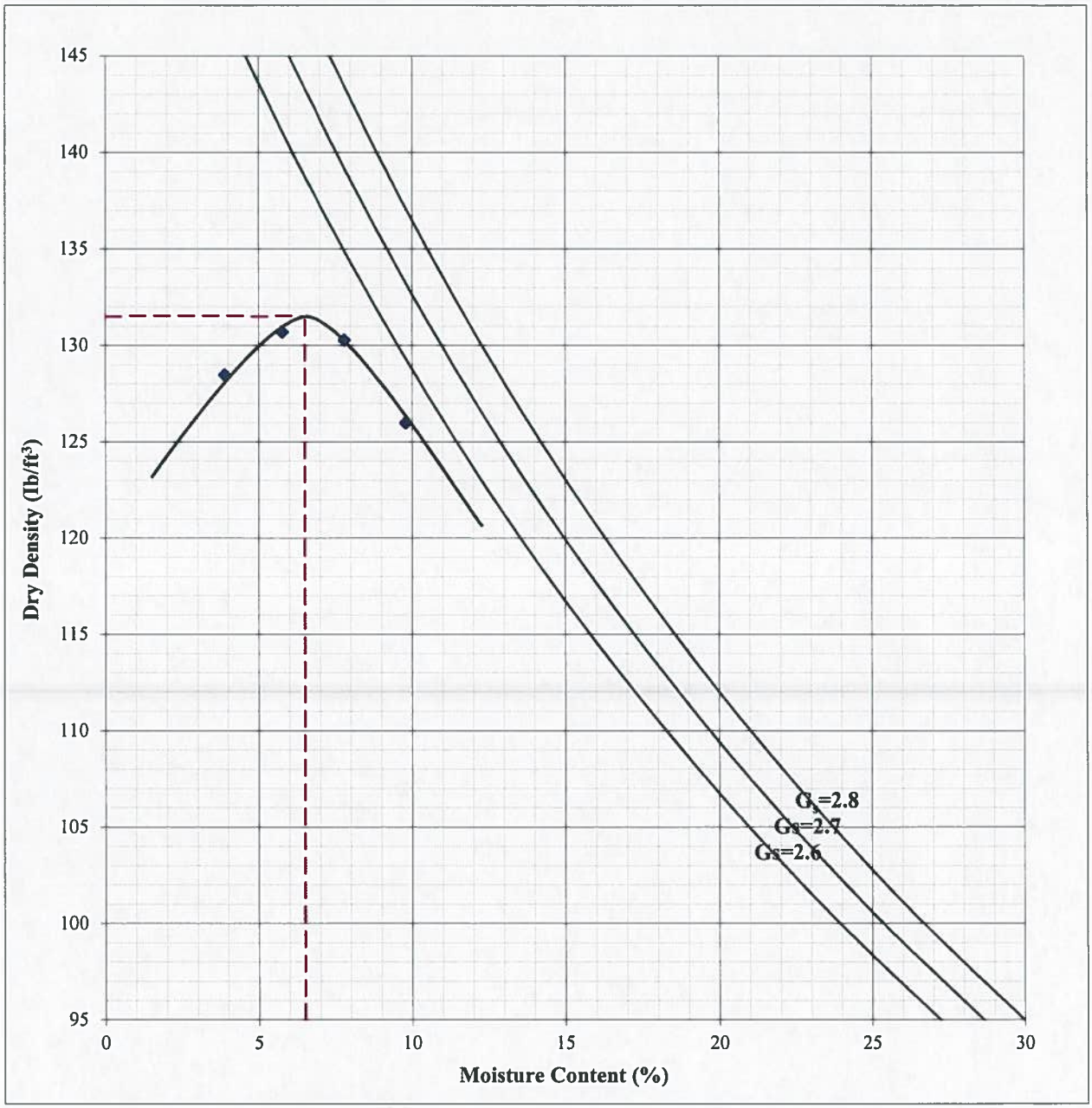
* Test performed by **A & R Laboratories**.
** Per Table 4.2.1, 'Exposure Categories and Classes,' in **American Concrete Institute (ACI)** 318-11, Chapter 4, *Durability Requirements*, Section 4.2.1.

June 5, 2017 1100-A17.1

SUMMARY OF LABORATORY TEST RESULTS

PERCENT PASSING #200 SIEVE TEST RESULTS (ASTM D1140 Test Method)	
SAMPLE	PERCENT PASSING #200 SIEVE
T-2, 2.5'-3.0'	12
T-5, 1.5'-2.0'	16

HILLTOP GEOTECHNICAL, INC.



Maximum Dry Density (lb/ft^3)	131.5
Optimum Moisture Content (%)	6.5
Procedure	C
Corrected Maximum Dry Density for 16.9% +3/4" (lb/ft^3)	136.4
Corrected Optimum Moisture Content for 16.9% +3/4" (%)	5.6

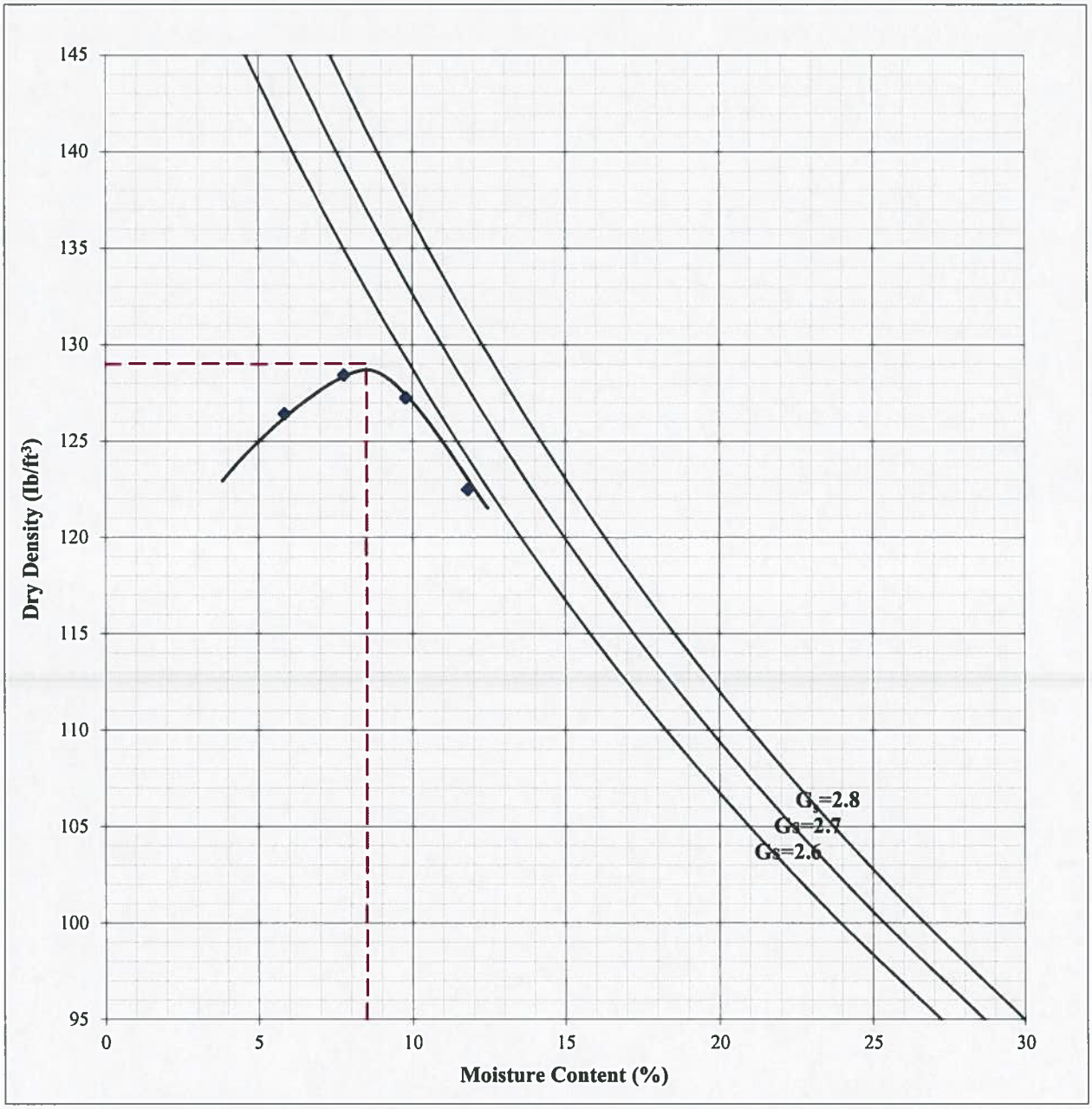
HILLTOP GEOTECHNICAL INCORPORATED

MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT RELATIONSHIP TEST RESULTS (ASTM D1557 Test Method)

SAMPLE: T-2, 2.5'-3.0'

SOIL DESCRIPTION: Light brown, silty, fine to coarse sand, some gravel, a little cobbles, trace boulders (SM)

BY:	DLC	DATE:	2/2014
JOB NO.:	950-A14.1	PLATE NO.:	12



Maximum Dry Density (lb/ft^3)	129.0
Optimum Moisture Content (%)	8.5
Procedure	B

Corrected Maximum Dry Density for 5.8% +3/8" (lb/ft^3)	130.7
Corrected Optimum Moisture Content for 5.8% +3/8" (%)	8.1

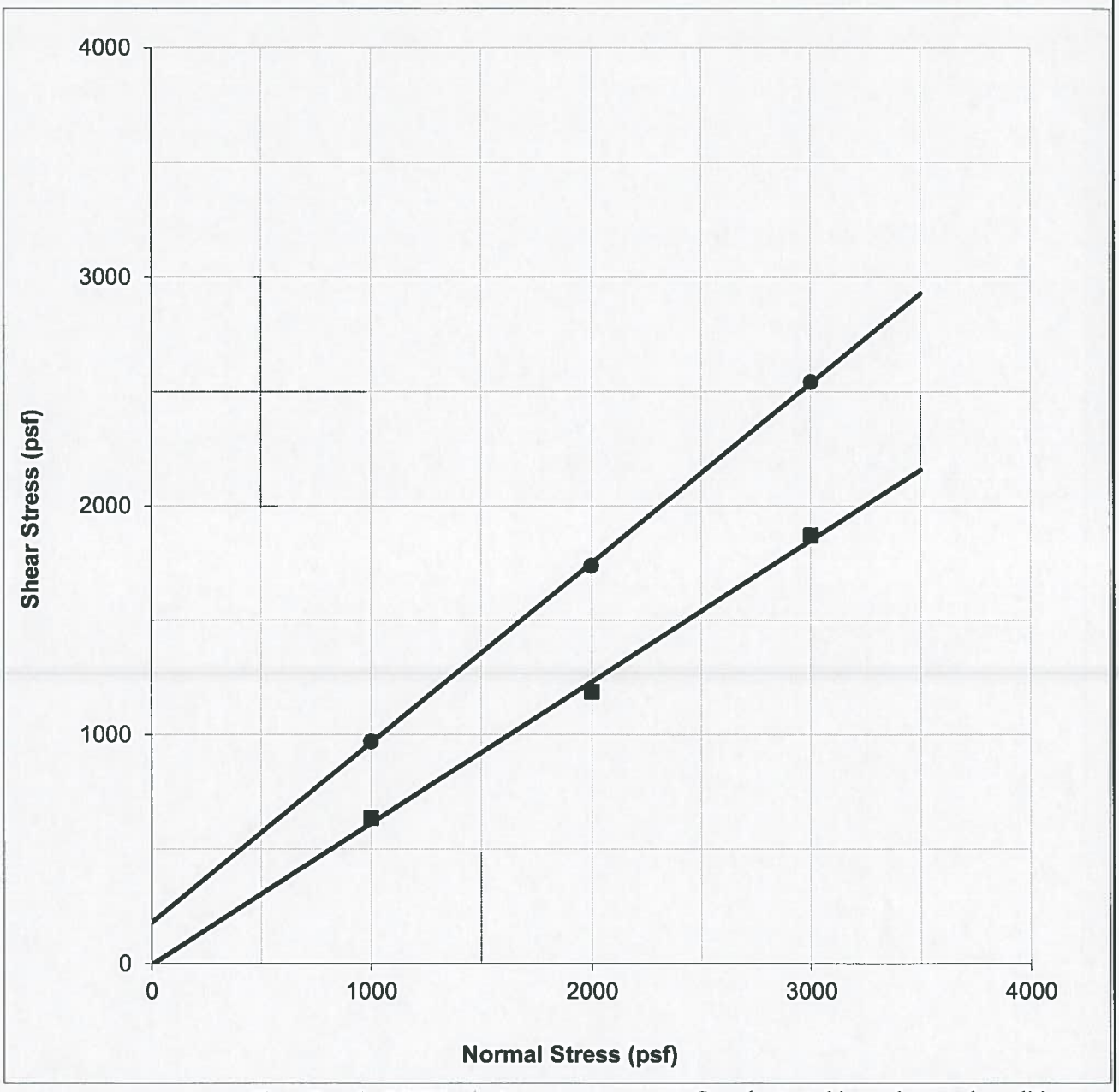
HILLTOP GEOTECHNICAL INCORPORATED

MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT RELATIONSHIP TEST RESULTS (ASTM D1557 Test Method)

SAMPLE: T-5, 1.5'-2.0'

SOIL DESCRIPTION: Orange-brown, silty, fine to coarse sand, trace gravel, trace cobbles (SM)

BY:	DLC	DATE:	2/2014
JOB NO.:	950-A14.1	PLATE NO.:	13



Shear Speed: 0.005 in. / min. Samples tested in a submerged condition.

Average Dry Density (pcf)	116.9
Average Moisture Content (%)	8.2

Peak	Cohesion	180 psf
	Internal Friction Angle	38 degrees
Ultimate	Cohesion	0 psf
	Internal Friction Angle	32 degrees
Residual	Cohesion	psf
	Internal Friction Angle	degrees

HILLTOP GEOTECHNICAL INCORPORATED

DIRECT SHEAR TEST RESULTS
(ASTM D3080 Test Method)

SAMPLE:	T-05, 1.5'-2.09' (Remolded to 90% of maximum dry density at optimum moisture content)		
SOIL DESCRIPTION:	Orange-brown, silty, fine to coarse sand, trace gravel, trace cobbles (SM)		
BY:	DLC	DATE:	2/2014
PROJECT NO.:	950-A14.1	PLATE NO.:	14

APPENDIX B

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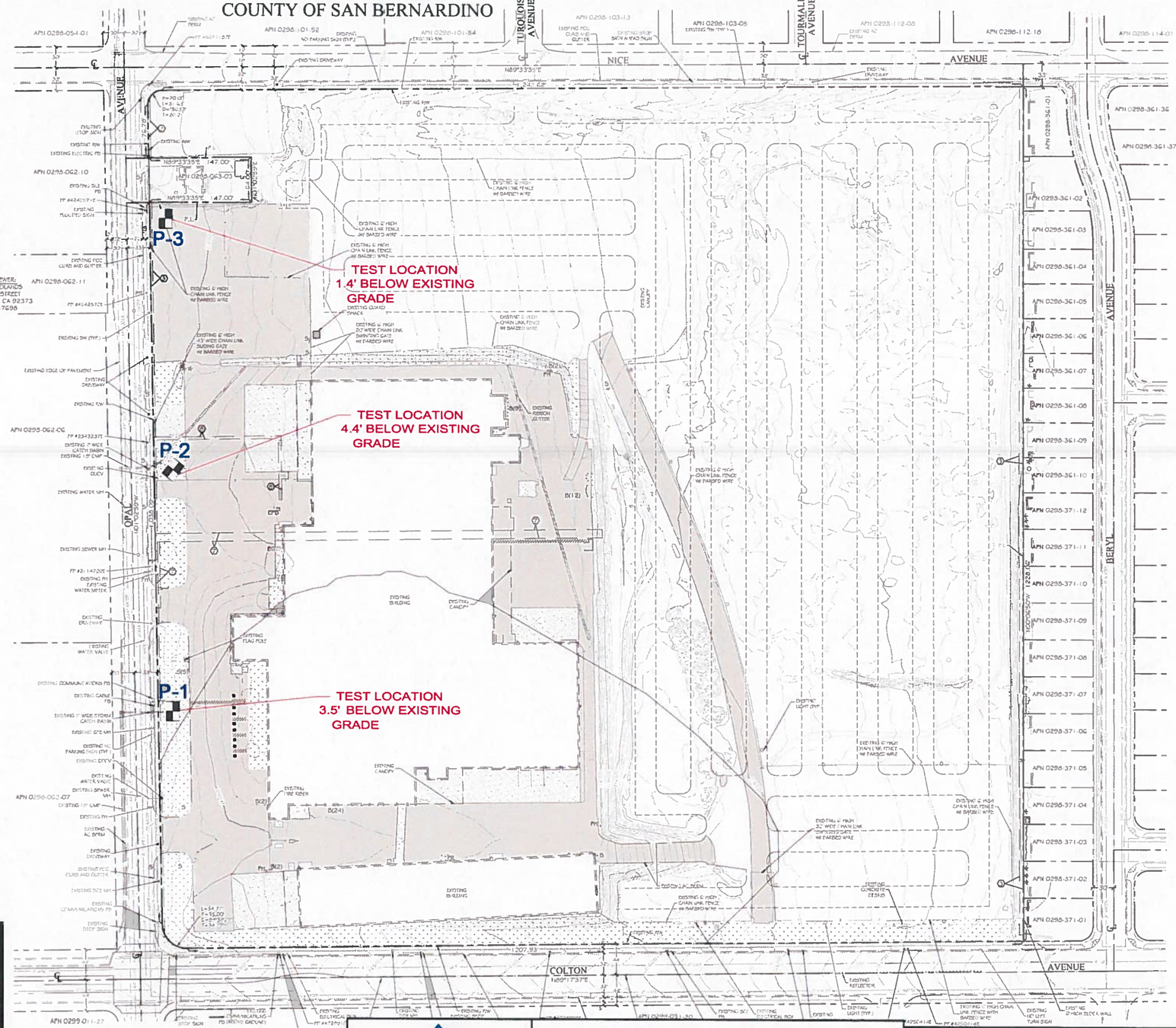
APPENDIX C

INFILTRATION TEST LOCATION EXHIBIT

APN 0298-063-07
801 OPAL AVENUE
COUNTY OF SAN BERNARDINO



UTILITIES

ELECTRIC:
SOUTHERN CALIFORNIA EDISON COMPANY 287 TENNESSEE STREET REDLANDS, CA 92373 (909) 307-4731

GAS:
SOUTHERN CALIFORNIA GAS COMPANY 1981 WEST LUGONIA AVENUE REDLANDS, CA 92373 (909) 335-7750

CABLE:
TIME WARNER CABLE 1971 W REDLANDS BLVD REDLANDS, CA 92374 (800) 692-2253

TELEPHONE:
VERIZON 9 SOUTH 4TH STREET REDLANDS, CA 92373 (909) 748-6276

WATER & SEWER:
CITY OF REDLANDS 35 CAJON STREET REDLANDS, CA 92373 (909) 798-7696

LEGEND

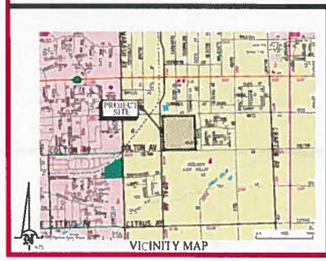
- EXISTING AC PAVING
- EXISTING PCC PAVING
- EXISTING LANDSCAPING

AC	ASPHALT CONCRETE
B	BOLLARD
BF	BACKFLOW
EC	ELECTRICAL CABINET
EX.	EXISTING
FH	FIRE HYDRANT
FR	FIRE RISER
MB	MAILBOX
PCC	PORTLAND CEMENT CONCRETE
PL	PROPERTY LINE
PP	POWER POLE
R/W	RIGHT-OF-WAY
S	SIGN
SMH	SEWER MANHOLE

SOURCE OF SURVEY
TOPOGRAPHIC SURVEY
DATED AUGUST 2013
AS CONDUCTED BY
ONPOINT LAND SURVEYING, INC.
1910 ORANGE TREE LANE, SUITE 344
REDLANDS, CALIFORNIA 92374
PHONE: (909) 792 2221

SCALE: 1"=60'
0 60 120 180

UNDERGROUND SERVICE ALERT
Call: Toll FREE
1-800-227-2600
TWO WORKING DAYS BEFORE YOU DIG
"CAUTION: Remember that the USA Center notifies only those utilities belonging to the center. There could be other utilities present at the work site. The center will inform you of whom they will notify.



VICINITY MAP

LEGAL DESCRIPTION

PARCEL A:

ALL THAT PORTION OF THE SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SECTION 19, TOWNSHIP 1 SOUTH, RANGE 2 WEST, SAN BERNARDINO MERIDIAN, DESCRIBED AS FOLLOWS:

BEING A STRIP OF LAND OF UNIFORM WIDTH OF 30 FEET ON AND ALONG THE SOUTH BOUNDARY LINE OF THE SOUTHEAST ONE QUARTER OF THE SOUTHWEST ONE QUARTER OF SECTION 19, TOWNSHIP 1 SOUTH, RANGE 2 WEST, SAN BERNARDINO MERIDIAN.

EXCEPTING AND RESERVING UNTO UNION PACIFIC RAILROAD COMPANY, A DELAWARE CORPORATION, ITS SUCCESSORS AND ASSIGNS, FOREVER, ALL MINERALS AND ALL MINERAL RIGHTS OF EVERY KIND AND CHARACTER NOW KNOWN TO EXIST OR HEREAFTER DISCOVERED UNDERLYING THE PROPERTY, INCLUDING, WITHOUT LIMITING THE GENERALITY OF THE FOREGOING, OIL AND GAS AND RIGHTS THERETO, TOGETHER WITH THE SOLE, EXCLUSIVE AND PERPETUAL RIGHT TO EXPLORE FOR, REMOVE AND DISPOSE OF SAID MINERALS BY ANY MEANS OR METHODS SUITABLE TO GRANTOR, ITS SUCCESSORS AND ASSIGNS, BUT WITHOUT ENTERING UPON OR USING THE SURFACE OF THE PROPERTY, AND IN SUCH MANNER AS NOT TO DAMAGE THE SURFACE OF THE PROPERTY, OR TO INTERFERE WITH THE USE THEREOF BY GRANTEE, ITS SUCCESSORS OR ASSIGNS, AS RESERVED ON QUITCLAIM DEED RECORDED APRIL 07, 2006, AS INSTRUMENT NO. 2006-0239408, OF OFFICIAL RECORDS.

PARCEL B:

THE SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER OF SECTION 19, TOWNSHIP 1 SOUTH, RANGE 2 WEST, SAN BERNARDINO MERIDIAN, IN THE COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO THE OFFICIAL PLAT THEREOF.

EXCEPTING THE SOUTHERLY 39 FEET THEREOF, AS CONVEYED TO THE SOUTHERN PACIFIC RAILROAD BY DEED RECORDED OCTOBER 09, 1891, IN BOOK 139, PAGE 225 OF DEEDS

ALSO SAVING AND EXCEPTING THE FOLLOWING DESCRIBED PROPERTY:

BEGINNING AT A POINT ON THE WEST LINE OF APOREMAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE QUARTER OF SECTION 19, DISTANT THEREON 130 FEET SOUTH OF THE NORTHWEST CORNER THEREOF, THENCE EAST PARALLEL TO THE NORTH LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER A DISTANCE OF 180 FEET; THENCE SOUTH PARALLEL TO THE WEST LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER A DISTANCE OF 64 FEET; THENCE WEST PARALLEL TO THE NORTH LINE OF SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER A DISTANCE OF 180 FEET TO THE WEST LINE OF SAID SOUTHEAST ONE QUARTER OF THE SOUTHWEST ONE-QUARTER OF SECTION 19; THENCE NORTH ALONG SAID WEST LINE A DISTANCE OF 64 FEET TO THE POINT OF BEGINNING

APN: 0298-063-07

EASEMENTS

1 AN EASEMENT FOR CARRIAGE OF WATER TO DIG AND LAY WATER WAYS, ALSO THE RIGHT TO BUILD CONSTRUCT AND MAINTAIN UPON SAID DAMS AND RESERVOIRS AND INCIDENTAL PURPOSES IN FAVOR OF THE MENTONE IRRIGATION COMPANY RECORDED DECEMBER 01, 1887, IN BOOK 69 OF DEEDS, PAGE 144.

SAID EASEMENT IS NOT PLOTTABLE.

2 AN EASEMENT FOR HIGHWAY, ROADWAY AND INCIDENTAL PURPOSES IN FAVOR OF COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED JUNE 21, 2007 AS INSTRUMENT NO. 2007-0369493 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE COLTON AVENUE RIGHT OF WAY.

3 AN EASEMENT FOR POLE LINES AND INCIDENTAL PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA EDISON COMPANY RECORDED DECEMBER 30, 1953 IN BOOK 3302, PAGE 397 OF OFFICIAL RECORDS.

4 AN EASEMENT FOR STREET AND INCIDENTAL PURPOSES IN FAVOR OF LESTER C ALBERTON, ET UX. RECORDED JULY 02, 1956 IN BOOK 3976, PAGE 359 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN APN 0298-063-03.

5 AN EASEMENT FOR THE DEDICATION FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED OCTOBER 28, 1977 IN BOOK 9294, PAGE 1750 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE NICE AVENUE RIGHT OF WAY.

6 AN EASEMENT FOR THE DEDICATION FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED OCTOBER 28, 1977 IN BOOK 9294, PAGE 1752 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE OPAL AVENUE RIGHT OF WAY.

7 AN EASEMENT FOR CONSTRUCT, USE, MAINTAIN, OPERATE, ALTER, AND TO REPAIR, REPLACE, RECONSTRUCT, INSPECT AND REMOVE AT ANY TIME AND FROM TIME TO TIME AND INCIDENTAL PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA EDISON, A CORPORATION, RECORDED OCTOBER 31, 1977 IN BOOK 9295, PAGE 1491 OF OFFICIAL RECORDS.

8 AN EASEMENT FOR PUBLIC UTILITIES AND INCIDENTAL PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA EDISON COMPANY, A CORPORATION, ITS SUCCESSORS AND ASSIGNS, RECORDED FEBRUARY 13, 1986 AS INSTRUMENT NO 86-040551 OF OFFICIAL RECORDS.

9 AN EASEMENT FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED JUNE 21, 2007 AS INSTRUMENT NO 2007-0369494 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE OPAL AVENUE RIGHT OF WAY.

10 AN EASEMENT FOR HIGHWAY AND ROAD AND INCIDENTAL PURPOSES IN FAVOR OF THE COUNTY OF SAN BERNARDINO, A BODY CORPORATE AND POLITIC OF THE STATE OF CALIFORNIA RECORDED JUNE 21, 2007 AS INSTRUMENT NO. 2007-0362735 OF OFFICIAL RECORDS.

SAID EASEMENT IS CONTAINED WITHIN THE OPAL AVENUE AND NICE AVENUE RIGHT OF WAY.

INFILTRATION TEST LOCATION EXHIBIT
APN 0298-063-07
801 OPAL AVENUE
COUNTY OF SAN BERNARDINO

HILLTOP GEOTECHNICAL INCORPORATED

Infiltration Test Location Plan	
By: AH	Date: 05/2017
Project No.: 1100-A17.1	Plate No.: 15

BENCHMARK
CITY OF REDLANDS BENCHMARK R-43:
BRASS DISK IN THE TOP OF CURB @ NE COR. BERYL AVE & COLTON AVE EAST END OF RETURN.
ELEVATION = 1,683.679

BASIS OF BEARING
CENTERLINE OF OPAL AVENUE PER RS 55/28 BEING N01°02'59"W

PREPARED FOR:
WALDEN STRUCTURES
ATTN: CHARLES WALDEN & JOEL MINER
801 OPAL AVENUE
MENTONE, CA 92359
PHONE: (909) 389 9102

thatcher engineering & associates, inc.
1461 ford street suite 105 redlands ca 92373
• land planning
• civil engineering
• landscape architecture
phone 909 748 7777
fax 909 748 7776

PATRICK C. FLANAGAN, JR. No. 66046 Exp. Sep. 30, 2015 CIVIL STATE OF CALIFORNIA

Job Number:	Date Prepared:	Drawn By:	Reference Drawing:
154801	4/5/17	PF	154801 INFILTRATION DWG

INFILTROMETER TEST **P-1**

PROJECT IDENTIFICATION: 1100-A17.1

TEST LOCATION: South

LIQUID USED: Municipal H20

TESTED BY AH

DEPTH TO WATER TABLE:

DATE OF TEST 11-May-17

	AREA(CM2)		DEPTH OF LIQUID (CM)
INNER	699.6	INNER	15.24
OUTER	2128.5	OUTER	15.24

LIQUID LEVEL MAINTAINED USING: __X__ MANUAL ADDITIONS (VISUAL)

INNER RING AVERAGE RATE	CM/H	**11.50**	IN/H	**4.53**
OUTER RING AVERAGE RATE	CM/H	**9.70**	IN/H	**3.82**

Increment No.	DATE	TIME START= 09:19 AM HR: MM	ELAPSED TIME/ INCREMENT MIN	FLOW READINGS INNER FLOW CM3	FLOW READINGS OUTER FLOW CM3	LIQUID TEMP. F	INCREMENTAL INFILTRATION RATE INNER CM/H	INCREMENTAL INFILTRATION RATE ANNULAR CM/H	INCREMENTAL INFILTRATION RATE INNER IN/H	INCREMENTAL INFILTRATION RATE ANNULAR IN/H	GROUND TEMP = 72 F @ DEPTH OF 12 INCHES AIR TEMP, WEATHER
1	11-May-2017	9:34	15	3,360	7,687	72	19.21	14.45	7.57	5.69	62, Sunny
2	11-May-2017	9:49	15	3,270	6,530	72	18.70	12.27	7.37	4.83	63, Sunny
3	11-May-2017	10:04	15	2,790	6,660	72	15.95	12.52	6.29	4.93	63, Sunny
4	11-May-2017	10:19	15	2,350	5,610	73	13.44	10.54	5.29	4.15	63, Sunny
5	11-May-2017	10:49	30	4,000	12,000	70	11.44	11.28	4.51	4.44	68, Sunny
6	11-May-2017	11:19	30	2,600	9,000	71	7.43	8.46	2.93	3.33	74, Sunny
7	11-May-2017	12:19	60	5,300	18,000	72	7.58	8.46	2.98	3.33	78, Sunny
8	11-May-2017	13:19	60	5,200	14,000	77	7.43	6.58	2.93	2.59	84, Sunny
9	11-May-2017	14:19	60	5,000	13,500	80	7.15	6.34	2.82	2.50	88, Sunny
10	11-May-2017	15:19	60	4,700	13,000	78	6.72	6.11	2.65	2.41	86, Sunny

	CM/H Annular	CM/H Inner	IN/H Annular	IN/H Inner
Steady State Rates:	6.87	7.22	2.71	2.84

INFILTROMETER TEST **P-2** DATE OF TEST 11-May-17 DEPTH OF

PROJECT IDENTIFICATION: 1100-A17.1 AREA(CM2) LIQUID (CM)

TEST LOCATION: Middle INNER 699.6 INNER 15.24

LIQUID USED: Municipal H20 OUTER 2128.5 OUTER 15.24

TESTED BY AH LIQUID LEVEL MAINTAINED USING: __X__ MANUAL ADDITIONS (VISUAL)

DEPTH TO WATER TABLE: INNER RING AVERAGE RATE CM/H **18.17** IN/H **7.16**

OUTER RING AVERAGE RATE CM/H **19.52** IN/H **7.69**

Increment No.	DATE	TIME START= 09:52 AM HR: MM	ELAPSED TIME/ INCREMENT MIN	FLOW READINGS INNER FLOW CM3	FLOW READINGS OUTER FLOW CM3	LIQUID TEMP. F	INCREMENTAL INFILTRATION RATE INNER CM/H	INCREMENTAL INFILTRATION RATE ANNULAR CM/H	INCREMENTAL INFILTRATION RATE INNER IN/H	INCREMENTAL INFILTRATION RATE ANNULAR IN/H	GROUND TEMP = 72 F @ DEPTH OF 12 INCHES AIR TEMP, WEATHER
1	11-May-2017	10:07	15	5,780	16,570	72	33.05	31.14	13.02	12.27	62, Sunny
2	11-May-2017	10:22	15	5,400	16,280	72	30.87	30.59	12.16	12.05	63, Sunny
3	11-May-2017	10:37	15	2,000	9,000	71	11.44	16.91	4.51	6.66	68, Sunny
4	11-May-2017	10:52	15	4,000	13,500	71	22.87	25.37	9.01	10.00	68, Sunny
5	11-May-2017	11:22	30	6,000	21,300	74	17.15	20.01	6.76	7.89	72, Sunny
6	11-May-2017	11:52	30	5,500	16,500	75	15.72	15.50	6.19	6.11	75, Sunny
7	11-May-2017	12:52	60	9,700	33,000	78	13.87	15.50	5.46	6.11	78, Sunny
8	11-May-2017	13:52	60	8,500	27,500	78	12.15	12.92	4.79	5.09	88, Sunny
9	11-May-2017	14:52	60	8,700	30,000	79	12.44	14.09	4.90	5.55	87, Sunny
10	11-May-2017	15:52	60	8,500	28,000	80	12.15	13.15	4.79	5.18	88, Sunny

	CM/H Annular	CM/H Inner	IN/H Annular	IN/H Inner
Steady State Rates:	13.92	12.65	5.48	4.98

INFILTROMETER TEST **P-3**

PROJECT IDENTIFICATION: 1100-A17.1

TEST LOCATION: North

LIQUID USED: Municipal H20

TESTED BY AH

DEPTH TO WATER TABLE:

DATE OF TEST 12-May-17

	AREA(CM2)		DEPTH OF LIQUID (CM)
INNER	699.6	INNER	15.24
OUTER	2128.5	OUTER	15.24

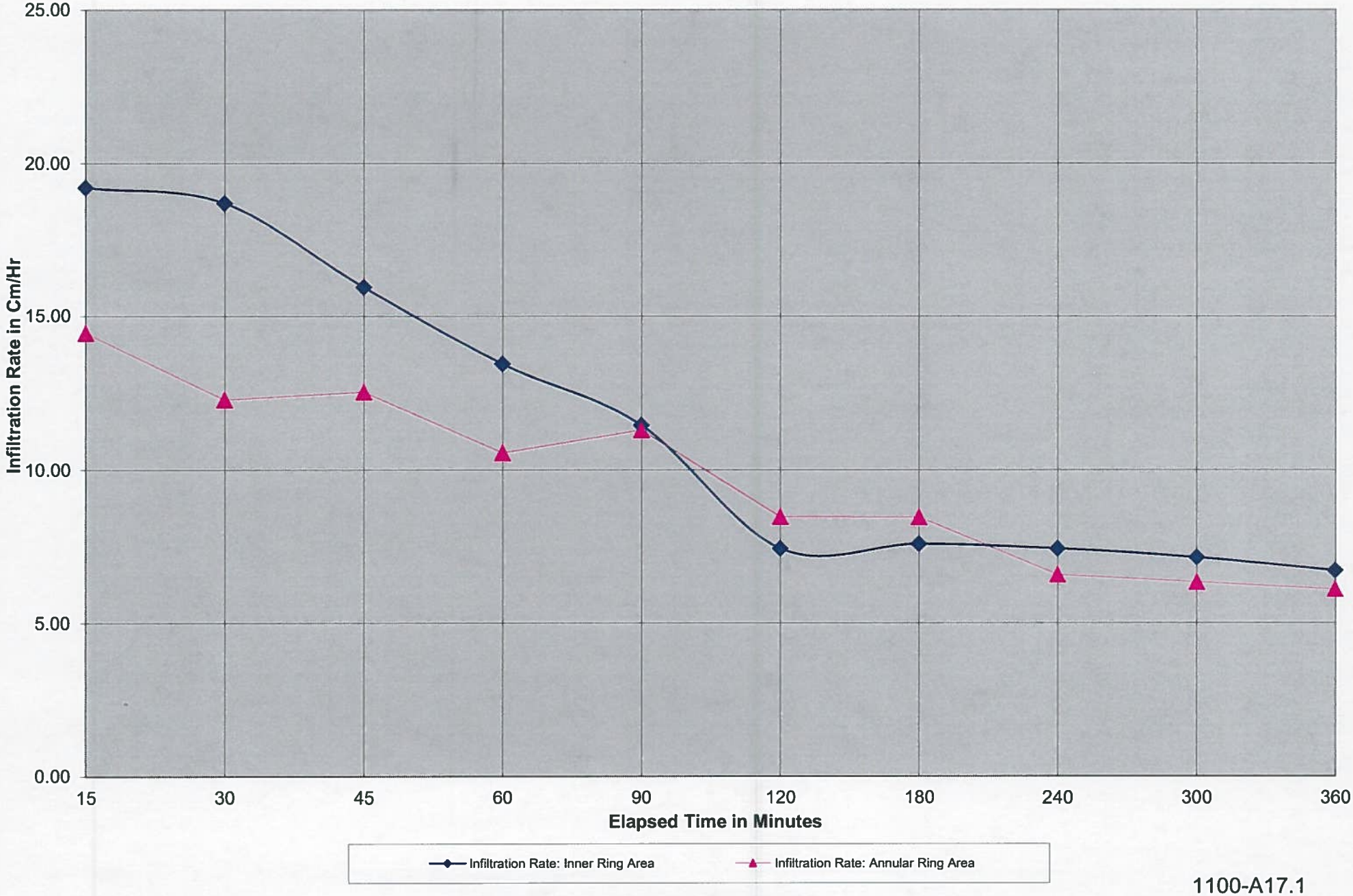
LIQUID LEVEL MAINTAINED USING: __X__ MANUAL ADDITIONS (VISUAL)

INNER RING AVERAGE RATE	CM/H	**7.00**	IN/H	**2.76**
OUTER RING AVERAGE RATE	CM/H	**8.00**	IN/H	**3.15**

Increment No.	DATE	TIME START= 07:58 AM HR: MM	ELAPSED TIME/ INCREMENT MIN	FLOW READINGS INNER FLOW CM3	FLOW READINGS OUTER FLOW CM3	LIQUID TEMP. F	INCREMENTAL INFILTRATION RATE INNER CM/H	INCREMENTAL INFILTRATION RATE ANNULAR CM/H	INCREMENTAL INFILTRATION RATE INNER IN/H	INCREMENTAL INFILTRATION RATE ANNULAR IN/H	GROUND TEMP = 72 F @ DEPTH OF 12 INCHES AIR TEMP, WEATHER
1	12-May-2017	8:13	15	2,200	9,000	72	12.58	16.91	4.96	6.66	62, Sunny
2	12-May-2017	8:28	15	1,200	4,000	72	6.86	7.52	2.70	2.96	64, Sunny
3	12-May-2017	8:43	15	1,100	4,200	72	6.29	7.89	2.48	3.11	64, Sunny
4	12-May-2017	8:58	15	1,100	4,000	71	6.29	7.52	2.48	2.96	65, Sunny
5	12-May-2017	9:28	30	2,100	8,000	74	6.00	7.52	2.37	2.96	70, Sunny
6	12-May-2017	9:58	30	2,200	8,000	74	6.29	7.52	2.48	2.96	72, Sunny
7	12-May-2017	10:58	60	4,300	14,400	75	6.15	6.77	2.42	2.67	74, Sunny
8	12-May-2017	11:58	60	4,600	12,600	75	6.58	5.92	2.59	2.33	80, Sunny
9	12-May-2017	12:58	60	4,400	13,500	79	6.29	6.34	2.48	2.50	86, Sunny
10	12-May-2017	13:58	60	4,700	13,000	78	6.72	6.11	2.65	2.41	85, Sunny

	CM/H Annular	CM/H Inner	IN/H Annular	IN/H Inner
Steady State Rates:	6.28	6.43	2.48	2.53

PROPOSED INFILTRATION BASIN

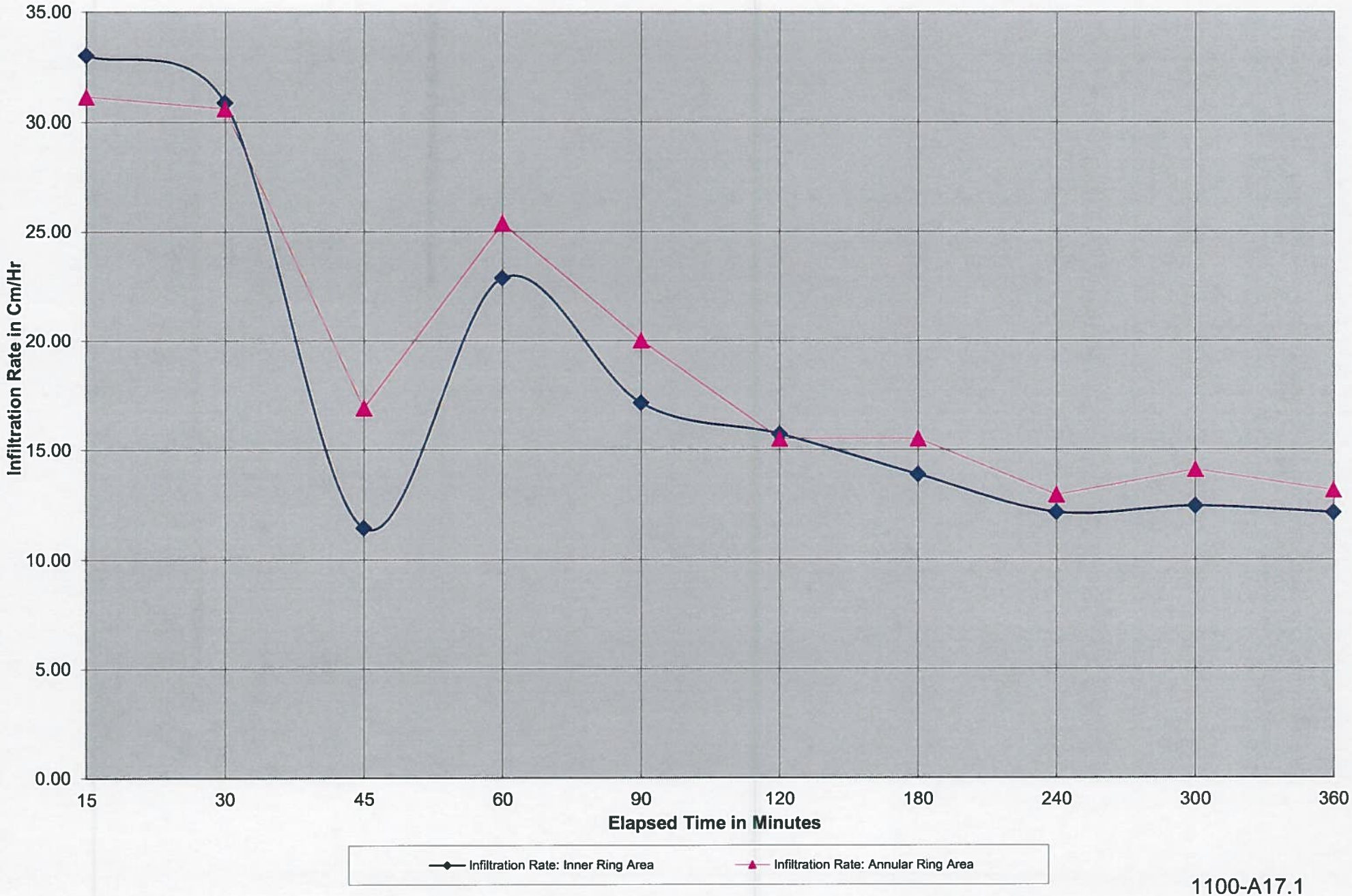


Hilltop Geotechnical, Inc.

INFITROMETER TEST P-1

1100-A17.1
Plate No. 19

PROPOSED INFILTRATION BASIN

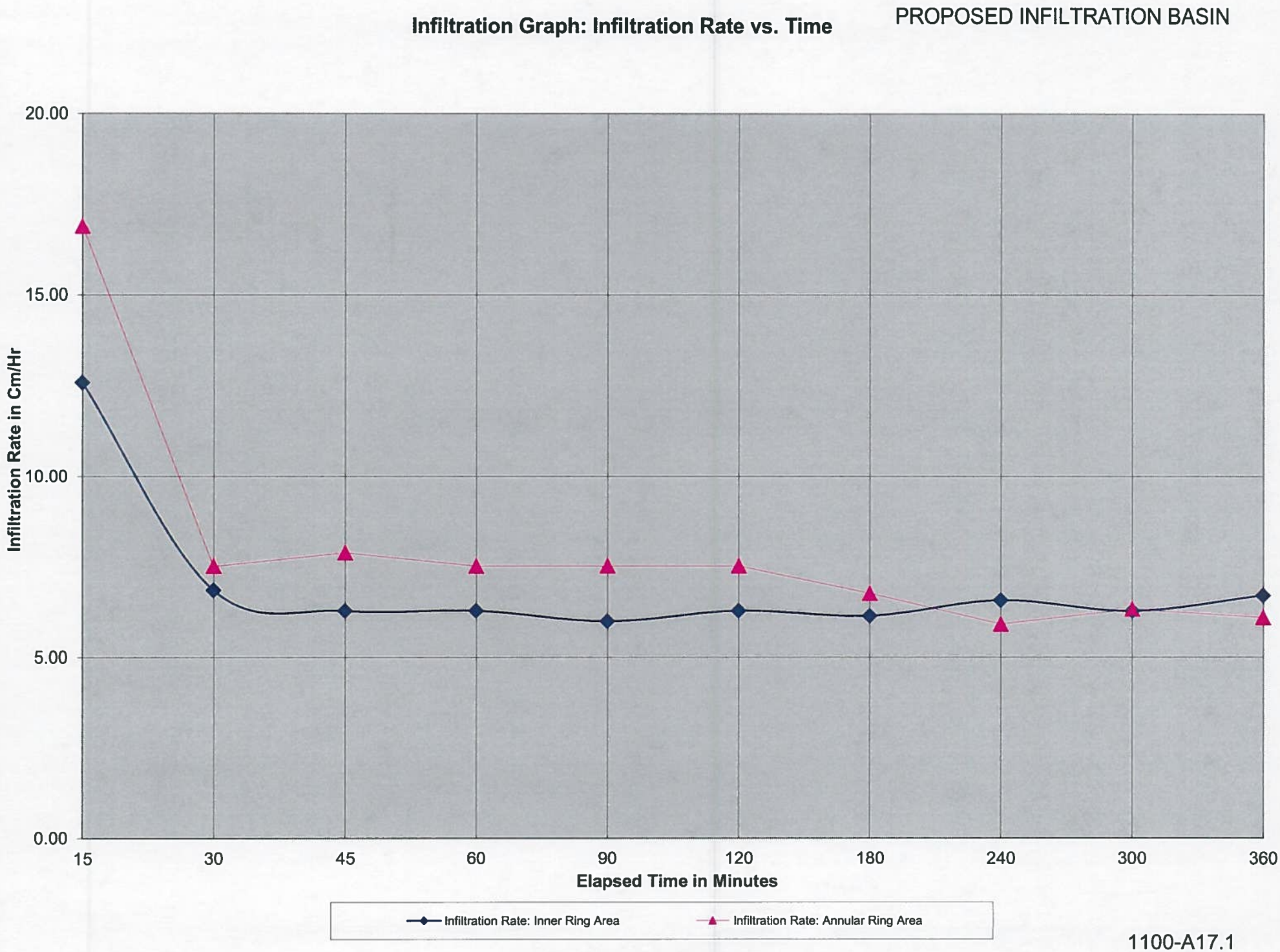


Hilltop Geotechnical, Inc.

INFITROMETER TEST P-2

1100-A17.1
Plate No. 20

PROPOSED INFILTRATION BASIN



Hilltop Geotechnical, Inc.

INFITROMETER TEST P-3

1100-A17.1
Plate No. 21

REPORT OF PRELIMINARY GEOTECHNICAL / GEOLOGIC STUDY PROPOSED 132 LOT SUBDIVISION TENTATIVE TRACT MAP 18952 NORTHEAST CORNER OF COLTON AVENUE AND OPAL AVENUE IN THE MENTONE AREA OF SAN BERNARDINO COUNTY, CALIFORNIA

PROJECT NO.: 950-A14
REPORT NO.: 1

FEBRUARY 20, 2014

SUBMITTED TO:

WALDEN STRUCTURES c/o
THATCHER ENGINEERING & ASSOCIATES, INC.
1461 FORD STREET, SUITE 105
REDLANDS, CA 92373

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 20, 2014

Walden Structures c/o
Thatcher Engineering & Associates, Inc.
1461 Ford Street, Suite 105
Redlands, CA 92373

Project No.: 950-A14
Report No.: 1

Attention: Ms. Vicky Valenzuela
Project Manager

Subject: **Report of Preliminary Geotechnical / Geologic Study, Proposed 132 Lot Subdivision, Tentative Tract 18952, Northeast Corner of Colton Avenue and Opal Avenue in the Mentone Area of San Bernardino County, California.**

References:

1. **Thatcher Engineering & Associates, Inc.**, January 15, 2014, Unsigned, *Tentative Tract Map No. 18952, APN 0298-063-07, 801 Opal Avenue, County of San Bernardino*, Job No.: 154801.

2. Technical References - See Appendix 'B.'

According to your request, we have completed a preliminary geotechnical / geologic study for the design and construction of the proposed 132 lot single family residential (SFR) subdivision. We are presenting, herein, our findings and recommendations.

The recommendations presented in this report are considered preliminary since the final locations of the proposed structures on the lots, the type of structure 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 Single Family Residential development 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 the other consultants for the project (i.e., 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, along with any other required documentation to the appropriate agency having jurisdiction over the project for 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.

REGISTERED PROFESSIONAL ENGINEER
DONALD L. CURRAN
No. GE254
Exp: 3/31/15
GEOTECHNICAL
STATE OF CALIFORNIA

Mark Hulett, CEG No. 1623
President

Donald L. Curran, GE No. 254
Senior Engineer
Date Signed: 2-20-14

AH/MH/DLC/ah

Distribution: (4) Addressee
Via U.S. Postal Service
(1) Addressee
pdf copy Via E-Mail (vickyv@thatcherengineering.com)

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REPORT OF PRELIMINARY GEOTECHNICAL / GEOLOGIC STUDY PROPOSED 132 LOT SUBDIVISION TENTATIVE TRACT MAP 18952 NORTHEAST CORNER OF COLTON AVENUE AND OPAL AVENUE MENTONE AREA SAN BERNARDINO COUNTY, CALIFORNIA

PROJECT NO.: 950-A14
REPORT NO.: 1

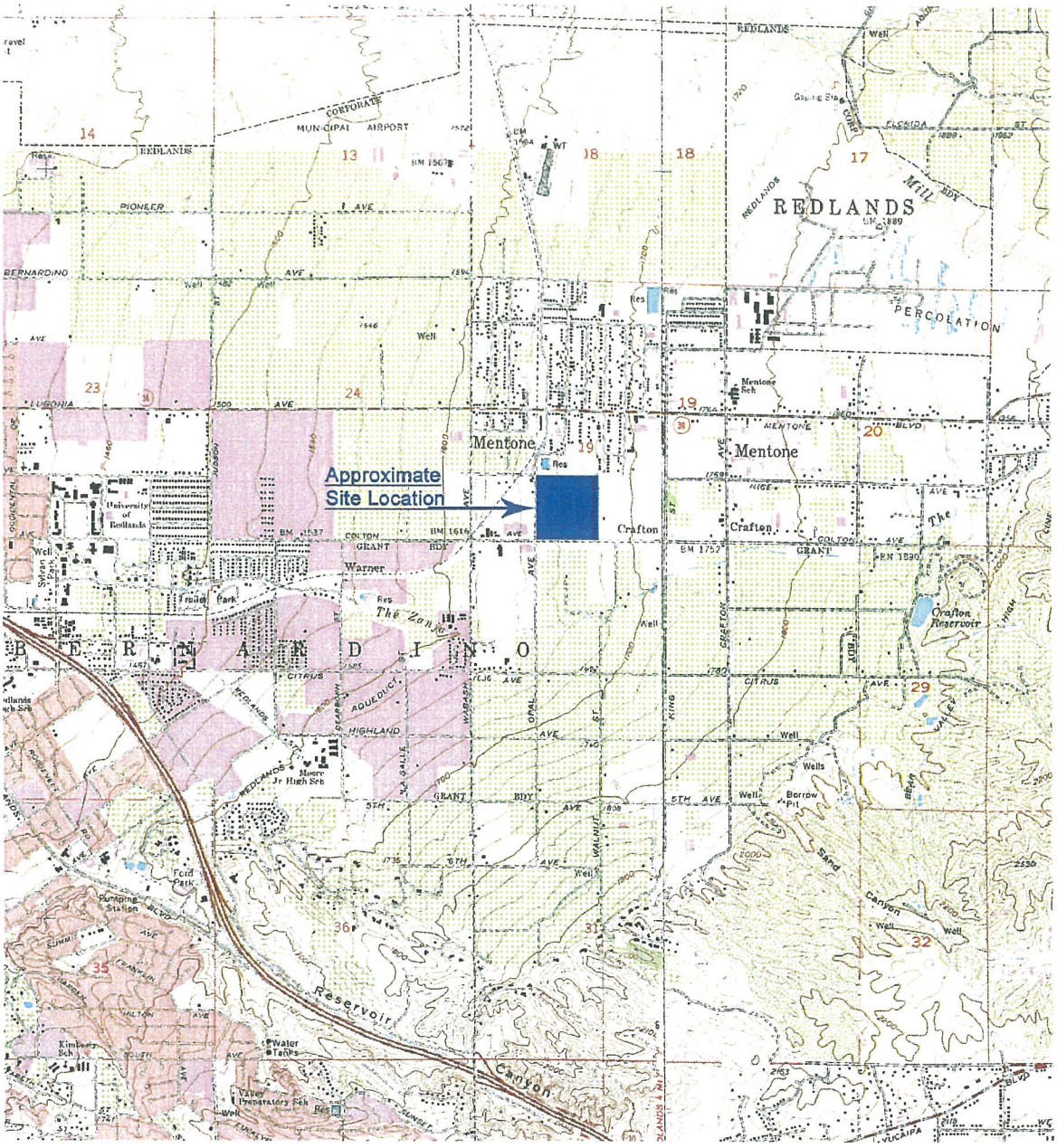
FEBRUARY 20, 2014

INTRODUCTION

AUTHORIZATION

This report presents results of the preliminary geotechnical / geologic study conducted on the subject site for the proposed 132 lot, single family residential (SFR) subdivision, Tentative Tract Map No. 18952, to be located to the north of Colton Avenue between Opel Avenue to the west and Beryl Avenue to the east in the Mentone area of 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 **Hilltop Geotechnical, Inc. (HGI)** (Geotechnical / Geologic Consultant) to **Walden Structures** (Client), dated December 31, 2013, Proposal Number: P13178 and signed by Mr. Charles Walden of **Walden Structures**.



0 3500 7000

Approximate Scale in Feet

N

Reference: **United States Department of the Interior, Geologic Survey**, 1967, Photorevised 1988, *Redlands Quadrangle, California,* 7.5 Minute Topographic Series, Scale: 1:24,000.
United States Department of the Interior, Geologic Survey, 1967, Photorevised 1988, *Yucaipa Quadrangle, California,* 7.5 Minute Topographic Series, Scale: 1:24,000.

HILLTOP GEOTECHNICAL INCORPORATED

SITE LOCATION MAP	
By: AH	Date: 2/2014
Project No.: 950-A14.1	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 of 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'), 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 backhoe trenches to characterize earth materials, geologic, and groundwater conditions that could influence the proposed development.
- Sampling of on-site earth materials from the exploratory excavations.
- Percolation testing for the design of recharge basins.
- 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 2013 California Building Code (CBC), effective on January 1, 2014.
- Engineering and geologic analysis of field and laboratory data to provide a basis for geotechnical and geologic 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.
- Evaluation of stability of proposed cut and/or fill slopes.
- 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.
- Infiltrometer parameters for the design of the proposed recharge basin.

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.

This study was prepared for the exclusive use of **Walden Structures** and their consultants for specific application to the development of the 132 lot, single family residential subdivision 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.

PROJECT DESCRIPTION / PROPOSED DEVELOPMENT

As part of our study, we have discussed the project with Ms. Vicky Valenzuela of **Thatcher Engineering & Associates, Inc.**, the Civil Engineer for the project. We also have been provided with the Reference No. 1 'Tract Map' noted on the first page of the cover letter for this report.

The Reference No. 1 'Tract Map' indicates the subject property will be subdivided into 132 single family residential lots which will be developed with one (1) and/or two (2) story, slab-on-grade, structures with accompanying underground utilities (i.e., sewer, water, gas, electric, storm drain, phone & cable TV, etc.), Portland Cement Concrete (PCC) driveways, Hot Mix Asphaltic (HMA) concrete streets with

concrete curbs and gutters, and open space lots (i.e., Lot 'A' through 'O'). The referenced 'Tract Map' indicate that the proposed grading for the lots will encompass cuts and fills of approximately 7.0 feet and 9.0 feet in vertical height, respectively, to create pads for structures, driveways, and streets. Cut and fill slope inclinations are assumed to be 2H:1V (Horizontal to Vertical). Structures are expected to be of one (1) or two (2) story wood-frame design. It is assumed that light loads will be imposed on the foundations. The foundation loads are not anticipated to exceed 2,500 plf for continuous footings and 50 kips for column footings. The proposed floors for the structures will consist of a concrete slab cast on compacted subgrade. Subterranean construction is not anticipated for the proposed structures.

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 20, 2014 and January 23, 2014.

The subsurface exploration consisted of excavating seven (7) exploratory backhoe trenches on the subject property. Four (4) additional excavations were also performed for infiltrometer testing in the area of the proposed recharge basins. The approximate locations of the exploratory excavations and infiltrometer testing are shown on the 'Exploratory Excavation Location Plan,' Plate No. 1, presented in the map pocket in Appendix 'A.' 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.' The results are presented on the 'Subsurface Exploration Log,' Plate Nos. 3 through 9, presented in Appendix 'A.' A more detailed explanation of the field study which was performed for this report is presented in Appendix 'A.'

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 moisture content tests, an expansion index test, soluble sulfate tests, sieve analysis tests, maximum dry density / optimum moisture content relationship tests, and a direct shear test. A more detailed explanation of laboratory tests performed for this study and test results are presented in Appendix 'A,' Plate Nos. 10 through 14.

FINDINGS

SITE DESCRIPTION

The subject property comprises approximately 42.37 acres and is rectangular in shape, and approximately 1,230 feet by 1,245 feet in plan dimension as shown on the Reference No. 1 'Tract Map' noted on the first page of the cover letter for this report. The subject property is located in the northeast quadrant of the intersection of Opal Avenue and Colton Avenue in the Mentone area of San Bernardino County, California. The subject property is located in the southwest portion of Section 19, T1S, R2W of the San Bernardino Principle Meridian at Latitude: 34.0647° North, Longitude: 117.1320° West.

The subject property is bounded by Colton Avenue to the south, Opal Avenue to the west, and Nice Avenue to the north. A wall and housing community bounds the proposed site to the east, as shown on the 'Exploratory Excavation Location Plan,' Plate No. 1, presented in Appendix 'A.'

Walden Structures Construction occupies the west portion of the site. Grading reports and/or compaction reports were not made available at the time of this study, nor were/or they available at the County of San Bernardino Building and Safety Department since 1987. A recent telephone conversation with Kristi Werner. The west portion of the site contains office buildings, equipment buildings, trailers, storage areas, rock roadways, several parking lots, concrete curbs. Surrounding Walden Structures Construction facility were various fenced areas and open areas that allow access to the eastern portion of the site.

Total on-site relief in the area of the proposed 132 lot subdivision was approximately 40 feet. The minimum and maximum elevations within the

immediate area of the proposed development on the subject site was approximately 1647 and 1687 Mean Sea Level (MSL), respectively. On-site drainage was generally accomplished by sheetflow toward the west.

At the time the field exploration was made, the surface of the site was firm, vegetation was minimal, and the backhoe did not experience difficulty moving around on the site.

At the time of the field study, buildings or other type structures were present on the site. 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 in the existing street right-of-way. Some of the utilities were noted on the referenced plans and are adjacent to the site. Due to the ages of the structures and the locations on the site, it is anticipated that cisterns, leach lines, and septic tanks also may still be present on the site.

Several end dumped piles of construction debris, miscellaneous debris and refuse, soil, etc. were observed at various locations throughout the subject property, mainly on the undeveloped portion of the site at the time the field study was performed.

At the time of the field study, vegetation across the east portion of the proposed project on the subject site was light and consisted of seasonal native grasses, weeds, forbs, and brush. The west portion of the subject site was developed and consisted of one area of grass and a few open areas with light brush, curbs, gutters and pavement.

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, 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 the 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

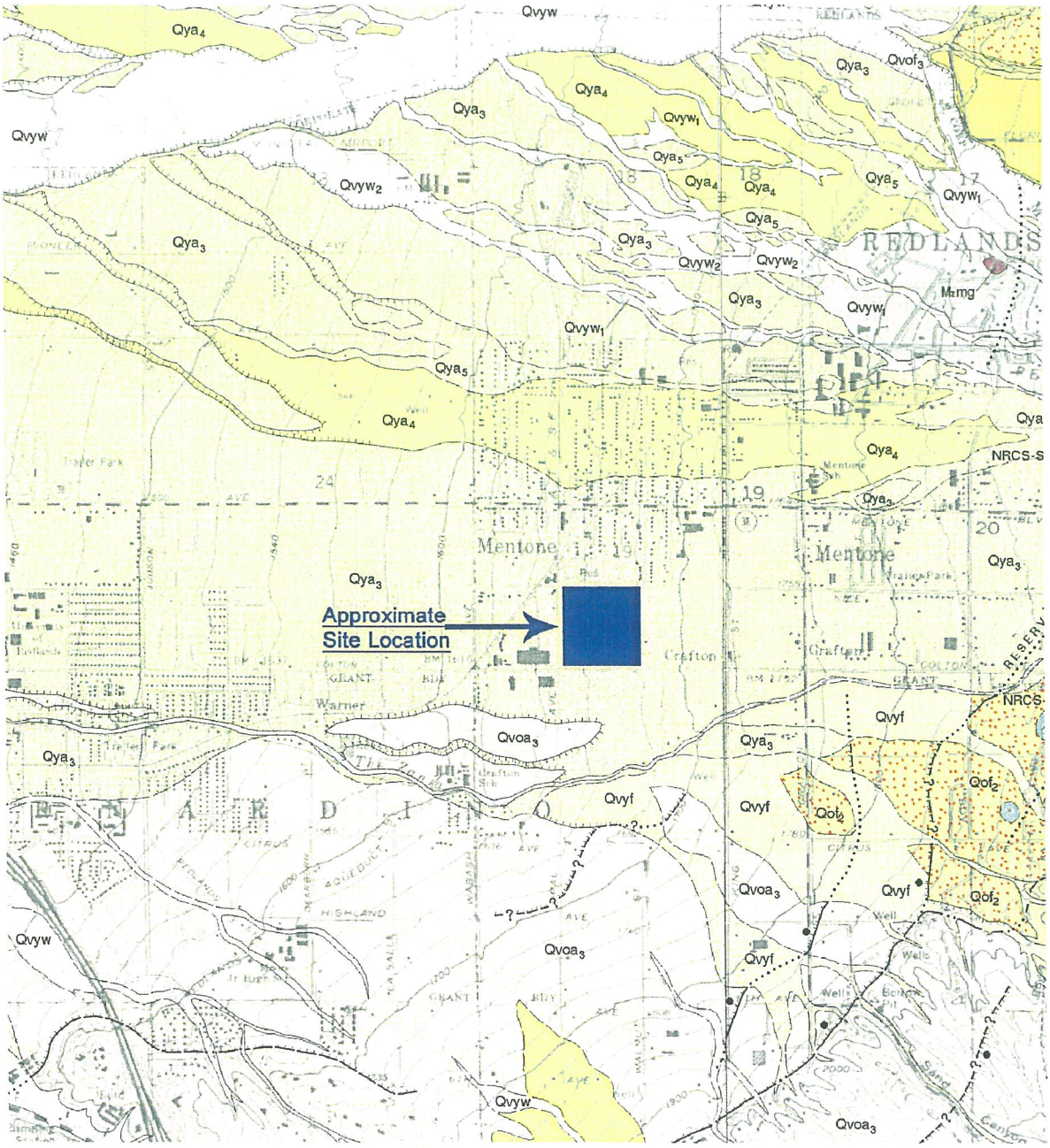
deep structural basin that apparently continues to slowly subside in response to the transference of slip from the San Jacinto fault to the San Andreas fault.

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 rocks, 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.

Surficial native soils on the site have been mapped as young axial-valley deposits, that locally consist of sands, gravels, cobbles and boulders overlain by silty, fine to coarse grained soils, likely deposited from Mill Creek. A review of available alluvial contour maps show the depth of alluvium in the general area of the subject site to be in excess of 200 feet (Fife and Rodgers 1974). The general geology in the area of the subject site is shown on the 'Regional Geology Map,' and 'Regional Geology Map Legend,' Figure Nos. 2a and 2b, respectively.

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. 3 through 9, presented in Appendix 'A.' The earth material strata, as shown on the logs, represent conditions at the actual



0 0.5 1

Approximate Scale in Miles

N

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.

California Department of Conservation, Division of Mines and Geology, 2003 Johnathon C. Matti, Douglas M. Morton, Brett F. Cox, Scott E. Carson, Thomas J. Yetter and others, Geologic Map of the Yucaipa 7.5' Quadrangle, San Bernardino and Riverside Counties, Version 1.0, Open File Report 03-301, Scale: 1:24,000.

HILLTOP GEOTECHNICAL INCORPORATED

REGIONAL GEOLOGY MAP	
By: AH	Date: 2/2014
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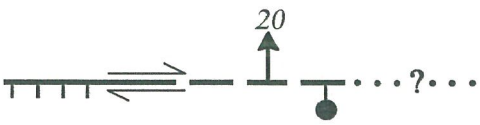
Legend for Geologic Symbols and Units

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).

Qvyw2 — Qvyw2 - Very Young Wash Deposit, Unit 2 (latest Holocene).

Qya5 — Qya5 - Young Axial Valley Deposit, Unit 5 (latest Holocene).

Qya4 — Qya4 - Young Axial Valley Deposit, Unit 4 (late Holocene).

Qya3 — Qya3 - Young Axial Valley Deposit, Unit 3 (middle Holocene).

Qvoa3 — Qvoa3 - Very Old Axial Valley Deposit, 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.

California Department of Conservation, Division of Mines and Geology, 2003 Johnathon C. Matti, Douglas M. Morton, Brett F. Cox, Scott E. Carson, Thomas J. Yetter and others, Geologic Map of the Yucaipa 7.5' Quadrangle, San Bernardino and Riverside Counties, Version 1.0, Open File Report 03-301, Scale: 1:24,000.

HILLTOP GEOTECHNICAL INCORPORATED

REGIONAL GEOLOGY MAP LEGEND	
By: AH	Date: 2/2014
Project No.: 950-A14.1	Figure No.: 2b

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 man-made fill (af) and young axial valley deposits (alluvium) (Qya_3).

Man made fill was encountered at the location of trench T-2, T-3, T-5, and T-6. The fill extended to a depth of approximately 1.5 to 4.5 feet at the locations of the exploratory excavations. The fill generally consisted of silty fine to coarse sand with a trace to some gravel, a little cobbles, and a trace boulders. The fill encountered was orange-brown, light brown, and brown in color and dry at the surface to moist with depth. Additionally, numerous end-dumped piles of soil, concrete, and other hard construction materials were also observed in various areas on the site. The fill is considered to be undocumented and unsuitable for support of structural fill and/or a building structure. Where easily visible, the approximate location of the fill materials is shown on the Exploratory Excavation Location Plan, Plate No. 1, presented in Appendix 'A.'

Alluvium was encountered below the fill materials and at the surface at the locations of trench T-1, T-4, and T-7. The alluvium generally consisted of silty fine to coarse sands with varying amounts of gravel, cobbles, and boulders (SM), gravelly, fine to coarse sands with traces of silt, gravels, and cobbles (SP), fine to coarse, sandy gravel with a little to some cobbles and a trace to a little boulders (GP), gravel with some cobbles and a trace boulders (GP), cobbles with a little gravel, a little fine to coarse sand, and a trace boulders (GP), and gravel with a

trace silt and a trace fine to coarse sand (GP). The alluvium was light brown, brown, dark brown, orange-brown, gray-brown, and gray in color and dry near the surface to moist with depth. Locally, the alluvium extended to depths in excess of 12 feet below the existing ground surfaces at the excavation locations on the subject site. A distinct coarsening of the materials with was noted with depth. The excavations were terminated in the alluvial deposit.

Groundwater: Groundwater was not encountered in the exploratory excavations to the maximum depth explored of approximately 12 feet below existing ground surface at the trench locations at the time the field study was performed for this report.

No groundwater data was found during a literature search pertaining to the subject property. There are no known, shallow, groundwater, bearing soil or rock formations beneath the subject property. No evidence of onsite springs was found during the field study.

A review of available groundwater contour maps indicated the historical minimum depth to groundwater in the general area has been approximately 100 feet (1985, Matti and Carson).

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. 01S02W30C001S, located approximately 300 feet west, (just south of Colton Avenue), of the subject site was approximately 120 feet on December 4, 1990. The surface elevation of this well is 1651 feet, generally 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 site 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 trench 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. Accordingly, the potential for surface fault rupture on this site is considered to be very low.

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 31 kilometers to the northeast of the subject property at Latitude: 34.202999° North, Longitude: 116.827003° 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 eight (8) regionally significant active faults as listed in the following table. Other significant fault zones, including several zones in the high desert area are located at distances exceeding 38 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 eight (8) 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 Andreas (San Bernardino Segment) (rl-ss)[3]	6.2 / Northeast	103±10	24.0±6.0	7.5	A
San Jacinto (San Jacinto Valley Segment) (rl-ss)	10.4 / Southwest	43±4	12.0±6.0	6.9	A
San Jacinto (San Bernardino Segment) (rl-ss)	11.0 / West	36±4	12.0±6.0	6.7	A
North Frontal (Western Segment) ®, 45 S)	19.5 / North	51±5	1.0±0.5	7.2	B
Cleghorn (ll-ss)	25.2 / North	25±3	3.0±2.0	6.5	B
Cucamonga (r,45 N)	30.9 / North-Northwest	28±3	5.0±2.0	6.9	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]
North Frontal (Eastern Segment) (r,45 S)	34.5 / Northeast	27±3	0.5±0.3	6.7	B
Pinto Mountain (ll-ss)	37.7 / East	74±7	2.5±2.0	7.2	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; ® 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	0.626g
Sa @ 0.2 Sec.	1.327g

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 270 m/sec was assumed for the on-site materials.

Probabilistic seismic hazard maps and data files prepared by the **U.S. Geological Survey (USGS)** assign a 2-percent likelihood that a Peak Horizontal Ground Acceleration (pga) of approximately 0.9577g will occur at this site within the next 50 years (2,475 years mean return time) due to a Model Magnitude earth quake of 7.62 located at a distance of approximately 5.2 km from the subject site. This data was available at the **U.S. Department of the Interior, U.S. Geological Survey**, Geologic Hazards Science Center's 2008 NSHMP PSHA Interactive Deaggregation Web Site (https://geohazards.usgs.gov/deaggint/2008/). The web site also assigns a 10-percent likelihood that a Peak Horizontal Ground Acceleration (pga) of approximately 0.5973g will occur at this site within the next 50 years (475 years mean return time) due to a Model Magnitude earth quake of 7.62 located at a distance of approximately 5.2 km from the subject site. An average shear wave velocity (v_s) for the alluvial soils on the subject site of 270 meters per second (m/sec) (i.e., 886 ft/s) was assumed for the analysis.

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. As of the date of this report, the site has not been identified or excluded from a State-delineated zone of mandatory study for either landsliding or liquefaction.

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 a lack of shallow groundwater.

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, coarse grained deposits that should not be prone to a significant degree of seismic settlement. Where applicable, loose, near-surface, 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 structures 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

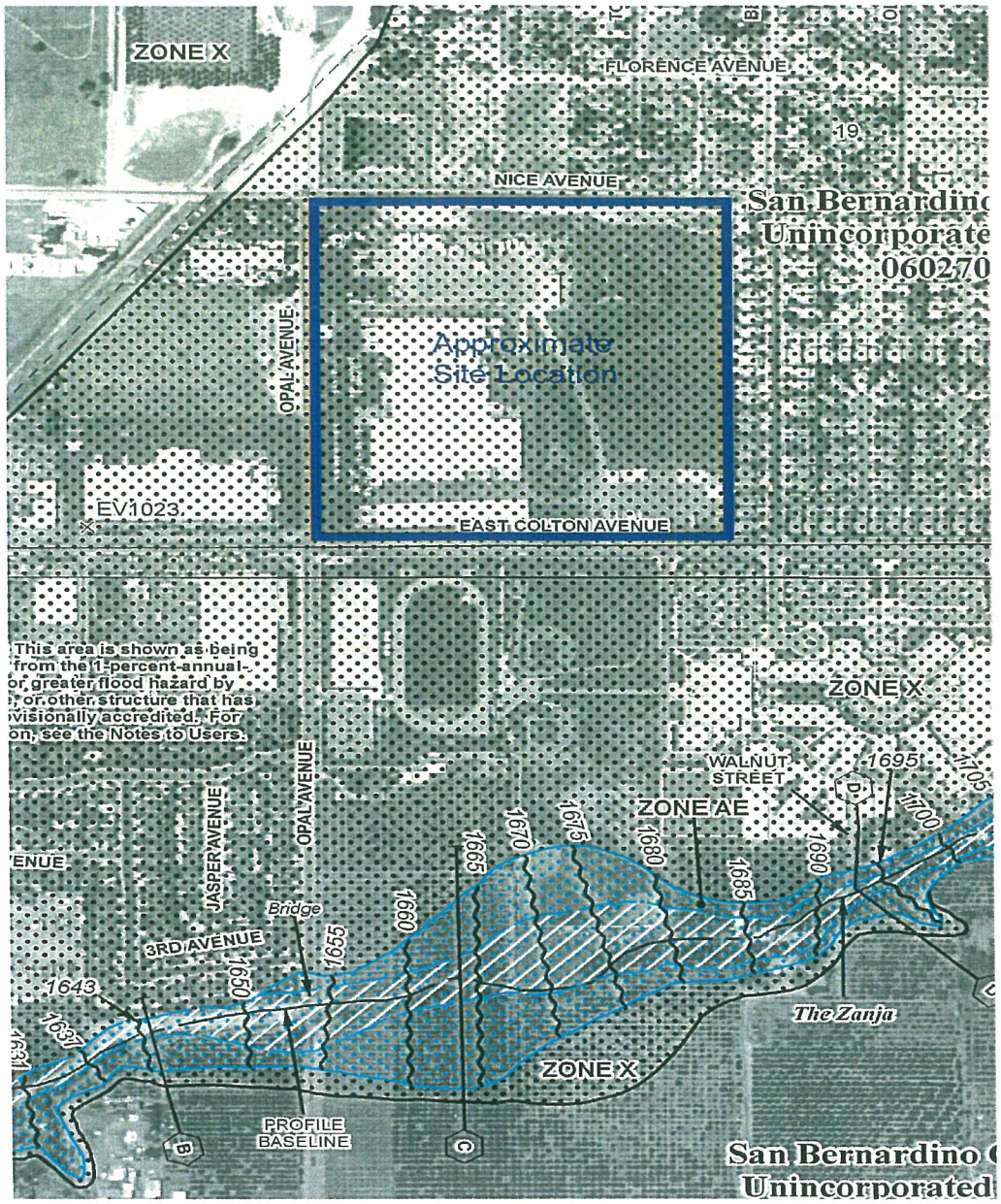
The subject site is located within a designated area as having a 500 year flooding potential per **San Bernardino County Planning Department**, *San Bernardino County Land Use Plan, GENERAL PLAN, Hazard Overlays*, Sheet FH31 B, Redlands, Plot Date: 03/09/2010, Scale: 1:14,400 (http://www.co.san-bernardino.ca.us/landuseservices/general...).

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, 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 seven (7) exploratory



0 550 1100

Approximate Scale in Feet

N

Reference: **U.S. Federal Emergency Management Administration (FEMA)**, Effective August 28, 2008, *Flood Insurance Rate Map*, Map Nos. 06071C8709H, 06071C8717H, Panels 9709 and 8717 of 9400. Site specific information obtained through FEMA website, Map Service Center (http://msc.fema.gov/).

HILLTOP GEOTECHNICAL INCORPORATED	FEMA FLOOD HAZARD MAP	
	By: AH	Date: 2/2014
	Project No.: 950-A14.1	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.

HILLTOP GEOTECHNICAL INCORPORATED

FEMA FLOOD HAZARD MAP LEGEND	
By: AH	Date: 2/2014
Project No.: 950-A14.1	Figure No.: 3b

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 suitable from a geotechnical / geologic standpoint. The subject property can be developed without adverse 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 to 7.0 feet of the near-surface alluvial materials on the subject site suggests that the soils have an average relative compaction of approximately 85 percent.

The field observations indicate that up to 4.5 feet of material present in some areas 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, fill slopes, foundations, slab-on-grade floor slabs, hardscape, and/or pavement.

The near-surface, on-site soils were identified as not having an expansion potential per the criteria presented in Section 1803.5.3, 'Expansive Soil,' in the 2013 CBC. Therefore, no special design considerations such as deepened footings or pre-saturation of earth materials is required due to expansion potential.

Some remedial grading consisting of removals and replacement will have to be performed within loose, compressible, artificial fill and 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.

Recommendations for site grading, foundations, slab support, pavement design, etc., 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 engineered building pads and satisfactory support for exterior hardscape (i.e., sidewalks, patios, etc.) and pavement; and 2) the use of a conventional, 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 site, 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 following recommendations may need to be modified and/or supplemented during grading as field conditions dictate.

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 County of San Bernardino, 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 structures, grasses, weeds, brush, trees, 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. Trees, bushes, etc. and their roots should be completely removed, ensuring that 95 percent or more of the root systems are extracted.

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 backhoe 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 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 existing fill materials and the near-surface 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 average 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. Some over-size material is anticipated to be encountered within the near-surface soils on the subject site which will require special handling.

Any 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.), fill slopes, 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 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.

- In the proposed fill areas, the near-surface undocumented fill and the loose, near-surface, alluvial earth materials on the site are recommended to be overexcavated and recompacted. Based upon our exploratory excavations and laboratory test results, we anticipate that the overexcavation will extend to a depth of approximately 3.0 to 4.0 feet below existing ground surface 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.

- Where a cut / fill transition zone or a compacted fill / alluvial transition extends through a proposed building pad area, a compacted mat of fill will have to be constructed under the building area to prevent differential settlement between the two (2) dissimilar materials. This mat should be constructed by overexcavating the materials in the cut portion of the pad to a distance outside the proposed building limits of 5.0 feet or to the depth of the overexcavation below the finish pad grade, whichever is greater. The overexcavation should extend to a depth of 4.0 feet below the pad elevation or to a minimum depth of 0.5 times the depth of the deepest fill within the building pad, whichever is greater.

- In total cut building pads for the proposed structures, overexcavation and recompaction is recommended to be performed to a depth of 4.0 feet below the proposed cut pad elevation. This will provide a uniformly compacted building pad for support of the structure and remove oversize materials within the anticipated depths of foundations and underground utilities.

- 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.

- 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.

- In landscape or non-structural fill areas where non-structural fill will be placed, overexcavation will not need to be performed prior to placing non-structural fill materials. Proposed fill slopes are structural fills and do not fall under this provision. Any non-structural fill areas should be clearly designated on the project grading and/or site plan by the Civil Engineer or Architect.

- 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 fill slopes should extend to a distance of 4.0 feet beyond the toe of the slope or to the depth of the overexcavation beneath the toe of the slope, whichever is greater. 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.

  In areas where overexcavation can not be performed to the required distance beyond the foundations, (i.e., perimeter project block walls, retaining walls, etc.) along property lines, the foundations should be deepened to extend through any undocumented fill materials and/or the loose, near-surface alluvial earth materials and be founded to a minimum depth of 1.0 foot into the firm underlying material.

- Where the exploratory backhoe trenches are located within the limits of the proposed overexcavations for the proposed structural fills, structures, decorative walls, retaining walls, exterior hardscape, and/or pavement areas, the trenches should be overexcavated to the width and depth of the trench.

- It is noted that localized areas, once exposed, may warrant additional overexcavation for the removal of existing undocumented fills, loose, near-surface, alluvial, earth material, and subsurface obstructions and/or debris which may be associated with the existing structures on th site and/or past usage of the site and may 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.

- 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. In landscape and non-structural fill areas, the scarified and moisture conditioned earth materials need only be compacted to 85 percent or greater relative compaction prior to placing 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 2013 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.

Any existing HMA concrete or PCC pavement materials on the subject site 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., 12 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, tree root removal, or the removal of other subsurface features and may very 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 5.0 to 7.0 feet of the site which will be removed and replaced will be approximately 6.0 to 12 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 6.0 percent shrinkage factor would mean that it would take 1.06 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. Oversize rock removal and export will also result in additional shrinkage.

A subsidence factor (loss of elevation due to compaction of existing undocumented fill and/or the near-surface alluvial earth materials in-place) of 0.06 to 0.11 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 10 feet of fill (not including the depth of overexcavation and replacement) during the planned grading operation or rebound of the underlying alluvium due to unloading 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

SIEVE SIZE	PERCENT PASSING
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.

Over-Size Rock Disposal

Over-size rock material with measurements of 12 inches or greater in maximum dimension will have to be properly disposed of off site since it is anticipated that there will not be any deep fills to be placed in which to properly dispose of the over-size material as part of the site development.

Fill Slopes

Finish fill slopes should not be inclined steeper than 2H:1V (Horizontal to Vertical). Fill slope surfaces should be compacted to 90 percent relative compaction to the face of the finished slope. Overexcavation beneath proposed fill slopes should be performed in accordance with the recommendations presented in previous sections of this report. Fill slopes should be constructed in a skillful

manner so that they are positioned at the design orientations and slope ratio. Achieving a uniform slope surface by subsequent thin wedge filling should be avoided. Add-on correction to a fill slope should be conducted under the observation and recommendations of the project Geotechnical / Geologic Consultant. The proposed add-on correction procedures should be submitted in writing by the contractor before commencement of corrective grading and reviewed by the project Geotechnical / Geologic Consultant. Compacted fill slopes should be backrolled with appropriate equipment for the type of earth material being used during fill placement at intervals not exceeding 4.0 feet in vertical height. As an alternative to the bankrolling of the fill slopes, over-filling of the slopes will be considered acceptable and preferred. The fill slope should be constructed by over-filling with compacted fill to a distance of 3.0 feet or greater horizontally, and then trimmed back to expose the dense inner core of the slope surface. Fill slopes steeper than 3H:1V are moderately susceptible to erosion due to the low cohesion parameters of the earth materials.

Cut Slopes

Finish cut slopes in alluvium should not be inclined steeper than 2H:1V (Horizontal to Vertical). The cut slopes should be observed by the project Geotechnical / Geologic Consultant and/or his representative during grading to provide supplemental recommendations for stability of slopes, if needed. Cut slopes that face in the same direction as the prevailing natural slope will require top of cut paved interceptor swales. Cut slopes steeper than 3H:1V are moderately susceptible to erosion due to the low cohesion parameters of the earth materials.

Fill-Over-Cut Slopes

Generally, fill-over-cut slopes should be eliminated by overexcavating the cut portion of the slope a minimum of 15 feet. The transition between cut and fill, on the slope, should be maintained as steep as possible.

Loose Material on Slope Face

The grading contractor should be made aware to take care to avoid spillage of loose material down the face of slopes during grading and during drainage terrace and downdrain construction. Fine grading operations for benches and downdrains should not deposit loose trimmed earth materials on the finished slope surfaces.

Slope Protection

Permanent slope maintenance and protection measures as presented in the subsequent 'Slope Maintenance and Protection Recommendations' section of this report should be initiated as soon as practicable after completion of cut and/or fill slope construction. Fill slopes, cut slopes in undocumented fill, and cut slopes in alluvial materials steeper than 3H:1V (Horizontal to Vertical) are moderately susceptible to erosion due to the low cohesion parameters of the earth materials. The plant mix, method of application, and maintenance requirements are subject to the approval of a registered Landscape Architect or other qualified landscape professional. Construction delays, climate or weather conditions, and plant growth rates may be such that additional short-term non-plant erosion management measures may be needed. Examples would include matting, netting, plastic sheets, deep staking (5.0 feet or deeper), etc.

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 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.

2013 CBC SEISMIC DESIGN CRITERIA

Per the **California Building Standards Commission**, *2013 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 Types**

  Categorizing the upper 30 meters (±100 ft.) of earth materials into one (1) of the site class types A, B, C, D, E, and F that are based on average shear wave velocities, Standard Penetration Test blow counts, or undrained shear strength.

- **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 1-second, S_s and S_1 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.

Based on our understanding of local geologic conditions, the 'Site Class' judged applicable to this site is 'D', 'Stiff Soil' per Table 20.3-1, 'Site Classification,' in Chapter 20 of ASCE 7-05 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 2013 CBC based on a 2-percent probability of being exceeded in the next 50 years (2,475 years mean return time).

SEISMIC DESIGN CRITERIA	
Site Location	Latitude: 34.0647° North Longitude: 117.1320° West
Site Class[1]	D
Mapped, Maximum Considered Earthquake (MCE), 5.0 Percent Damped, Spectral Response Acceleration Parameter at Short Period (S_s)[2] (0.2 Second) for Site Class B.	1.690
Mapped, Maximum Considered Earthquake (MCE), 5.0 Percent Damped, Spectral Response Acceleration Parameter at 1-Second (S_1)[2] for Site Class B.	0.754
Site Coefficients (F_a)[2] for Site Class.	1.0
Site Coefficients (F_v)[2] for Site Class.	1.5
The MSC, 5.0 Percent Damped, Spectral Response Acceleration Parameter at Short Periods Adjusted for Site Class Effects (S_{MS})[2].	1.690
The MSC, 5.0 Percent Damped, Spectral Response Acceleration Parameter at 1-Second Adjusted for Site Class Effects (S_{M1})[2]	1.131
Design, 5.0 Percent Damped, Spectral Response Acceleration Parameter at Short Periods (S_{DS})[2] for Site Class.	1.127
Design, 5.0 Percent Damped, Spectral Response Acceleration Parameter at 1-Second (S_{D1})[2] for Site Class.	0.754
Model Magnitude Earthquake (M)[3]	7.62
Average Shear Wave Velocity in the Top 30m of the Site for Site Class 'D.'[3]	270 m/s
Peak Ground Acceleration (pga)[3]	0.9577g

1. Per Table 20.3-1, 'Site Classification,' in Chapter 20 of ASCE 7-05.
2. 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** 7-05, 'Standard, Minimum Design Loads for Buildings and Other Structures,' 2005 Edition.
3. Probabilistic seismic hazard maps and data files prepared by the **USGS** assign a 2-percent likelihood that the pga will occur at this site within the next 50 years (2,475 years mean return time). This data was available at the **USGS**, Geologic Hazards Science Center's 2008 NSHMP PSHA Interactive Deaggregation Web Site (https://geohazards.usgs.gov/deaggint/2008/).

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 foundation recommendations presented in this report are considered preliminary since the locations of the proposed structures, the type of structures construction, the structural loads, etc. were not known at the time of this report.

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 2013 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, or firm, competent, undisturbed

alluvial earth material at a depth of 5.0 to 7.0 feet below the existing site grades, but not a combination of earth material types within a structure.

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 for 1- and 2-story structures supported by the foundations in accordance with Table 1809.7, 'Prescriptive Footings Supporting Walls of Light-Frame Construction,' in the 2013 CBC. 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 or undisturbed, firm, alluvial, earth material at a depth of 5.0 to 7.0 feet below the existing site grades at the time the study was performed for this report should extend to a depth of 12 inches or greater below lowest adjacent finish grade. Frost is not considered a design factor for foundations in the Mentone area of San Bernardino County, California, since there will not be any significant frost penetration in the winter months.

Footings should be founded in undisturbed, documented, properly compacted fill or undisturbed, alluvial earth material, but not a combination of the different earth materials within a structure. Where building, decorative wall, or retaining wall footings will be constructed directly on the property line or where the limits of overexcavation do not extend sufficiently beyond the footing edges per the 'Earthwork Recommendations' section of this report, the footings should be deepened to extend through the unsuitable earth material and be founded to a depth of 12 inches or greater into firm, competent, undisturbed, natural earth material.

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 2013 CBC or the current County of San Bernardino, California codes and ordinances, whichever is greater.

Foundations for the proposed structure and/or retaining walls on slopes that are steeper than 10H:1V (Horizontal to Vertical) (10 percent slope) should be designed in accordance with the provisions of Section 1809.3, 'Stepped Footings,' in the 2013 CBC. The top surface of the footings should be level or should be stepped so that both the top and bottom of such foundations are in accordance with the provisions in Section 1809.3 in the 2013 CBC. The stepped foundation should be suitably reinforced and designed by a qualified Civil or Structural Engineer.

Bearing Capacity

Compacted Fill: 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 2013 CBC for footings founded in undisturbed, documented, properly, compacted fill material (Class 4 Material - SW, SP, SM, SC, GM, GC). 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.

Alluvial Earth Material: Provided the recommendations 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 3,000 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 2013 CBC for footings founded in undisturbed, sandy gravel and/or gravels (GP/GW) material (Class 3 Material) found at a depth of 5.0 to 7.0 feet or greater below the existing site grades at the time the field study was performed for this report. 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 or in undisturbed, sandy gravel and/or gravels (GP/GW) material found at a depth of 5.0 to 7.0 feet or greater below the existing site grades at the time the field study was performed for this report 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, sandy gravel and gravels (Class 3 Material) and/or 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:

Undisturbed, On-Site Sandy Gravel and/or Gravel* - 200 pcf**
Undisturbed, Documented, Compacted, 'Non-Expansive' Fill*** - 150 pcf

* Per Table 1806.2, 'Presumptive Load-Bearing Value,' for a Class 3 Material (GW and GP) in the 2013 CBC.
** 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 2013 CBC.

Allowable Lateral Sliding Coefficient of Friction Between Soil and Concrete:

Undisturbed, On-Site Sandy Gravel and/or Gravel* - 0.35
Undisturbed, Documented, Compacted, 'Non-Expansive' Fill** - 0.25

* Per Table 1806.2, 'Presumptive Load-Bearing Values,' for a Class 3 Material (GW and GP) in the 2013 CBC.
** Per Table 1806.2, 'Presumptive Load-Bearing Values,' for a Class 4 Material (SW, SP, SM, SC, GM, and GC) in the 2013 CBC.

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 us 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 2013 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 3.5 inches or greater in thickness for residential structures 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 200 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 6.0 to 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 San Bernardino County, California. Subgrade earth materials should be moisture conditioned to optimum moisture content to 3.0 percent above optimum moisture content to a depth of 6.0 to 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

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 2013 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 2013 CBC for the structures, seismic loads should also be added to the design loads on the retaining walls. 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, or firm, competent, undisturbed, sandy gravel or gravel alluvial earth material as standard foundations. 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 2013 CBC.

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 0.75-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 San Bernardino County, 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

Preliminary tests on samples of near-surface, on-site earth material suggest a soluble sulfate concentration of less than 0.0019 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, and a 'Not Applicable' Severity in accordance with Table 4.2.1, 'Exposure Categories and Classes,' in **American Concrete Institute (ACI)** 318-11, 'Building Code Requirements for Structural Concrete,' Chapter 4. Therefore the requirements in Table 4.3.1, 'Requirements for Concrete by Exposure Class,' in **ACI** 318-11, Chapter 4 are applicable. The referenced **ACI** Table 4.3.1 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.). 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 2013 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 'Moderate' severity (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,

with a 'Moderate' Severity criteria presented in **ACI** 318-11, Chapter 4, Table 4.3.1, 'Requirements for Concrete By Exposure Class,' 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 evaporation 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

The life of buried metals depends on type of material, thickness, and construction details. Tests were not performed as part of this study to evaluate the potential for corrosion of bare metal in direct contact with the on-site earth materials. If corrosion protection of metals in direct contact with the on-site earth materials is considered to be a design issue, tests should be performed at the completion of the grading for the building pads and/or 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.

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.

SWIMMING POOL RECOMMENDATIONS

Retaining walls and foundations for a swimming pool and/or spa can be designed in accordance with the recommendations previously presented in this report.

A subdrain system should be constructed around and beneath the pool and spa structures to allow drainage and to prevent the buildup of excessive hydrostatic pressures and uplift if the pool and/or spa are drained. Typical subdrains may include perforated pipe surrounded by filter rock, or another approved system. Gravel galleries and/or filter rock, if not designed and graded for the on-site and/or import backfill materials, should be enclosed in a geotextile fabric such as Mirafi 140N series, or an equivalent substitute, to prevent infiltration of fine soil particles and clogging of the system. The perforated pipes should be 4.0 inches or larger in diameter. Pipe perforations should be placed downward. Gravel filters should have a volume of 1.0 cubic feet or larger per linear foot of pipe. Subdrains should maintain a positive flow gradient and have outlets that drain in a non-erosive manner or be connected to a sump with a pump or reverse flow valves installed in the pool bottom.

The walls of the pool and spa should be designed for the following conditions:

- Pool full of water without earth material on the outside.
- Pool empty and earth material on the outside.

The approximate earth material pressures acting on the walls of the pool and spa can be determined by the recommendations presented in the retaining wall section of this report.

If a new pool and/or spa are to be constructed near an existing structure, special design and construction procedures will be needed if the foundations for the existing structure are located above a zone defined by a 1:1 (Horizontal to Vertical) plane inclined upward toward the existing structure from the nearest edge of the pool excavation.

If the existing foundations are within this zone, the foundations for the existing structure should be underpinned or deepened to a depth below the above described plane or the pool and spa walls designed for the additional surcharge loads due to the footings. The amount of the additional surcharge load will be dependent on the actual loads on the existing footings and the actual location of the existing footings with respect to the pool and spa walls. If the footings for the existing structure are located within the above described zone, and are not underpinned, special construction techniques such as shoring or slot cuts, will have to be utilized to prevent loss of vertical and lateral support of the existing foundations.

Recommendations for wall surcharge loads, foundation underpinning, shoring, or slot cut procedures can be presented when specific information regarding the pool

location, the depth of the pool or spa, and the depth and loads on the existing structure foundations are available.

If the pool and/or spa are to be constructed near the top of a slope and within the anticipated creep zone, the design of the foundations should be such that the improvement within the creep zone are supported below the anticipated creep zone.

SLOPE STABILITY EVALUATION

Since anticipated cut and fill slopes for the development of the site are not anticipated to exceed 10 feet in vertical height and will not be steeper than 2H:1V (Horizontal to Vertical), a formal slope stability analysis was not performed as part of this study. The proposed cut and fill slopes should be constructed at an inclination of 2H:1V or flatter. It is anticipated that the proposed cut slopes will expose undocumented fill or alluvial material. It is anticipated that the proposed fill slopes will be constructed of the materials obtained from the proposed cuts for the development of the subject site and will be composed of the near-surface undocumented fill and alluvial materials which are present on the subject site. It is the opinion of this firm that the proposed cut and fill slopes will be grossly and surficially stable when designed at a 2H:1V inclination or flatter. However, the compacted fill and exposed cut materials will be vulnerable to erosion if precautions as recommended in the 'Slope Maintenance and Protection' section of this report are not implemented as soon as practicable after completion of grading.

PRELIMINARY PAVEMENT RECOMMENDATIONS

The following are preliminary recommendations for the structural pavement sections for the proposed streets, parking areas, and driveway areas for the subject development. The Hot Mix Asphalt (HMA) 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 an assumed Traffic Index (TI) for a 20 year design life and an assumed R-Value based on the laboratory test results, 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 number as the recommended HMA pavement sections 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**
Parking Areas for Autos and Light Weight Vehicles Only.	≤5.0	40	3.0" Hot Mix Asphaltic Concrete (HMA) over 4.0" Aggregate Base (AB) or 4.6" PCC @ 2,500 psi over properly prepared subgrade.
Subdivision Streets	≤5.5	40	3.0" HMA over 5.0" AB or 5.0" PCC @ 2,500 psi over properly prepared subgrade.

RECOMMENDED PAVEMENT SECTIONS			
Site Area	**Traffic Index***	**Subgrade R-Value****	**Pavement Section**
* Traffic Index was assumed for the project. ** R-Value was assumed for the project.			

The San Bernardino County minimum guidelines may override the above pavement recommendations without prior County review and approval.

The pavement section for individual lot driveways should be according to current San Bernardino County, California standards.

HMA concrete pavement materials should be as specified in Section 39, 'Hot Mix Asphalt,' in the current CALTRANS Standard Specifications with the July 27, 2012 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 26-1.02A, 'General,' in the current, 2010 CALTRANS Standard Specifications with the July 27, 2012 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 1.0 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 6.0 inches 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 HMA 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 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 streets in a development or 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 2013 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 26-1.02A, 'General,' of the current 2010 CALTRANS 'Standard Specifications,' 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 2010 CALTRANS 'Standard Specifications.' 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 2013 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

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 2010 CALTRANS 'Standard Specifications,' 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 San Bernardino County, California.

POST-GRADING CRITERIA

Earth materials generated from the excavation of foundations, utility trenches, swimming pools and/or spas, 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, the project plans, and/or the 2013 CBC.

SLOPE MAINTENANCE AND PROTECTION RECOMMENDATIONS

Although the design and construction of slopes are planned to create slopes that possess stability against mass rotational failure, surficial slumping, creep, and pop-outs, certain factors are beyond the influence of the project Geotechnical / Geologic Consultant. Earth material slopes are subject to some erosion when subjected to sustained water application. To reduce long term erosion, the following recommendations for slope protection and maintenance should be considered when planning, designing, and implementing slope erosion methods:

- Surface water should <u>not</u> be allowed to flow over the on-site natural or proposed man-made slopes other than incidental rainfall and irrigation. Alterations of manufactured or natural slopes, terraces, top of slope berms, and/or pad gradients should not be allowed that will prevent pad and roof run-off from the structures from being expediently directed to approved disposal areas and away from the tops of slopes.

- Surface drainage should be positively maintained from the rear yard, through the side yards, and to the street or storm drain in a non-erosive manner.

- Top of slope berms should be constructed and compacted as part of finish grading of the lots and should be maintained by the lot owners and/or home owners association. The recommended drainage patterns should be established at the time of finish grading and maintained throughout the life of the proposed development.

- Concentrated surface waters entering the subject lots from off-site sources should be collected and directed to a permanent drainage system.

- The individual lot owners and/or home owners association are responsible for the maintenance and cleaning of the interceptor ditches, drainage terraces, downdrains and other drainage devices that have been installed to promote slope stability.

- It is recommended that slopes be planted with light-weight ground cover, shrubs and trees that possess deep (5.0 feet or greater), dense root structures that require minimal of irrigation (drought resistance). It should be the responsibility of the Landscape Architect or other suitably qualified individual to provide such plants initially and of the individual lot owners and/or home owners association to maintain such planting. Alteration of the planting scheme is at the individual lot owner's and/or home owners association risk.

- If automatic sprinkler systems are installed their use should be adjusted to account for natural rainfall.

- The individual lot owners and/or home owners association should establish a program for the elimination of burrowing animals. This should be an on-going program to protect slope stability.

- The individual lot owners and/or home owners association should observe the lot drainage during heavy precipitation periods as this is often when trouble occurs. Problems such as gullying or ponding should be corrected as soon as practicable.

- High moisture content in slope earth materials is a major factor in slope erosion and slope failures. Therefore, precautions should be taken to minimize earth material saturation. Leakage from pools, waterlines, irrigation systems, etc. or bypassing of clogged drains should be promptly repaired.

The above guidelines are provided to mitigate slope maintenance and protection problems and should be included in information packets to individual home buyers and/or home owners association, when applicable, by the project developer. The above guidelines are general maintenance and design procedures but may be

superseded under specific direction of a licensed Landscape Architect or other suitably qualified individual.

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. 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.

SIEVE SIZE	CRUSHED ROCK OR GRAVEL (PERCENT PASSING)
1"	100
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 2013 Supplement. The majority of the man-made fills and alluvial soils on the subject site may not be suitable to be used as bedding and pipe zone backfill materials depending upon the bedding and pipe zone backfill specifications required by the project designer and/or the agency having jurisdiction over the utility line.

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 lots 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 2013 CBC and/or the current San Bernardino County, 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 2013 CBC and/or the current San Bernardino County 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.

RETENTION BASIN / STORM WATER STORAGE RECOMMENDATIONS

Location of Infiltrometer Testing

Infiltrometer testing was conducted on the northwest and southwest portions of the site at depths of approximately 17 inches and 3.0 feet below existing site grades, per the request of **Thatcher Engineering & Associates, Inc.** A backhoe was used to excavate and place the rings. The approximate infiltrometer test locations are shown on the 'Exploratory Excavation Location Plan', Plate No. 1, presented in the map pocket in Appendix 'A.'

Infiltrometer Test Procedures

Testing was performed in general accordance with ASTM D 3385 procedures. This method consists of driving two (2) open cylinders, one (1) inside the other, into the ground, partially filling the rings with water, maintaining the water at a constant level, and measuring the volume of water required to maintain the constant level. The steel rings used for this project had nominal inside diameters of 11.75 inches and 23.75 inches. The volume of water added to the inner ring to maintain a constant liquid level was the measure of the volume of liquid that infiltrates into the soil. The test data for each infiltrometer test is tabulated on Plate Nos. 15 through 18 presented in Appendix 'C'. The volume infiltrated during timed intervals was converted to an incremental infiltration velocity expressed in centimeters per hour, and the results were plotted on a graph versus elapsed time, as shown on the 'Infiltration Graphs: Infiltration Rate vs. Time,' Plate Nos. 19 through 22 presented in Appendix 'C.'

Test sites were chosen within the northwest and southwest portion of the site, by **Thatcher Engineering & Associates, Inc.** The backhoe was used to excavate a small area of similar diameter of the rings at each of the infiltration test locations to a depth of approximately 17 inches and 3.0 feet below existing grade. The outer and inner infiltrometer rings were then pressed into place to a depth of 6.0 inches. Upon excavation, hand tools were used to prepare a smooth, flat test site free of loose, disturbed, and smeared soils.

Clear municipal water, was poured into the rings while using protective cardboard sheeting to prevent splashing and disturbance of the soil boundary. The pre-selected water test depth was approximately 6.0 inches (15.24 cm). Water levels were maintained within 5.0 millimeters of this depth during the test by periodic additions from 1000 milliliter graduated cylinder. The apparatus was covered with

reflective styrofoam to minimize evaporative losses from the sun. No significant wind occurred on the day of testing.

A tally of water added to the inner ring and annular space was made at periodic time intervals ranging from 15 to 60 minutes.

Soil Profile

- Percolation Hole No. 1a: Infiltrometer test (P-1a) was located in the southwestern portion of the site and tested in alluvial deposits. A backhoe was used to excavate to 17 inches, then used to push the rings 6.0 inches into the soil. Native axial valley soils (alluvium) in the test area consisted of light brown, moist, silty, fine to coarse grained sand, a little gravel, trace cobbles and slightly compacted. The test hole was classified in general accordance with the Unified Soil Classification System as SM.

- Percolation Hole No. 1b: Infiltrometer test (P-1b) was conducted in alluvium in the southwestern portion of the site at approximately 3.0 feet beneath the existing grade. A backhoe was used to excavate the test pit to 3.0 feet then used to push the rings 6.0 inches into the soil. Native axial valley soils (alluvium) in the test area consisted of orange-brown, moist, fine to coarse grained sand with a little silt, a little gravel, a little cobbles and slightly compacted. The test hole was classified in general accordance with the Unified Soil Classification System as SM.

- Percolation Hole No. 2a: Infiltrometer test (P-2a) was located in the northwestern portion of the site and tested in alluvial deposits. A backhoe was used to excavate to 17 inches, then used to push the rings 6.0 inches into the soil. A dense grass lawn existed at the surface of the test area. At depth axial valley soils (alluvium) were found beneath the grass and consisted of dark brown, moist, silty, fine to coarse grained sand, a little gravel, trace cobbles, trace boulders and slightly compacted. The test hole was classified in general accordance with the Unified Soil Classification System as SM.

- Percolation Hole No. 2b: Infiltrometer test (P-2b) was conducted in alluvium in the northwestern portion of the site at approximately 3.5 feet beneath the existing grade. A backhoe was used to excavate the test pit to 3.5 feet then used to push the rings 6.0 inches into the soil. A dense grass

lawn existed at the surface of the test area. At depth axial valley soils (alluvium) were found beneath the grass and consisted of dark brown, moist, fine to coarse grained sand, a little silt, a little gravel, trace cobbles, trace boulders and slightly compacted. The test hole was classified in general accordance with the Unified Soil Classification System as SM.

- No large plants or roots were encountered in the infiltrometer test areas.
- There were no wet or saturated soils encountered in the infiltrometer test areas.
- No groundwater was encountered within our infiltrometer test areas, however, the lawn was routinely watered in test holes P-2a and P-2b.

Infiltrometer Test Results

The infiltration rates were similar between the test holes and depths. The calculated average inner-ring infiltration rates in test holes P-1a and P-1b were 1.89 cm/hr and 4.32 cm/hr. The calculated average inner-ring infiltration rates in test holes P-2a and P-2b were 0.16 cm/hr and 4.32 cm/hr. The outer-ring infiltration rates were 2.65 cm/hr in P-1a and 2.99 cm/hr in P-1b. The outer-ring infiltration rates were 0.89 cm/hr in P-2a and 8.57 cm/hr in P-2b.

Soil Characteristics of the Subject Site

- There was no visible evidence of shallow groundwater or impervious bedrock materials.
- 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. 01S02W30C001S, located approximately 300 feet west, (just south of Colton Avenue), of the subject site was approximately 120 feet on December 4, 1990. The surface elevation of this well is 1651 feet, generally lower (topographically) than that of the site.
- Tests performed agreed with visual evidence.

- The natural slope of the ground surface above the proposed water infiltration areas are less than a 2.0 percent gradient.

- The proposed infiltration BMP areas are adjacent to proposed fill slopes that are shown to range between 2-7 feet in height. The slopes are proposed at 2:1 and should be compacted to 90% relative compaction or greater. The soils underneath these proposed slopes are granular in nature. As such, the proposed infiltration basin or underground storm water BMP are not anticipated to adversely impact the proposed fill slopes, nor would they result in a significant increased risk of geotechnical hazards.

- Soil conditions for the on-site, water infiltration systems were acceptable at depth (3.0 feet) below the existing ground surfaces at both test areas. Additionally, based upon additional subsurface exploration, the soils were found to be coarser with depth, with increased gravel and cobble content.

Discussion

This area of Mentone is underlain by alluvial axial valley deposits that primarily consist of interbedded gravels, cobbles, and boulders, and sands to fine-grained silts. The subject areas tested contained silty deposits toward the surface with a decrease in the amount of silt at depth. Test pits P-1a and P-2a resulted in very slow percolation rates. Test pits P-1b and P-2b were conducted at depth and the data shows relatively faster, more favorable percolation rates. The rates presented above are generally consistent with the soil classifications in each area tested.

Field infiltration tests are subject to many factors that affect the infiltration rate, including soil texture, the condition of the soil surface, soil-moisture tension or the degree of saturation, the temperature of the water and soil, the percentage of entrapped air in the soil, and the head of the applied water.

Infiltration Basin / Storm Water Storage Recommendations

Infiltration testing in the proposed storm water storage infiltration areas indicated percolation rates that appear to be consistent with respect to there respective on-site soil classification. The Project Civil Engineer should evaluate this information for final infiltration design.

Caution should be used in determining a percolation rate for any proposed infiltration basin or structure. Eventual siltation, water-borne silt from irrigation and precipitation runoff, and the accumulation of organic material in surface soils due to landscape grass and plant growth, can drastically reduce percolation rates over time. We recommend that suitable methods to prevent siltation be considered 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 20, 2014 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 the map pocket in this Appendix.

A study of the property's subsurface condition was performed to evaluate underlying earth strata and the presence of groundwater. Seven (7) exploratory backhoe excavations were performed on the subject site on January 20, 2014. Locations of the exploratory excavations were determined in the field by sighting from the adjacent existing streets, adjacent structures, and topographic features as shown on the Reference No. 1 'Tract Map,' noted on the first page of the cover letter for this report. Approximate locations of the exploratory excavations are denoted on the 'Exploratory Excavation Location Plan' presented in the map pocket in this Appendix. Approximate elevations at the locations of the exploratory excavations were determined by interpolation to the closest 1.0 foot from a 1.0 foot contour interval topographic plot of the site (Reference No. 1 noted on the first page of the cover letter for this report). 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 trenches were excavated by using a rubber tired, tractor-mounted backhoe. The depths explored in the trenches was approximately 9.5 to 12 feet below the existing land surface at the excavation locations. Bulk and relatively undisturbed chunk samples were obtained from cuttings developed during the

backhoe excavation process and represent the earth materials within the depth indicated. In-place dry density and moisture content tests were also performed at various depths in the backhoe exploratory excavations. The tests were performed in general accordance with current Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) - ASTM D6938 test method. The dry density and moisture content test results are presented on the 'Summary of Field In-Place Density Test Results,' Plate No. 3 through 9, presented in this Appendix.

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 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 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.

Four (4) infiltrometer tests were also performed on the subject site as part of this study. The infiltrometer tests were performed in the proposed retention basin / storm water storage areas.

The exploratory backhoe 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. Recompaction of the exploratory backhoe excavation backfill, if located within proposed structural fill, building, hardscape, and/or pavement areas, should be addressed during site grading operations. In an area as small and deep as a backhoe 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.

LABORATORY TESTING PROGRAM

Laboratory tests were performed on selected, 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. 3 through 9, 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. 10, presented in this Appendix.

SOLUBLE SULFATE TEST

The concentration of soluble sulfate was determined on selected samples of near-surface earth materials in general accordance with current EPA 300.0 procedures. The test results are summarized in the 'Summary of Laboratory Test Results,' Plate No. 10, presented in this Appendix.

SIEVE ANALYSIS

The percent by weight finer than a No. 200 sieve (silt and clay content) was determined for selected samples of earth materials 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. 11, presented in this Appendix.

MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT RELATIONSHIP TEST

Maximum dry density / optimum moisture content relationship determinations were performed on samples of near-surface earth materials in general accordance with current ASTM D1557 procedures using a 4-inch and 6-inch diameter molds

for Methods 'B' and 'C,' respectively. Samples were prepared at various moisture contents and compacted in five (5) layers using a 10-pound weight dropping 18 inches and with 25 and 56 blows per layer for Methods 'B' and 'C,' respectively. 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 Nos. 12 and 13, presented in this Appendix.

DIRECT SHEAR TEST

A direct shear test was performed on a selected remolded sample of near-surface earth material obtained from the borings in general accordance with current ASTM D3080 procedures. The shear machine is of the constant strain type. The shear machine is designed to receive a 1-inch high, 2.416-inch diameter ring sample. Three (3) specimens from the selected bulk sample of earth material were remolded at approximately 90 percent relative compaction and at optimum moisture content based on the maximum dry density and optimum moisture content of the earth material as determined by current ASTM D1557 procedures. Specimens from the remolded samples were sheared at various pressures normal to the face of the specimens. The specimens were tested in a submerged condition. The peak and ultimate shear stresses were plotted verses the normal confining stresses to determine the shear strength (cohesion and angle of internal friction). The test results are summarized in the 'Direct Shear Test Results,' Plate No. 14, presented in this Appendix.

SUBSURFACE EXPLORATION LEGEND

UNIFIED SOIL CLASSIFICATION SYSTEM Visual-Manual Procedure (ASTM D2488-09a)					CONSISTENCY / RELATIVE DENSITY
MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES	CRITERIA
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	Reference: 'Foundation Engineering', Peck, Hansen, Thornburn, 2nd Edition.
			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	

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 (Few)	< 5 %
Slight	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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(Revised 7-10-2013)

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SUBSURFACE EXPLORATION LOG
TRENCH NO. T-1

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.
Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH
Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1649

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SM			Qya_3		YOUNG AXIAL VALLEY DEPOSIT: Silty, fine to coarse sand, a little gravel, a little cobbles; Light brown to orange-brown; Moist.
1	B/N			120.1	5.8			
2								
3	N			99.4	5.7			
4			SP					Gravelly, fine to coarse sand, trace boulders, trace silt; Brown; Moist.
5	B		GP					Fine to coarse, sandy gravel, some cobbles, trace boulders; Light gray-brown; Moist.
6								
7								
8								
9								
10								
11								
12								Bottom of trench at 11.5 feet. No groundwater encountered. Trench backfilled with excavated material.
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

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SUBSURFACE EXPLORATION LOG
TRENCH NO. T-2

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.
Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH
Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1668

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
1			SM			af		ARTIFICIAL FILL: Silty, fine to coarse sand, some gravel, a little cobbles, trace boulders, trace roots, trace asphalt particles and plastic pieces; Light brown; Moist.
2	N			114.6	3.3			
3	B							4 to 5 Large Boulders.
4	N		SM	110.0	6.9	Qya_3		YOUNG AXIAL VALLEY DESPOSIT: Silty, fine to coarse sand, a little gravel, a little cobbles; Light brown to orange-brown; Moist.
5								
6								
7			GP					Fine to coarse, sandy gravel, a little cobbles, trace boulders; Light gray-brown; Moist.
8								
9								
10								
11	B							
12								Bottom of trench at 11.5 feet. No groundwater encountered. Trench backfilled with excavated material.
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

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SUBSURFACE EXPLORATION LOG
TRENCH NO. T-3

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.

Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH

Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1668

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SM			af		ARTIFICIAL FILL: Silty, fine to coarse sand, a little gravel, a little cobbles; Light brown; Moist.
1	N			128.8	2.9			
2								Asphalt pieces found at 2'
3	B N			126.1	4.5			
4								
5			SP			Qya_3		YOUNG AXIAL VALLEY DESPOSIT: Fine to coarse sand, a little gravel; Gray; Moist.
6			SM					Silty, fine to coarse sand, some gravel, trace cobble, trace boulders; Dark orange-brown; Moist.
7			GP					Fine to coarse, sandy gravel, some cobbles, a little boulders; Light gray-brown; Moist.
8								
9								
10								
11								
12								Bottom of trench at 11.5 feet. No groundwater encountered. Trench backfilled with excavated material.
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

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SUBSURFACE EXPLORATION LOG
TRENCH NO. T-4

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.
Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH
Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1677

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SM			Qya_3		YOUNG AXIAL VALLEY DEPOSIT: Silty, fine to coarse sand, a little gravel, a little cobbles, trace boulders; Light brown to orange-brown; Moist
1								
2	N			104.6	2.7			
3			GP					5 Large boulders.
4	B/N		GP	116.4	4.2			Gravel, some fine to coarse sand, some cobbles, trace boulders; Gray-brown; Moist.
5								
6								
7								
8								
9								
10								Bottom of trench at 9.5 feet. No groundwater encountered. Trench backfilled with excavated material.
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

SUBSURFACE EXPLORATION LOG
TRENCH NO. T-5

HILLTOP GEOTECHNICAL INCORPORATED

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.

Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH

Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1678

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
1	N		SM	109.9	3.3	af		ARTIFICIAL FILL: Silty, fine to coarse sand, trace gravel, trace cobbles; Orange-brown; Moist.
2	B		SM			Qya_3		YOUNG AXIAL VALLEY DEPOSIT: Silty, fine to coarse sand, trace gravel, trace cobbles; Orange-brown; Moist.
3	N			112.0	4.6			
4								
5			GP					Cobbles, a little gravel, a little fine to coarse sand, trace boulders; Gray; Moist.
6								
7			GP					Gravel, trace silt, trace fine to coarse sand; Gray; Moist.
8			GP					Cobbles, a little gravel, a little fine to coarse sand, trace boulders; Gray; Moist.
9								
10			GP					Gravel, trace silt, trace fine to coarse sand; Gray; Moist.
			GP					Cobbles, a little gravel, a little fine to coarse sand, trace boulders; Gray; Moist.
11								Bottom of trench at 10.5 feet. No groundwater encountered. Trench backfilled with excavated material.
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

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SUBSURFACE EXPLORATION LOG
TRENCH NO. T-6

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.

Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH

Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1659

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
1	B		SM			af		ARTIFICIAL FILL: Silty, fine to coarse sand, a little gravel, trace cobbles, trace boulders, trace asphalt and plastics; Brown; Moist.
2			SM			Qya_3		YOUNG AXIAL VALLEY DEPOSIT: Silty, fine to coarse sand, a little gravel, trace cobbles, trace boulders; Orange-brown; Moist;.
3	N			108.8	4.8			
4								
5	B/N			102.5	5.8			
6			GP					Boulders, some cobbles, a little gravel, a little fine to coarse sand; Orange-brown to Gray-brown.
7			GP					Gravel, trace silt, trace fine to coarse sand; Gray; Moist.
8			GP					Boulders, some cobbles, a little gravel, a little fine to coarse sand; Orange-brown to Gray-brown.
9								
10								
11								
12								Bottom of trench at 12.0 feet. No groundwater encountered. Trench backfilled with excavated material.
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

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SUBSURFACE EXPLORATION LOG
TRENCH NO. T-7

Project Name: Proposed 132 Lot Subdivision, Tentative Tr. 18952, Mentone, CA.
Project No.: 950-A14.1 Date: 1/20/2014 Logged By: AH
Equipment Used: Rubber tired, tractor-mounted backhoe Elevation: ± 1651

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
			SM			Qya_3		YOUNG AXIAL VALLEY DEPOSIT: Silty, fine to coarse sand, a little gravel, trace cobbles, trace boulders; Dark brown; Very moist.
1	N			112.2	14.4			
2	B							
3	N			113.6	9.5			
4			SP					Fine to coarse sand, a little gravel, trace silt, trace cobbles; Dark brown; Moist.
5			GP					Cobbley, gravel, a little fine to coarse sand, trace silt, trace boulders; Dark brown; Moist.
6								
7								
8								
9								Bottom of trench at 9.0 feet due to sidewalll caving. No groundwater encountered. Trench backfilled with excavated material.
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

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 **
T-5, 1.5'-2.0'	8.1	116.2	48.6	13.6	0	Non-Expansive

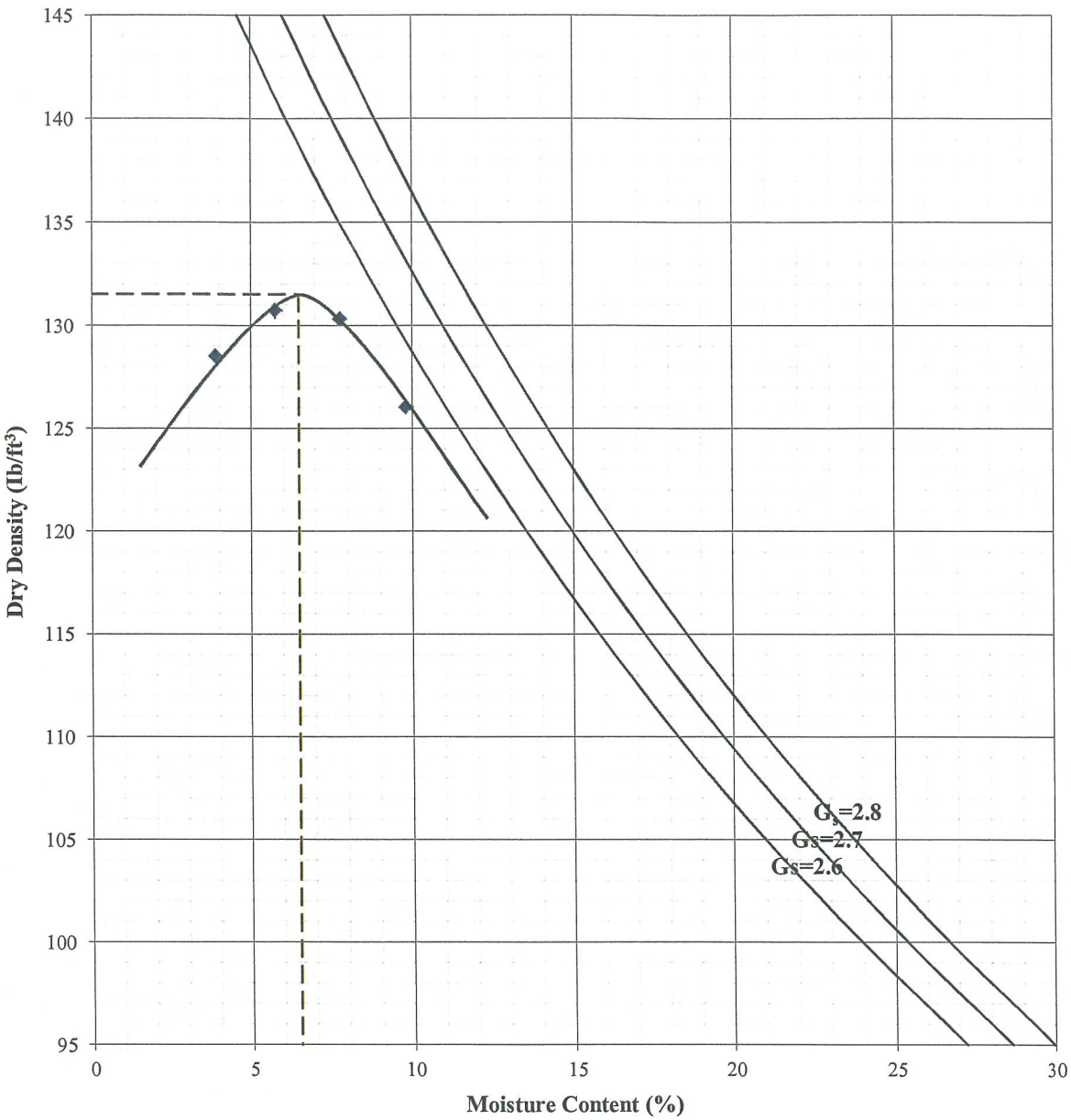
* Assumes a 2.70 Specific Gravity for the earth material.
** As defined in Section 1803.5.3, 'Expansive Soil,' in the 2013 California Building Code (CBC) (i.e., Non-Expansive: EI ≤20; Expansive: EI >20).

SOLUBLE SULFATE TEST RESULTS (EPA 300.0 Test Procedure)*			
SAMPLE NO.	SOLUBLE SULFATE CONTENT (%)	SULFATE EXPOSURE**	
		CLASS	SEVERITY
T-2, 2.5'-3.0'	0.0019	S0	Not Applicable
T-5, 1.5'-2.0'	<0.0005	S0	Not Applicable

* Test performed by **A & R Laboratories**.
** Per Table 4.2.1, 'Exposure Categories and Classes,' in **American Concrete Institute (ACI)** 318-11, Chapter 4, *Durability Requirements*, Section 4.2.1.

SUMMARY OF LABORATORY TEST RESULTS

PERCENT PASSING #200 SIEVE TEST RESULTS (ASTM D1140 Test Method)	
SAMPLE	**PERCENT PASSING #200 SIEVE**
T-2, 2.5'-3.0'	12
T-5, 1.5'-2.0'	16



Maximum Dry Density (Ib/ft^3)	131.5
Optimum Moisture Content (%)	6.5
Procedure	C

Corrected Maximum Dry Density for 16.9% +3/4" (Ib/ft^3)	136.4
Corrected Optimum Moisture Content for 16.9% +3/4" (%)	5.6

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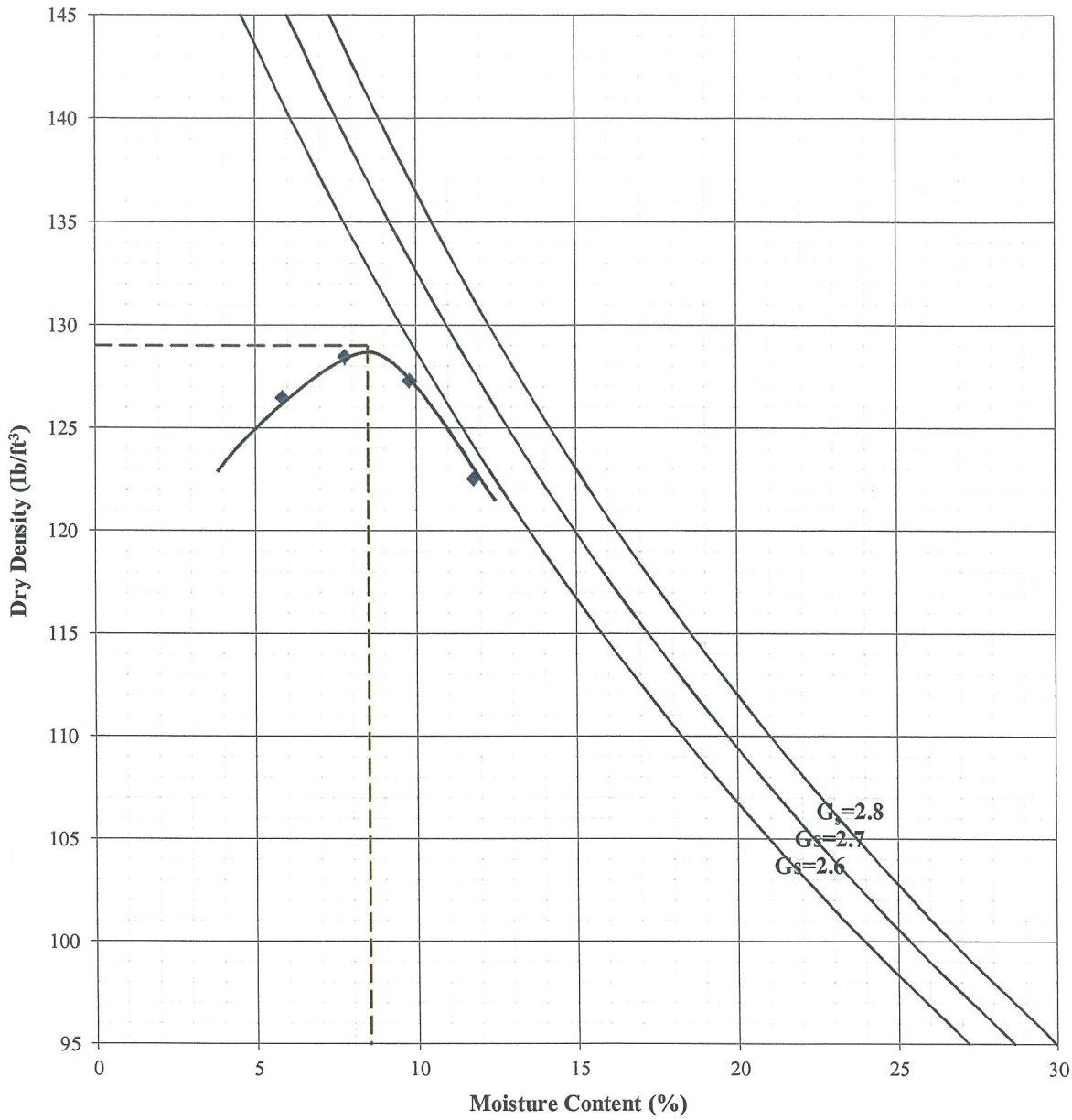
MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT RELATIONSHIP TEST RESULTS (ASTM D1557 Test Method)

SAMPLE: T-2, 2.5'-3.0'

SOIL DESCRIPTION: Light brown, silty, fine to coarse sand, some gravel, a little cobbles, trace boulders (SM)

BY:	DLC	DATE:	2/2014
JOB NO.:	950-A14.1	PLATE NO.:	12



Maximum Dry Density (Ib/ft^3)	129.0
Optimum Moisture Content (%)	8.5
Procedure	B
Corrected Maximum Dry Density for 5.8% +3/8" (Ib/ft^3)	130.7
Corrected Optimum Moisture Content for 5.8% +3/8" (%)	8.1

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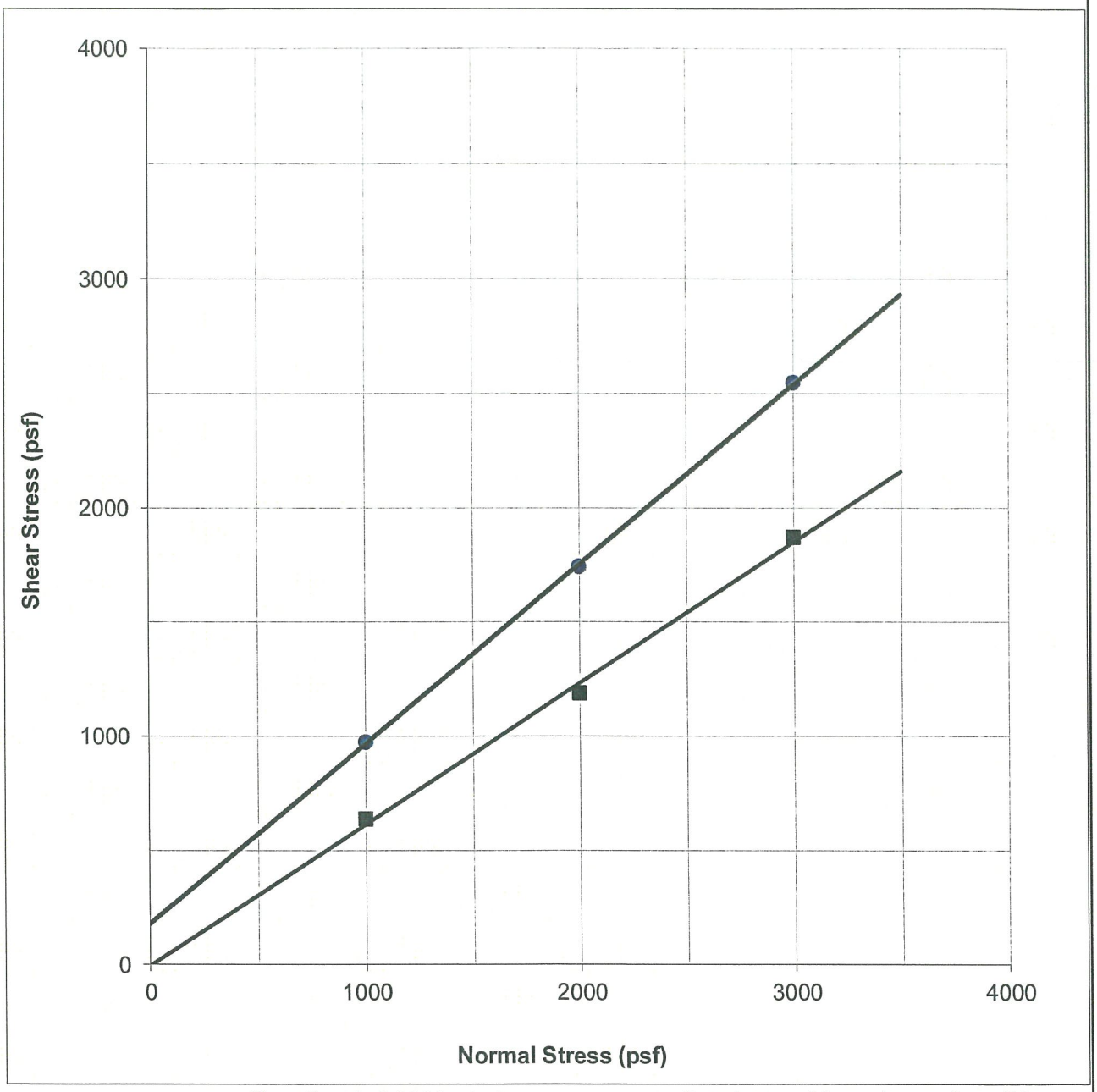
MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT RELATIONSHIP TEST RESULTS (ASTM D1557 Test Method)

SAMPLE: T-5, 1.5'-2.0'

SOIL DESCRIPTION: Orange-brown, silty, fine to coarse sand, trace gravel, trace cobbles (SM)

BY:	DLC	DATE:	2/2014
JOB NO.:	950-A14.1	PLATE NO.:	13



Shear Speed: 0.005 in. / min. Samples tested in a submerged condition.

Average Dry Density (pcf)	116.9
Average Moisture Content (%)	8.2

Peak	Cohesion	180 psf
	Internal Friction Angle	38 degrees
Ultimate	Cohesion	0 psf
	Internal Friction Angle	32 degrees
Residual	Cohesion	psf
	Internal Friction Angle	degrees

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DIRECT SHEAR TEST RESULTS
(ASTM D3080 Test Method)

SAMPLE:	T-05, 1.5'-2.09' (Remolded to 90% of maximum dry density at optimum moisture content)		
SOIL DESCRIPTION:	Orange-brown, silty, fine to coarse sand, trace gravel, trace cobbles (SM)		
BY:	DLC	DATE:	2/2014
PROJECT NO.:	950-A14.1	PLATE NO.:	14

APPENDIX B

TECHNICAL REFERENCES

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APPENDIX C

INFILTROMETER TEST **P-1a** DATE OF TEST 1/20/14 DEPTH OF

PROJECT IDENTIFICATION: 950-A14.1 Walden Structures AREA(CM2) LIQUID (CM)

TEST LOCATION: Bottom of Proposed Basin, 17" INNER 699.6 INNER 15.24

LIQUID USED: Municipal H20 OUTER 2128.5 OUTER 15.24

TESTED BY KB _____ LIQUID LEVEL MAINTAINED USING: __X__ MANUAL ADDITIONS (VISUAL)

DEPTH TO WATER TABLE: N/A INNER RING AVERAGE RATE **1.89**

OUTER RING AVERAGE RATE **2.65**

Increment No.	DATE	TIME START= 09:15 AM HR: MM	ELAPSED TIME/ INCREMENT MIN	FLOW READINGS INNER FLOW CM3	FLOW READINGS OUTER FLOW CM3	LIQUID TEMP. F	INCREMENTAL INFILTRATION RATE INNER CM/H	INCREMENTAL INFILTRATION RATE ANNULAR CM/H	GROUND TEMP = 60 F @ DEPTH OF 12 INCHES AIR TEMP, WEATHER
1	20-Jan-14	9:30	15	900	2,800	61	5.15	5.26	58, SUNNY, CLEAR
2	20-Jan-14	9:45	15	600	1,800	62	3.43	3.38	65, SUNNY, CLEAR
3	20-Jan-14	10:00	15	400	1,700	62	2.29	3.19	73, SUNNY, CLEAR
4	20-Jan-14	10:15	15	400	1,700	62	2.29	3.19	73, SUNNY, CLEAR
5	20-Jan-14	10:45	30	650	2,700	65	1.86	2.54	75, SUNNY, CLEAR
6	20-Jan-14	11:15	30	600	2,700	65	1.72	2.54	76, SUNNY, CLEAR
7	20-Jan-14	12:15	60	1,000	5,300	68	1.43	2.49	76, SUNNY, CLEAR
8	20-Jan-14	13:15	60	1,000	4,500	73	1.43	2.11	76, SUNNY, CLEAR
9	20-Jan-14	14:15	60	900	4,900	75	1.29	2.30	77, SUNNY, CLEAR
10	20-Jan-14	15:15	60	900	4,400	74	1.29	2.07	76, SUNNY, CLEAR

INFILTROMETER TEST **P-1b** DATE OF TEST 1/20/14 DEPTH OF

PROJECT IDENTIFICATION: 950-A14.1 Walden Structures AREA(CM2) LIQUID (CM)

TEST LOCATION: Proposed Basin, 3' INNER 699.6 INNER 15.24

LIQUID USED: Municipal H20 OUTER 2128.5 OUTER 15.24

TESTED BY KB _____ LIQUID LEVEL MAINTAINED USING: __X__ MANUAL ADDITIONS (VISUAL)

DEPTH TO WATER TABLE: N/A INNER RING AVERAGE RATE **4.32**

OUTER RING AVERAGE RATE **2.99**

Increment No.	DATE	TIME START= 09:05 AM HR: MM	ELAPSED TIME/ INCREMENT MIN	FLOW READINGS INNER FLOW CM3	FLOW READINGS OUTER FLOW CM3	LIQUID TEMP. F	INCREMENTAL INFILTRATION RATE INNER CM/H	INCREMENTAL INFILTRATION RATE ANNULAR CM/H	GROUND TEMP = 60 F @ DEPTH OF 12 INCHES AIR TEMP, WEATHER
1	20-Jan-14	9:20	15	800	1,600	61	4.57	3.01	58, SUNNY, CLEAR
2	20-Jan-14	9:35	15	250	1,850	62	1.43	3.48	65, SUNNY, CLEAR
3	20-Jan-14	9:50	15	700	1,800	62	4.00	3.38	73, SUNNY, CLEAR
4	20-Jan-14	10:05	15	900	1,700	62	5.15	3.19	73, SUNNY, CLEAR
5	20-Jan-14	10:35	30	1,400	3,200	65	4.00	3.01	75, SUNNY, CLEAR
6	20-Jan-14	11:05	30	2,100	3,000	65	6.00	2.82	76, SUNNY, CLEAR
7	20-Jan-14	12:05	60	3,900	5,800	68	5.57	2.72	76, SUNNY, CLEAR
8	20-Jan-14	13:05	60	3,000	5,200	73	4.29	2.44	76, SUNNY, CLEAR
9	20-Jan-14	14:05	60	2,900	6,000	75	4.15	2.82	77, SUNNY, CLEAR
10	20-Jan-14	15:05	60	3,000	6,500	74	4.29	3.05	76, SUNNY, CLEAR

INFILTROMETER TEST **P-2a** DATE OF TEST 1/23/14 DEPTH OF

PROJECT IDENTIFICATION: 950-A14.1 Walden Structures AREA(CM2) LIQUID (CM)

TEST LOCATION: Bottom of Proposed Basin, 17" INNER 699.6 INNER 15.24

LIQUID USED: Municipal H20 OUTER 2128.5 OUTER 15.24

TESTED BY KB _____ LIQUID LEVEL MAINTAINED USING: __X__ MANUAL ADDITIONS (VISUAL)

DEPTH TO WATER TABLE: N/A INNER RING AVERAGE RATE **0.16**

OUTER RING AVERAGE RATE **0.89**

Increment No.	DATE	TIME START= 08:52 AM HR: MM	ELAPSED TIME/ INCREMENT MIN	FLOW READINGS INNER FLOW CM3	FLOW READINGS OUTER FLOW CM3	LIQUID TEMP. F	INCREMENTAL INFILTRATION RATE INNER CM/H	INCREMENTAL INFILTRATION RATE ANNULAR CM/H	GROUND TEMP = 57 F @ DEPTH OF 12 INCHES AIR TEMP, WEATHER
1	23-Jan-14	9:07	15	310	2,630	61	1.77	4.94	59, SUNNY, CLEAR
2	23-Jan-14	9:22	15	0	1,280	61	0.00	2.41	62, SUNNY, CLEAR
3	23-Jan-14	9:37	15	110	680	62	0.63	1.28	65, SUNNY, CLEAR
4	23-Jan-14	9:52	15	50	865	62	0.29	1.63	65, SUNNY, CLEAR
5	23-Jan-14	10:22	30	60	840	63	0.17	0.79	68, SUNNY, CLEAR
6	23-Jan-14	10:52	30	30	420	63	0.09	0.39	70, SUNNY, CLEAR
7	23-Jan-14	11:52	60	50	1,000	64	0.07	0.47	72, SUNNY, CLEAR
8	23-Jan-14	12:52	60	35	730	65	0.05	0.34	72, SUNNY, CLEAR
9	23-Jan-14	13:52	60	70	500	65	0.10	0.23	73, SUNNY, CLEAR
10	23-Jan-14	14:52	60	45	1,000	66	0.06	0.47	74, SUNNY, CLEAR

INFILTROMETER TEST **P-2b** DATE OF TEST 1/23/14 DEPTH OF

PROJECT IDENTIFICATION: 950-A14.1 Walden Structures AREA(CM2) LIQUID (CM)

TEST LOCATION: Proposed Basin, 3'6" INNER 699.6 INNER 15.24

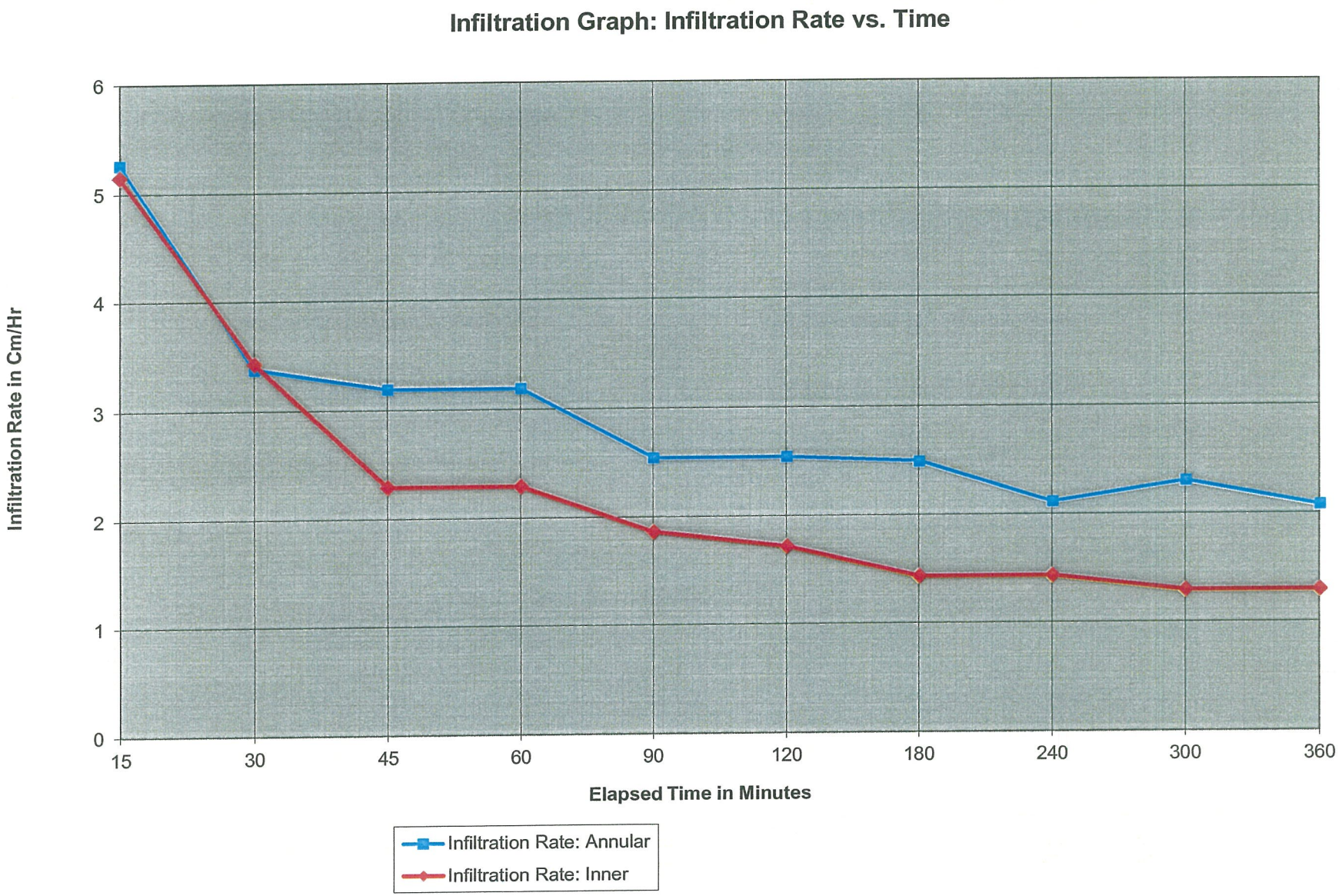
LIQUID USED: Municipal H20 OUTER 2128.5 OUTER 15.24

TESTED BY KB _____ LIQUID LEVEL MAINTAINED USING: __X__ MANUAL ADDITIONS (VISUAL)

DEPTH TO WATER TABLE: N/A INNER RING AVERAGE RATE **4.32**

OUTER RING AVERAGE RATE **8.57**

Increment No.	DATE	TIME START= 08:28 AM HR: MM	ELAPSED TIME/ INCREMENT MIN	FLOW READINGS INNER FLOW CM3	FLOW READINGS OUTER FLOW CM3	LIQUID TEMP. F	INCREMENTAL INFILTRATION RATE INNER CM/H	INCREMENTAL INFILTRATION RATE ANNULAR CM/H	GROUND TEMP = 57 F @ DEPTH OF 12 INCHES AIR TEMP, WEATHER
1	23-Jan-14	8:43	15	1,280	9,910	61	7.32	18.62	59, SUNNY, CLEAR
2	23-Jan-14	8:58	15	930	6,000	61	5.32	11.28	62, SUNNY, CLEAR
3	23-Jan-14	9:13	15	800	6,770	62	4.57	12.72	65, SUNNY, CLEAR
4	23-Jan-14	9:28	15	760	5,980	62	4.35	11.24	65, SUNNY, CLEAR
5	23-Jan-14	9:58	30	1,380	10,960	63	3.95	10.30	68, SUNNY, CLEAR
6	23-Jan-14	10:28	30	1,330	9,210	63	3.80	8.65	70, SUNNY, CLEAR
7	23-Jan-14	11:28	60	3,500	13,350	64	5.00	6.27	72, SUNNY, CLEAR
8	23-Jan-14	12:28	60	2,910	12,240	65	4.16	5.75	72, SUNNY, CLEAR
9	23-Jan-14	13:28	60	2,670	11,650	65	3.82	5.47	73, SUNNY, CLEAR
10	23-Jan-14	14:28	60	2,760	11,670	66	3.95	5.48	74, SUNNY, CLEAR

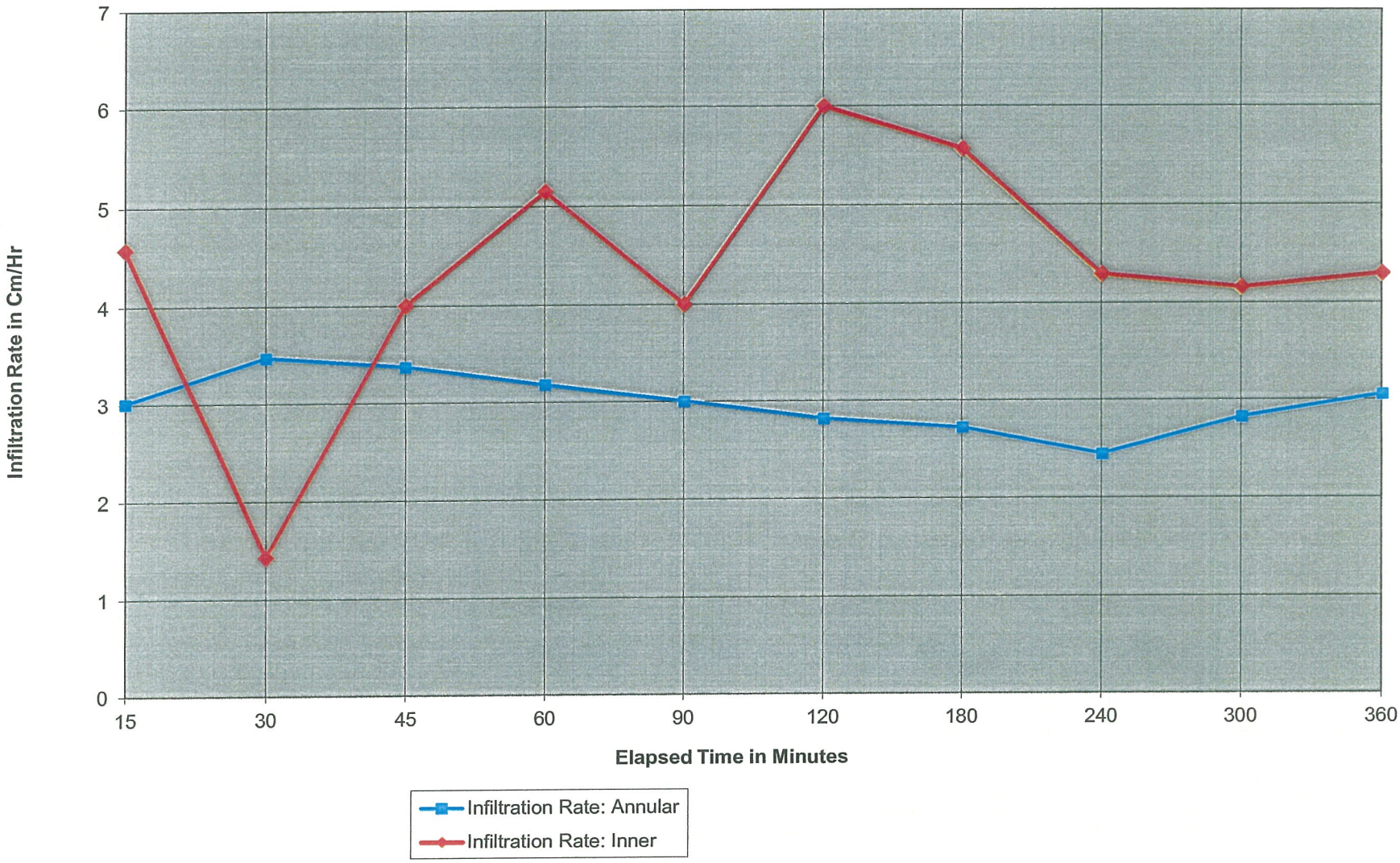


Hilltop Geotechnical, Inc.

Infiltrometer Test P-1a

950-A14.1
Plate No.19

Infiltration Graph: Infiltration Rate vs. Time

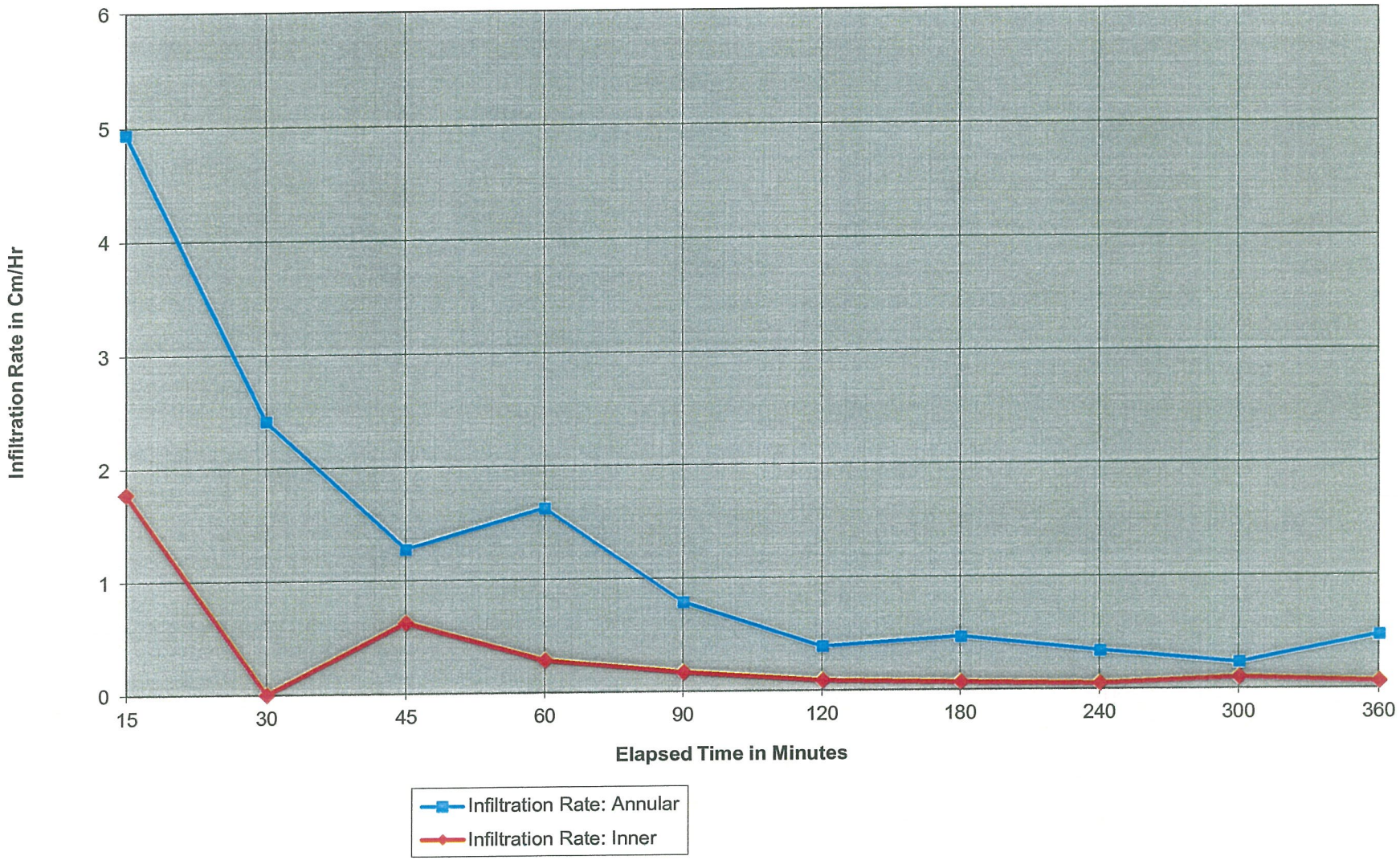


Hilltop Geotechnical, Inc.

Infiltrometer Test P-1b

950-A14.1
Plate No.20

Infiltration Graph: Infiltration Rate vs. Time

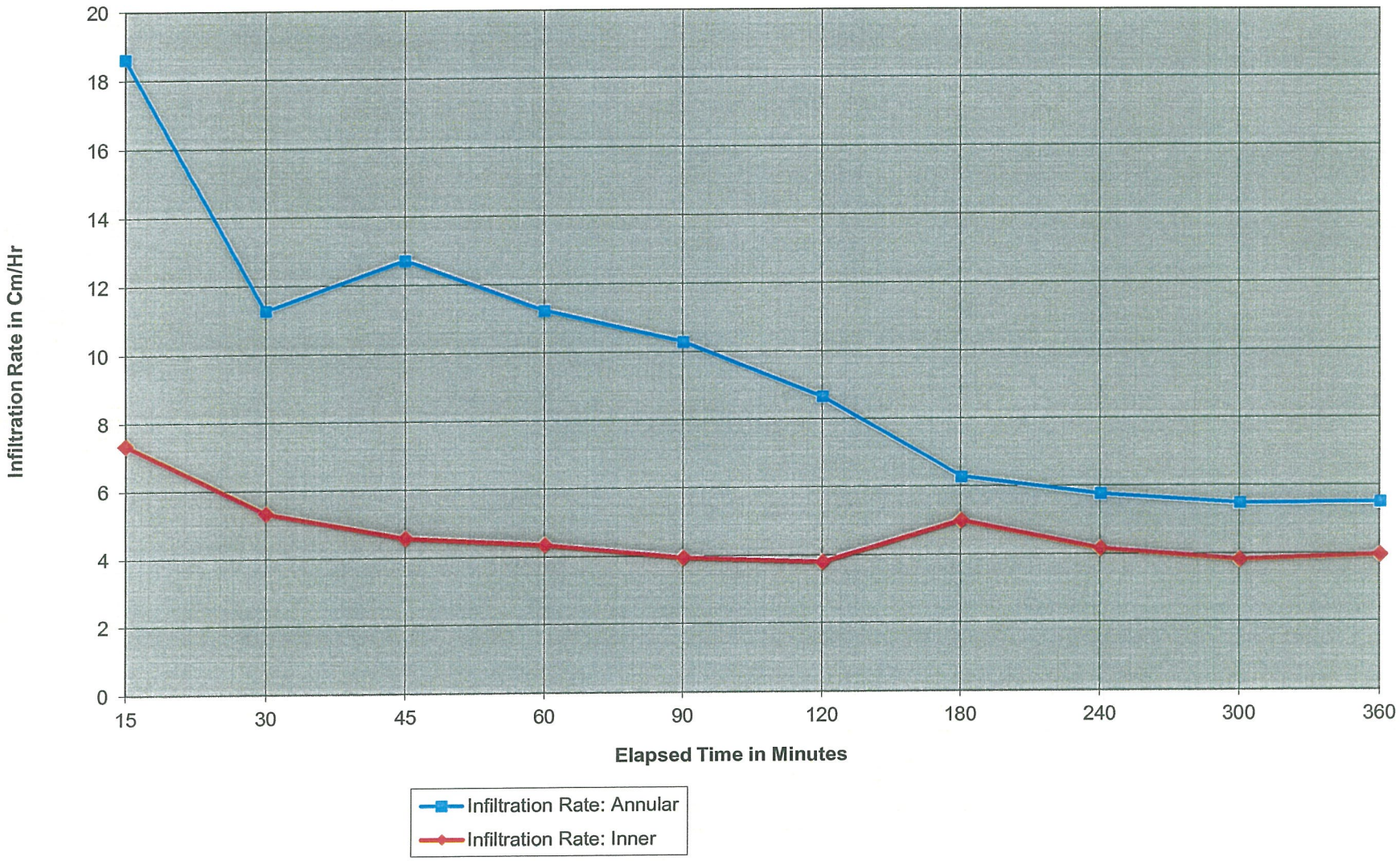


Hilltop Geotechnical, Inc.

Infiltrometer Test P-2a

950-A14.1
Plate No.21

Infiltration Graph: Infiltration Rate vs. Time



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.

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

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 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

Trash Storage Areas SD-32

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

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

Designing New Installations

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

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

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

Redeveloping Existing Installations

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

Additional Information

Maintenance Considerations

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

Other Resources

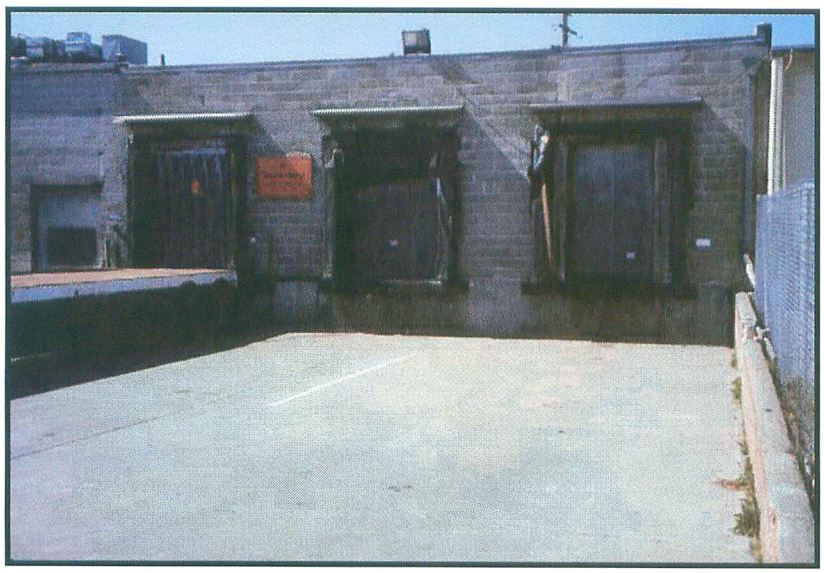
A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

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

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

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

Outdoor Loading/Unloading SC-30



Objectives

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

Description

The loading/unloading of materials usually takes place outside on docks or terminals; therefore, materials spilled, leaked, or lost during loading/unloading may collect in the soil or on other surfaces and have the potential to be carried away by stormwater runoff or when the area is cleaned. Additionally, rainfall may wash pollutants from machinery used to unload or move materials. Implementation of the following protocols will prevent or reduce the discharge of pollutants to stormwater from outdoor loading/unloading of materials.

Targeted Constituents

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

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Keep accurate maintenance logs to evaluate materials removed and improvements made.
- Park tank trucks or delivery vehicles in designated areas so that spills or leaks can be contained.
- Limit exposure of material to rainfall whenever possible.
- Prevent stormwater run-on.
- Check equipment regularly for leaks.

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Suggested Protocols

Loading and Unloading – General Guidelines

- Develop an operations plan that describes procedures for loading and/or unloading.
- Conduct loading and unloading in dry weather if possible.
- Cover designated loading/unloading areas to reduce exposure of materials to rain.
- Consider placing a seal or door skirt between delivery vehicles and building to prevent exposure to rain.
- Design loading/unloading area to prevent stormwater run-on, which would include grading or berming the area, and position roof downspouts so they direct stormwater away from the loading/unloading areas.
- Have employees load and unload all materials and equipment in covered areas such as building overhangs at loading docks if feasible.
- Load/unload only at designated loading areas.
- Use drip pans underneath hose and pipe connections and other leak-prone spots during liquid transfer operations, and when making and breaking connections. Several drip pans should be stored in a covered location near the liquid transfer area so that they are always available, yet protected from precipitation when not in use. Drip pans can be made specifically for railroad tracks. Drip pans must be cleaned periodically, and drip collected materials must be disposed of properly.
- Pave loading areas with concrete instead of asphalt.
- Avoid placing storm drains in the area.
- Grade and/or berm the loading/unloading area to a drain that is connected to a deadend.

Inspection

- Check loading and unloading equipment regularly for leaks, including valves, pumps, flanges and connections.
- Look for dust or fumes during loading or unloading operations.

Training

- Train employees (e.g., fork lift operators) and contractors on proper spill containment and cleanup.
- Have employees trained in spill containment and cleanup present during loading/unloading.
- Train employees in proper handling techniques during liquid transfers to avoid spills.
- Make sure forklift operators are properly trained on loading and unloading procedures.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Contain leaks during transfer.
- Store and maintain appropriate spill cleanup materials in a location that is readily accessible and known to all and ensure that employees are familiar with the site's spill control plan and proper spill cleanup procedures.
- Have an emergency spill cleanup plan readily available.
- Use drip pans or comparable devices when transferring oils, solvents, and paints.

Other Considerations (Limitations and Regulations)

- Space and time limitations may preclude all transfers from being performed indoors or under cover.
- It may not be possible to conduct transfers only during dry weather.

Requirements

Costs

Costs should be low except when covering a large loading/unloading area.

Maintenance

- Conduct regular inspections and make repairs as necessary. The frequency of repairs will depend on the age of the facility.
- Check loading and unloading equipment regularly for leaks.
- Conduct regular broom dry-sweeping of area.

Supplemental Information

Further Detail of the BMP

Special Circumstances for Indoor Loading/Unloading of Materials

Loading or unloading of liquids should occur in the manufacturing building so that any spills that are not completely retained can be discharged to the sanitary sewer, treatment plant, or treated in a manner consistent with local sewer authorities and permit requirements.

- For loading and unloading tank trucks to above and below ground storage tanks, the following procedures should be used:
  - The area where the transfer takes place should be paved. If the liquid is reactive with the asphalt, Portland cement should be used to pave the area.
  - The transfer area should be designed to prevent run-on of stormwater from adjacent areas. Sloping the pad and using a curb, like a speed bump, around the uphill side of the transfer area should reduce run-on.

- The transfer area should be designed to prevent runoff of spilled liquids from the area. Sloping the area to a drain should prevent runoff. The drain should be connected to a dead-end sump or to the sanitary sewer. A positive control valve should be installed on the drain.

- For transfer from rail cars to storage tanks that must occur outside, use the following procedures:

  - Drip pans should be placed at locations where spillage may occur, such as hose connections, hose reels, and filler nozzles. Use drip pans when making and breaking connections.

  - Drip pan systems should be installed between the rails to collect spillage from tank cars.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

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

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Efficient Irrigation SD-12

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

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

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

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

Redeveloping Existing Installations

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

Other Resources

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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.

Infiltration Basin TC-11

Design Considerations

- Soil for Infiltration
- Slope
- Aesthetics

Targeted Constituents

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

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

Description

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

California Experience

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

Advantages

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

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

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

Limitations

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

Design and Sizing Guidelines

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

Construction/Inspection Considerations

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

Performance

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

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

Siting Criteria

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

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

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

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

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

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

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

Secondary Screening Based on Site Geotechnical Investigation

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

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

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

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

Additional Design Guidelines

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

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

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

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

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

where A = Basin invert area (m^2)

WQV = water quality volume (m^3)

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

t = drawdown time (48 hr)

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

Maintenance

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

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

Cost

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

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

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

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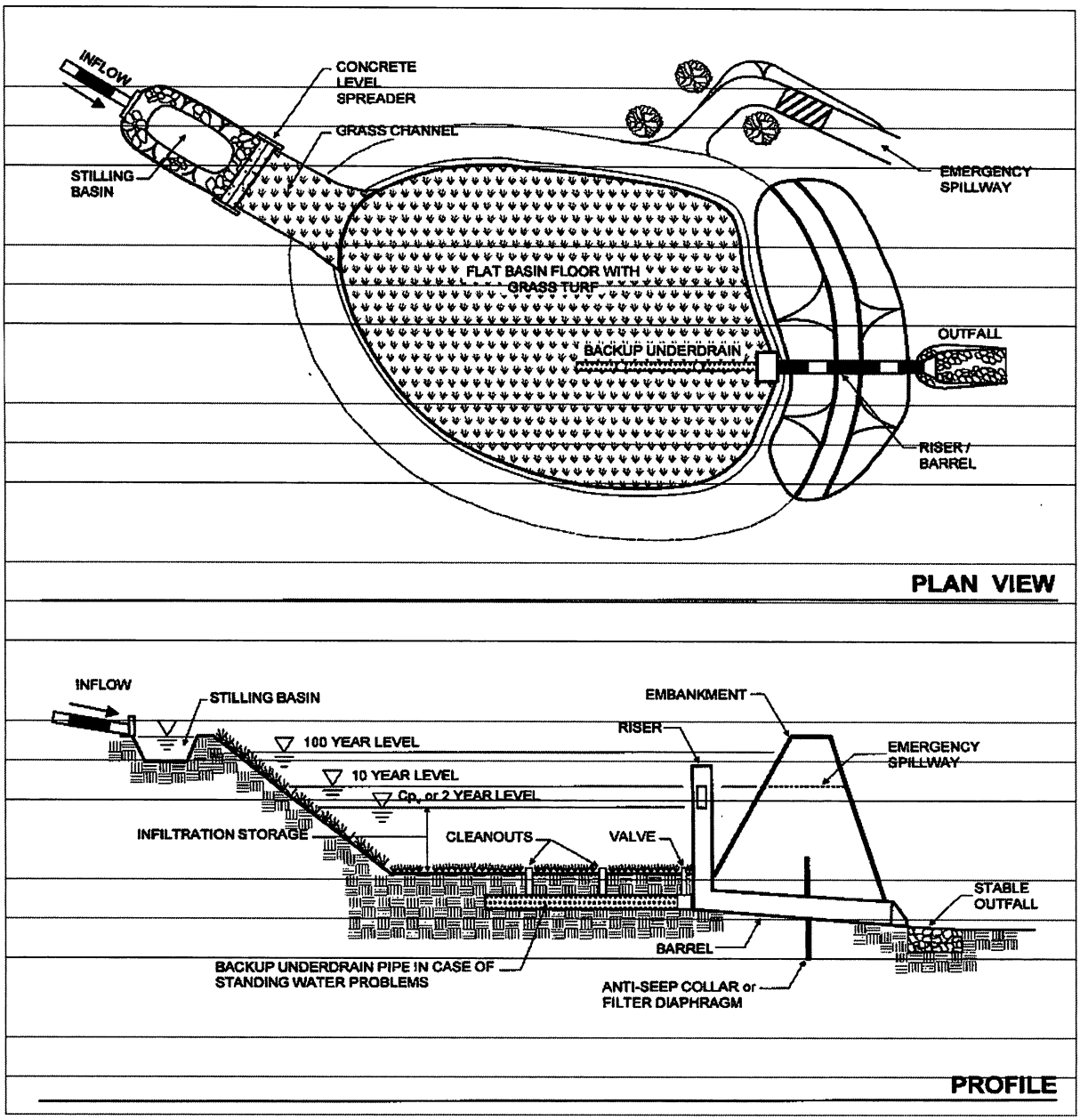
INFLOW
CONCRETE LEVEL SPREADER
GRASS CHANNEL
STILLING BASIN
EMERGENCY SPILLWAY
FLAT BASIN FLOOR WITH GRASS TURF
BACKUP UNDERDRAIN
OUTFALL
RISER / BARREL
PLAN VIEW
INFLOW
STILLING BASIN
100 YEAR LEVEL
10 YEAR LEVEL
Cp, or 2 YEAR LEVEL
INFILTRATION STORAGE
CLEANOUTS
VALVE
EMBANKMENT
RISER
EMERGENCY SPILLWAY
STABLE OUTFALL
BARREL
BACKUP UNDERDRAIN PIPE IN CASE OF STANDING WATER PROBLEMS
ANTI-SEEP COLLAR or FILTER DIAPHRAGM
PROFILE

Parking/Storage Area Maintenance SC-43

Objectives

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

Targeted Constituents

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

Description

Parking lots and storage areas can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants from parking/storage areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

Approach

The goal of this program is to ensure stormwater pollution prevention practices are considered when conducting activities on or around parking areas and storage areas to reduce potential for pollutant discharge to receiving waters. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Encourage alternative designs and maintenance strategies for impervious parking lots. (See New Development and Redevelopment BMP Handbook)
- Keep accurate maintenance logs to evaluate BMP implementation.

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SC-43 Parking/Storage Area Maintenance

Suggested Protocols

General

- Keep the parking and storage areas clean and orderly. Remove debris in a timely fashion.
- Allow sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low quantities.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.
- Discharge soapy water remaining in mop or wash buckets to the sanitary sewer through a sink, toilet, clean-out, or wash area with drain.

Controlling Litter

- Post "No Littering" signs and enforce anti-litter laws.
- Provide an adequate number of litter receptacles.
- Clean out and cover litter receptacles frequently to prevent spillage.
- Provide trash receptacles in parking lots to discourage litter.
- Routinely sweep, shovel, and dispose of litter in the trash.

Surface Cleaning

- Use dry cleaning methods (e.g., sweeping, vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system if possible.
- Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- Sweep all parking lots at least once before the onset of the wet season.
- Follow the procedures below if water is used to clean surfaces:
  - Block the storm drain or contain runoff.
  - Collect and pump wash water to the sanitary sewer or discharge to a pervious surface. Do not allow wash water to enter storm drains.
  - Dispose of parking lot sweeping debris and dirt at a landfill.
- Follow the procedures below when cleaning heavy oily deposits:
  - Clean oily spots with absorbent materials.
  - Use a screen or filter fabric over inlet, then wash surfaces.

- Do not allow discharges to the storm drain.
- Vacuum/pump discharges to a tank or discharge to sanitary sewer.
- Appropriately dispose of spilled materials and absorbents.

Surface Repair

- Preheat, transfer or load hot bituminous material away from storm drain inlets.
- Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff.
- Cover and seal nearby storm drain inlets where applicable (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.
- Use only as much water as necessary for dust control, to avoid runoff.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Inspection

- Have designated personnel conduct inspections of parking facilities and stormwater conveyance systems associated with parking facilities on a regular basis.
- Inspect cleaning equipment/sweepers for leaks on a regular basis.

Training

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.
- Train employees and contractors in proper techniques for spill containment and cleanup.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up fluid spills immediately with absorbent rags or material.
- Dispose of spilled material and absorbents properly.

Other Considerations

Limitations related to sweeping activities at large parking facilities may include high equipment costs, the need for sweeper operator training, and the inability of current sweeper technology to remove oil and grease.

SC-43 Parking/Storage Area Maintenance

Requirements

Costs

Cleaning/sweeping costs can be quite large. Construction and maintenance of stormwater structural controls can be quite expensive as well.

Maintenance

- Sweep parking lot regularly to minimize cleaning with water.
- Clean out oil/water/sand separators regularly, especially after heavy storms.
- Clean parking facilities regularly to prevent accumulated wastes and pollutants from being discharged into conveyance systems during rainy conditions.

Supplemental Information

Further Detail of the BMP

Surface Repair

Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff. Where applicable, cover and seal nearby storm drain inlets (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal. Only use only as much water as is necessary for dust control to avoid runoff.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

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

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

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

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Building & Grounds Maintenance SC-41

Objectives

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

Targeted Constituents

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

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Switch to non-toxic chemicals for maintenance when possible.
- Choose cleaning agents that can be recycled.
- Encourage proper lawn management and landscaping, including use of native vegetation.

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- Encourage use of Integrated Pest Management techniques for pest control.
- Encourage proper onsite recycling of yard trimmings.
- Recycle residual paints, solvents, lumber, and other material as much as possible.

Suggested Protocols

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.
- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.
- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures on exposed soils.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.
- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.
- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.
- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.
- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Dispose of empty pesticide containers according to the instructions on the container label.

- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Inspection

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

Training

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the nature of the staff.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Other Considerations

Alternative pest/weed controls may not be available, suitable, or effective in many cases.

Requirements

Costs

- Cost will vary depending on the type and size of facility.
- Overall costs should be low in comparison to other BMPs.

Maintenance

Sweep paved areas regularly to collect loose particles. Wipe up spills with rags and other absorbent material immediately, do not hose down the area to a storm drain.

Supplemental Information

Further Detail of the BMP

Fire Sprinkler Line Flushing

Building fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

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Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Site Design & Landscape Planning SD-10

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

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Designing New Installations

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

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.

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

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

Conserve Natural Areas during Landscape Planning

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

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.

- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.

- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.

- Promote natural vegetation by using parking lot islands and other landscaped areas.

- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.

- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

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

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

Protection of Slopes and Channels during Landscape Design

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

Redeveloping Existing Installations

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

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

Other Resources

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

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

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

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

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

Drainage System Maintenance SC-44

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize

Description

As a consequence of its function, the stormwater conveyance system collects and transports urban runoff and stormwater that may contain certain pollutants. The protocols in this fact sheet are intended to reduce pollutants reaching receiving waters through proper conveyance system operation and maintenance.

Targeted Constituents

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

Approach

Pollution Prevention

Maintain catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

Suggested Protocols

Catch Basins/Inlet Structures

- Staff should regularly inspect facilities to ensure compliance with 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 SC34 Waste Handling and Disposal).

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- Clean catch basins, storm drain inlets, and other conveyance structures 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.
- 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 if necessary 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. Do not dewater near a storm drain or stream.

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 and pump flushed effluent to the sanitary sewer for treatment whenever possible.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge to reach the storm drain system when cleaning a storm drain pump station or other facility.
- Conduct routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.

Open Channel

- Modify storm channel characteristics to improve channel hydraulics, increase pollutant removals, and 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

- Look for evidence of illegal discharges or illicit connections during routine maintenance of conveyance system and drainage structures:
  - 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 upgradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
- Eliminate the discharge once the origin of flow is established.

- Stencil or demarcate 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

- Inspect and clean up hot spots and other storm drainage areas regularly 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.

Training

- Train crews in proper maintenance activities, including record keeping and disposal.
- Allow only properly trained individuals to handle hazardous materials/wastes.
- Have staff involved in detection and removal of illicit connections trained in the following:
  - OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).

- OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).
- Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

Spill Response and Prevention

- Investigate all reports of spills, leaks, and/or illegal dumping promptly.
- Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags) or dig up, remove, and properly dispose of contaminated soil.
- Refer to fact sheet SC-11 Spill Prevention, Control, and Cleanup.

Other Considerations (Limitations and Regulations)

- Clean-up 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 prohibition against disposal of flushed effluent to sanitary sewer in some areas.
- Regulations may include adoption of substantial penalties for illegal dumping and disposal.
- Local municipal codes may include sections prohibiting discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.

Requirements

Costs

- An aggressive catch basin cleaning program could require a significant capital and O&M budget.
- The elimination of illegal dumping is dependent on the availability, convenience, and cost of alternative means of disposal. The primary cost is for staff time. Cost depends on how aggressively a program is implemented. Other cost considerations for an illegal dumping program include:
  - Purchase and installation of signs.
  - Rental of vehicle(s) to haul illegally-disposed items and material to landfills.
  - Rental of heavy equipment to remove larger items (e.g., car bodies) from channels.
  - Purchase of landfill space to dispose of illegally-dumped items and material.

- 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.

Maintenance

- Two-person teams may be required to clean catch basins with vactor trucks.
- Teams of at least two people plus administrative personnel are required to identify illicit discharges, depending on the complexity of the storm sewer system.
- Arrangements must be made for proper disposal of collected wastes.
- Technical staff are required to detect and investigate illegal dumping violations.

Supplemental Information

Further Detail of the BMP

Storm Drain Flushing

Flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in storm drainage systems. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as an open channel, another point where flushing will be initiated, or the sanitary sewer and the treatment facilities, thus preventing resuspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. 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, thereby releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce impacts of stormwater pollution, a second inflatable device placed well downstream may be used to recollect 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 recollect 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% for organics and 55-65% 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 sewer flushing.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

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http://www.co.clark.wa.us/pubworks/bmpman.pdf

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http://www.epa.gov/npdes/menuofbmps/poll_16.htm

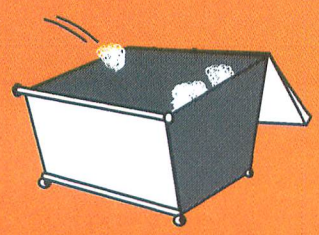
COMMERCIAL TRASH ENCLOSURES

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.**

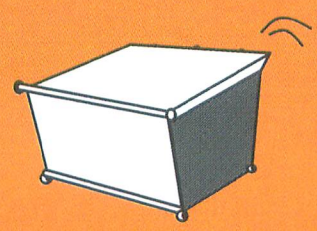
PROTECT WATER QUALITY BY FOLLOWING THESE SIMPLE STEPS

PUT TRASH INSIDE



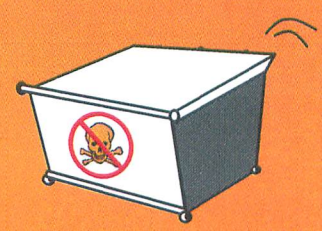
Place trash inside the bin (preferably in sealed bags)

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

To report illegal dumping **(877-WASTE18)** or
to find a household hazardous waste facility (800-OILY CAT): **sbcountystormwater.org**
To dispose of hazardous waste call the San Bernardino County Fire Dept. - CUPA Program **(909) 386-8401**

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

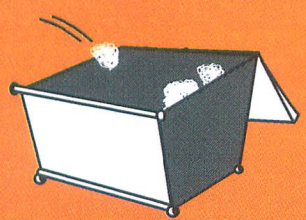
CONTENEDORES COMERCIALES PARA LA BASURA

SIGA ESTOS **PASOS** PARA MANTENER **LIMPIAS NUESTRAS VÍAS FLUVIALES**

Los contenedores de basura, tales como aquellos que se encuentran en las unidades comerciales y departamentos, generalmente contienen materiales que están destinados a los rellenos sanitarios o en algún establecimiento de reciclaje.
Estos materiales NO deben ser vertidos en nuestros lagos y ríos locales.

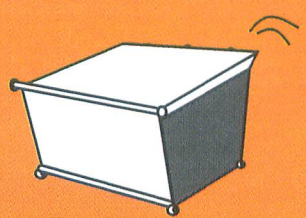
SIGA ESTOS PASOS PARA PROTEGER LA CALIDAD DEL AGUA

COLOQUE LA BASURA ADENTRO



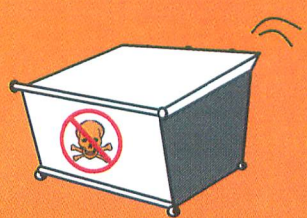
Coloque la basura adentro del contenedor (preferentemente en bolsas selladas)

CIERRE LA TAPA



Evite que la lluvia ingrese al contenedor para evitar un escape de escorrentía contaminada

MANTENGA LOS PRODUCTOS TÓXICOS AFUERA



- Pintura
- Lubricante, grasas y aceites usados
- Baterías, componentes electrónicos y luces fluorescentes

ALGUNAS GUÍAS ADICIONALES, LAS CUALES INCLUYEN

✓ BARRER CON FRECUENCIA

Barra con frecuencia las áreas de los recintos para la basura, en lugar de lavarlas con una manguera, para evitar que el agua contaminada se vierta en las calles y los desagües de lluvia.

✓ REPARE LAS GOTERAS

Ocúpese inmediatamente de las goteras en los contenedores de basura. Use los métodos de limpieza en seco e infórmele a su recolector de basura para que reciba un reemplazo.

✓ CONSTRUYA UN TECHO

Construya un techo de cubierta sólida sobre la estructura actual del recinto para la basura a fin de evitar que el agua de lluvia entre en contacto con los desechos y la basura. Consulte con su Ciudad/Condado para conocer los Códigos de Construcción.

En el Condado de San Bernardino, los desechos de alimentos y jardines, los productos químicos y otros restos que se vierten en los desagües de aguas pluviales y que terminan en nuestras vías fluviales sin tratamiento alguno provocan la contaminación de estas aguas. Usted puede ser parte de la solución si mantiene un recinto para la basura que no contamine el agua.

¡MUCHAS GRACIAS POR AYUDAR A MANTENER EL CONDADO DE SB LIMPIO Y SIN CONTAMINACIÓN!

San Bernardino County STORMWATER PROGRAM

Para informar acerca del vertedero ilegal, llame a **(877-WASTE18)**, o para encontrar un establecimiento donde arrojar los residuos peligrosos del hogar, llame a **(800-OILY CAT): sbcountystormwater.org**
Para deshacerse de los residuos peligrosos llame al Condado de San Bernardino Departamento de Bomberos - programa CUPA **(909) 386-8401**

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Stormwater Pollution Prevention

Important Phone Numbers

San Bernardino County Flood Control
(909) 387-8112

County of San Bernardino
(909) 387-8109

City of Big Bear Lake
(909) 866-5831

City of Chino (909) 591-9850

City of Chino Hills (909) 364-2722

City of Colton (909) 370-6128

City of Fontana (909) 350-6772

City of Grand Terrace
(909) 824-6671 x 226

City of Highland (909) 864-8732 x 230

City of Loma Linda (909) 799-4405

City of Montclair (909) 625-9470

City of Ontario (909) 395-2025

City of Rancho Cucamonga
(909) 477-2740 x 4063

City of Redlands (909) 798-7655

City of Rialto (909) 421-4921

City of San Bernardino (909) 384-5154

City of Upland (909) 931-4370

City of Yucaipa (909) 797-2489 x 243

San Bernardino County Stormwater Program
825 East Third Street • Room 201
San Bernardino, CA 94215-0835

STORMWATER Pollution Prevention

INDUSTRIAL AND COMMERCIAL FACILITIES

Pollution Prevention

STORMWATER

To reduce the amount of pollutants reaching our storm drain system, which leads to the Santa Ana River and Pacific Ocean, the San Bernardino County Stormwater Program has developed Best Management Practices (BMPs) for Industrial and Commercial Facilities. City and County ordinances require that businesses comply with these BMPs, where applicable, to protect local water quality. Local cities and the County are required to verify implementation of these BMPs by performing regular facility inspections.

Prohibited Discharges

- Discontinue all non-stormwater discharges to the storm drain system. It is prohibited to discharge any chemicals, wastes or wastewater into the gutter, street or storm drain.

Outdoor Storage

- Install covers and secondary containment areas for all hazardous materials and wastes stored outdoors in accordance with County and/or City standards.
- Keep all temporary waste containers covered, except when in direct use.
- Sweep outdoor areas instead of using a hose or pressure washer.

Outdoor Processes

- Move all process operations including vehicle and equipment maintenance inside of the building or into a covered and contained area.
- Wash equipment and vehicles in a contained and covered wash bay which is closed-loop or connected to a clarifier sized to city standards, then discharged to a sanitary sewer or take them to a commercial car wash.

Spills and Clean Ups

- Clean up spills immediately when they occur, using dry clean up methods such as absorbent materials and followed by proper disposal of materials.
- Always have a spill kit available near chemical loading dock doors, vehicle maintenance and fueling areas.
- Follow your Business Emergency Plan, as filed with the County Fire Department at (909) 386-8401.

Industrial and Commercial Facilities

- Report all prohibited discharges and non-implementation of BMPs to your local Stormwater Coordinator either at (800) CLEANUP or as listed at www.sbcounty.gov/stormwater.
- Report hazardous materials spills to (800) 33 TOXIC and your local Fire Department Hazmat Team at 911.

Training

Train employees in spill response procedures and prohibited discharges to the storm drain system, as prescribed in your local Stormwater Ordinance and in applicable Best Management Practices available at www.cabmphandbooks.com and www. sbcounty.gov/stormwater.

Permitting

Stormwater discharges associated with specific categories of commercial and industrial facilities are regulated by the State Water Resources Control Board (SWRCB) through an Industrial Storm Water General Permit. A copy of the General Permit and application forms are available at:
www.waterboards.ca.gov/stormwtr/industrial.html

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

1 (800) CLEANUP

or visit our websites at:

www.sbcounty.gov/stormwater

www.1800cleanup.org

San Bernardino County STORMWATER PROGRAM

Prevención de Contaminación
AL SISTEMA DE DRENAJE

Números de Teléfono Importantes

San Bernardino County Flood Control
(909) 387-8112

County of San Bernardino
(909) 387-8109

City of Big Bear Lake
(909) 866-5831

City of Chino (909) 591-9850

City of Chino Hills (909) 364-2722

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San Bernardino County Stormwater Program
825 East Third Street • Room 201
San Bernardino, CA 94215-0835

Prevención de Contaminación
AL SISTEMA DE DRENAJE

INSTALACIONES INDUSTRIALES Y COMERCIALES

Prevención de Contaminación
AL SISTEMA DE DRENAJE

Para reducir la cantidad de contaminantes que alcanzan nuestro sistema de aguas pluviales, las cuales desembocan en el Río Santa Ana y el Océano Pacífico, el Programa del Condado de San Bernandino ha desarrollado las pautas de Mejores Prácticas de Manejo (BMPs, por sus siglas en inglés) para instalaciones industriales y comerciales. Los decretos de la ciudad y del condado establecen que todas las empresas deben de cumplir con estas BMPs, cuando corresponda, para proteger la calidad del agua local. Las ciudades locales y el condado tienen la obligación de verificar la implementación de estas BMPs al llevar a cabo inspecciones regulares en sus instalaciones.

Desagües Prohibidos

- Descontinúe todo desagüe de aguas no pluviales al sistema de drenaje de aguas pluviales. Está prohibido descargar cualquier sustancia química, residuo o agua residual a los drenajes de la cuneta, de la calle o de aguas pluviales.

Almacenamiento al Aire Libre

- Instale cubiertas y áreas de retención secundarias para todos los materiales peligrosos y residuos almacenados al aire libre, estas instalaciones deberán de cumplir con los estándares establecidos por el condado y/o la ciudad.
- Mantenga todos los recipientes temporales de residuos cubiertos, con la excepción de cuando se estén utilizando directamente.
- Barra todas las áreas al aire libre en lugar de usar una manguera o un equipo de limpieza con agua a alta presión.

Procesos al Aire Libre

- Reubique todos los procesos u operaciones, incluyendo el mantenimiento de vehículos y equipo, dentro de un edificio en una área cubierta e independiente.
- Lave el equipo y los vehículos en una fosa de lavado independiente que tenga un anillo cerrado o bien, esté conectada a un clarificador del tamaño de los estándares municipales, luego elimine los residuos en un drenaje sanitario o llévelos a un lavador de carros comercial.

Derrames y Limpieza

- Limpie los derrames inmediatamente, utilice métodos de limpieza en seco como son el uso de materiales absorbentes y elimine estos materiales de la manera adecuada.
- Siempre tenga a la mano un estuche para derrames cerca de las puertas de los muelles de carga de sustancias químicas, en las áreas de mantenimiento de vehículos y en las áreas de combustible.
- Siga su Plan de Emergencia Comercial, como lo registró con el Departamento de Bomberos del

Instalaciones Industriales y Comerciales

Condado marcando al (909) 386-8401.

- Reporte todos los desagües prohibidos y cualquier punto no implementado de las BMPs a su coordinador local de Aguas Pluviales llamando al (800) CLEANUP o como se indica en el enlace www.sbcounty.gov/stormwater.
- Reporte cualquier derrame peligroso al (800) 33 TOXIC y al equipo Hazmat de su departamento local de bomberos marcando al 911.

Capacitación

Capacite a los empleados sobre los procedimientos de respuesta ante un derrame y los desagües prohibidos al sistema de aguas pluviales, como lo indica el decreto local de aguas pluviales de Mejores Prácticas de Manejo (BMPs) disponibles en el sitio www.cabmphandbooks.com y www.sbcounty.gov/stormwater.

Autoridad Competente

Los desagües de aguas pluviales relacionados con categorías específicas de instalaciones comerciales e industriales están regulados por la Junta Estatal de Control de Recursos Acuáticos (State Water Resources Control Board, SWRCB) a través de un permiso industrial general de aguas pluviales. Para obtener una copia de este permiso general y una solicitud, visite el sitio: www.waterboards.ca.gov/stormwtr/industrial.html

Para reportar el desagüe de residuos ilegales o para obtener información adicional sobre la prevención de contaminación a las aguas pluviales, llame a:

1 (800) CLEANUP

o visite nuestro sitio:

www.sbcounty.gov/stormwater

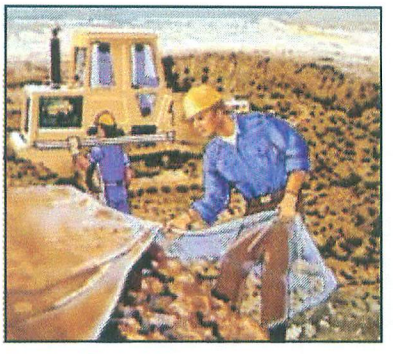
www.1800cleanup.org

San Bernardino County STORMWATER PROGRAM

Pollution Prevention STORMWATER

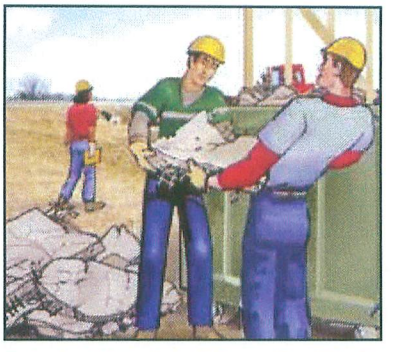
FRESH CONCRETE & MORTAR APPLICATION

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.



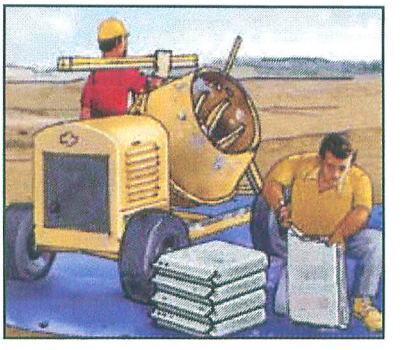
Storing Materials

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.

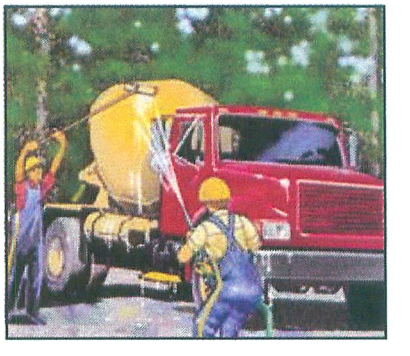


During Construction

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

(877) WASTE18

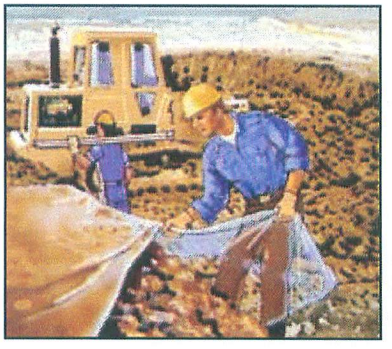
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

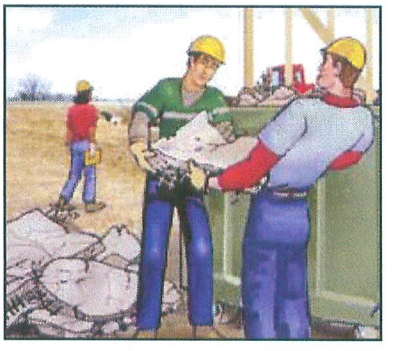
APLICANDO CONCRETO FRESCO

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

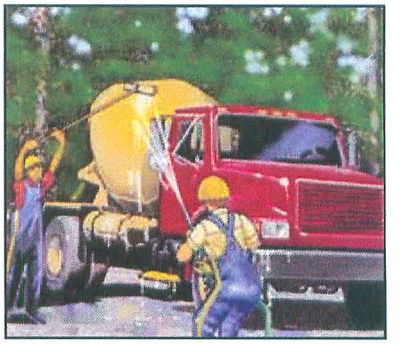
Reduce la cantidad al ordenar el material, solo ordena lo necesario. Usa materiales recicables cuando sea posible. Cuando estes rompiendo el pavimento, recicla los pedasos en la compañia demolidora. Se puede reciclar el aspfalto, concreto, madera y la vegetacion. Materiales no reciclados se deverian 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

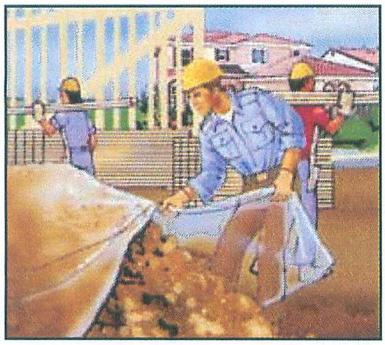
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

STORMWATER Pollution Prevention

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

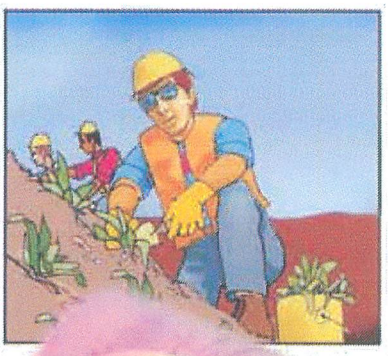
Keep construction materials and debris away from the street, gutter and storm drains. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.

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.

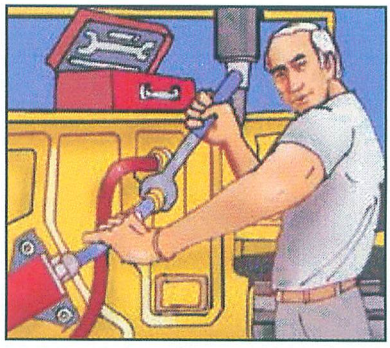
Cleaning & Preventing Spills

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.



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.



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

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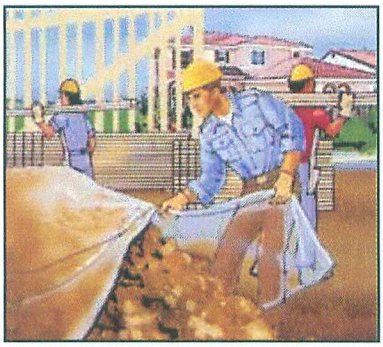
sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

Prevención de Contaminación del Desagüe

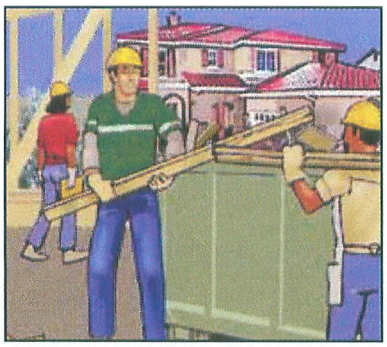
CONSTRUCCIÓN

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.

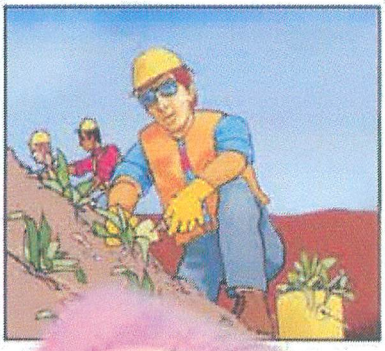


Ordenando Materiales & Reciclando Desechos

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.

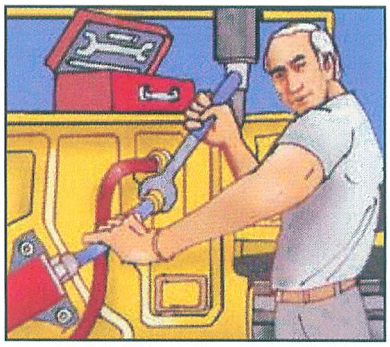
Limpiando & Previniendo Derrames

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

sbcountystormwater.org

San Bernardino County STORMWATER PROGRAM

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STORMWATER Pollution Prevention

LANDSCAPE MAINTENANCE

Pollution Prevention STORMWATER

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

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

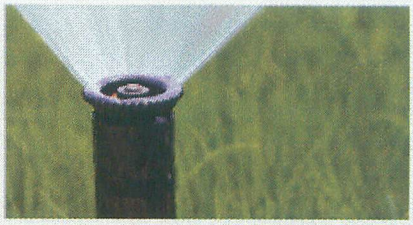
- Recycle leaves, grass clippings and other yard waste.
- Do not blow, sweep, rake or hose yard waste into the street or catch basin.
- **Try grasscycling:** the natural recycling of grass by leaving clippings on the lawn when mowing.

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

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

MANTENIMIENTO DE JARDINERÍA

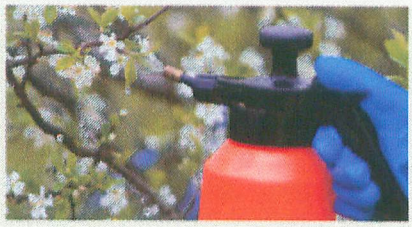
LAS DESCARGAS A LOS DESAGUES PLUVIALES, DE MANERA ACCIDENTAL O NO, PUEDEN INDUCIR A LA APLICACIÓN DE MULTAS Y OTRAS MEDIDAS.

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

RECICLAJE DE LOS DESECHOS DE JARDÍN

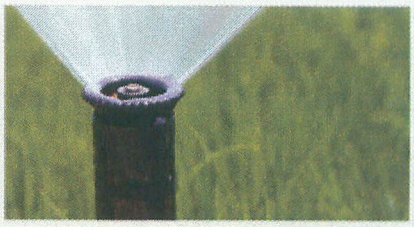
- Reciclar las hojas, recortes de césped y otros desechos de jardín.
- No soplar, barrer, o usar la manguera para empujar los desechos de jardín a la calle.
- **Poner a prueba el reciclaje de césped (grasscycling): la manera natural de reciclar el césped dejando los recortes sobre el césped cuando son 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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SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION

General industrial & manufacturing businesses:

If you own, manage or help operate a business, especially an industrial or manufacturing company, you can help reduce storm water pollution. From environmentally friendly cleaning and maintenance activities, to recycling hazardous waste materials, businesses can do a lot to prevent storm water pollution.

- Review your cleaning and maintenance activities to look for ways to reduce runoff into the storm drain system, especially in outdoor areas like parking lots, loading docks and maintenance yards. Keep trash enclosure swept and trash bin lids closed.
- Train employees to wash vehicles and equipment indoors in a wash rack that is connected to the sanitary sewer or off-site at a commercial wash facility. Train janitorial staff to dispose of floor cleaning water in the sewer and not into the parking lot. Make sure that cooling towers, boilers, compressors, water softeners and other process equipment are connected to the sanitary sewer and do not discharge wastewater into the parking lot.
- If you use hazardous materials in your everyday business, like ink and solvents for commercial printing, or polishes and chemicals for car detailing or manufacturing after-market accessories, do not put these hazardous materials in the trash or pour them into the gutter. Take them to be recycled safely. Store chemicals, wastes, raw materials and contaminated equipment indoors or in a covered, spill contained area, to prevent exposure of these materials to storm water. For information on proper hazardous waste disposal, call (909)386-8401.
- Take advantage of less-toxic alternatives to dangerous chemicals. From detergents to drain openers, there are a lot of ways to get the same or better result without having to rely toxic substances.
- Looking for raw materials? San Bernardino County Materials Exchange Program, or SBCoMax is a partnership between the County and the California Integrated Waste Management Board, for businesses to provide used but usable materials to those interested in obtaining them. The program helps divert used materials from landfills, saves resources and can save you money.

For more information about how you can prevent stormwater pollution:

www.sbcountystormwater.org

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

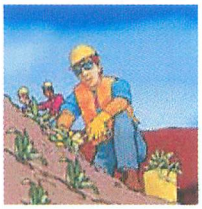
SAN BERNARDINO COUNTY
STORMWATER POLLUTION PREVENTION

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