



16011001/20174

March 8, 2021

**Isidro Abreo**  
**Development Services Department**  
**City of Chino**  
13220 Central Avenue  
Chino, CA 91710

**SUBJECT: Philadelphia & East End Industrial – TPM-20174 - PWQMP Approval**

Dear Isidro:

I have reviewed the Preliminary Water Quality Management Plan for the above-referenced project and have determined the document to be technically correct, in order and complete in terms of meeting the New Development requirements contained in the San Bernardino County MS4 Permit, the adopted SB County Water Quality Management Plan Guidance document and WQMP Template and City of Chino's Stormwater Quality Ordinance. The attached digital copy of the PWQMP document is now approved for use in project entitlement.

If we can be of further assistance, please contact me at 909/890-1255.

Respectfully yours,

**Stephen Wilson, QSD, CPESC**  
Senior Engineering Associate

Contact me at [swilson@erscinc.com](mailto:swilson@erscinc.com) or (909) 890-1255, for any questions.



# Preliminary

## Water Quality Management Plan

For:

### Philadelphia and East End Industrial

NWC Philadelphia St. and East End Ave, Chino, CA

APN: 1013-521-04

TPM - 20174

Prepared for:

Golden Management Services, Inc.

4900 Santa Anita Avenue, Suite 2C

El Monte, CA 91731

626-258-3374

Prepared by:

Huitt-Zollars, Inc.

Christopher Borunda

3990 Concours, Suite 330

Ontario, CA 91764

909-941-7799

Project: R310158.01

DATE 3/8/2021

**ERSC**

Engineering Resources of Southern California

*Stephen Wilson*

APPROVED AS SUBMITTED

Submittal Date: 01-16-20

Revision Date: 02-24-21

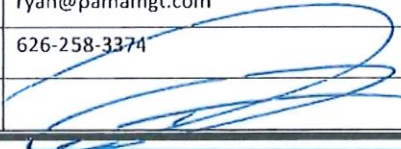
Approval Date: March 8, 2021



### Project Owner's Certification

This Water Quality Management Plan (WQMP) has been prepared for PAMA Management by Huitt-Zollars, Inc.. The WQMP is intended to comply with the requirements of the County of San Bernardino 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."

Project Data			
Permit/Application Number(s):	TBD	Grading Permit Number(s):	TBD
Tract/Parcel Map Number(s):	TPM - 20174	Building Permit Number(s):	TBD
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN: 1013-521-04
Owner's Signature			
Owner Name: Ryan Liu			
Title	Vice President / Controller		
Company	Golden Management Services, Inc.		
Address	34900 Santa Anita Avenue, Suite 2C, El Monte, CA 91731		
Email	ryan@pamamgt.com		
Telephone #	626-258-3374		
Signature:			Date

### Preparer's Certification

Project Data			
Permit/Application Number(s):	PL20-0005	Grading Permit Number(s):	TBD
Tract/Parcel Map Number(s):	TPM - 20174	Building Permit Number(s):	TBD
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN: 1013-521-04

"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."

<b>Engineer: David White</b>		PE Stamp Below  
Title	Vice President	
Company	Huitt-Zollars, Inc	
Address	3990 Concours, Suite 330. Ontario, CA 91764	
Email	dwhite@Huitt-Zollars.com	
Telephone #	909-941-7799	
Signature	<i>David White</i>	
Date	<i>2-24-21</i>	

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**Water Quality Management Plan (WQMP)**

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**Attachment A: WQMP Site Plan**

**Attachment B: BMP details & Calculations**

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**Attachment D: Infiltration Report**

**Attachment E: Rainfall Data (NOAA Atlas 14) & Factor of Safety Worksheet**

## 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.

<b>Form 2.1-1 Description of Proposed Project</b>					
<b><sup>1</sup> Development Category (Select all that apply):</b>					
<input type="checkbox"/> Significant re-development involving the addition or replacement of 5,000 ft <sup>2</sup> or more of impervious surface on an already developed site	<input checked="" type="checkbox"/> New development involving the creation of 10,000 ft <sup>2</sup> or more of impervious surface collectively over entire site	<input type="checkbox"/> Automotive repair shops with standard industrial classification (SIC) codes 5013, 5014, 5541, 7532- 7534, 7536-7539	<input type="checkbox"/> Restaurants (with SIC code 5812) where the land area of development is 5,000 ft <sup>2</sup> or more		
<input type="checkbox"/> Hillside developments of 5,000 ft <sup>2</sup> or more which are located on areas with known erosive soil conditions or where the natural slope is 25 percent or more	<input type="checkbox"/> Developments of 2,500 ft <sup>2</sup> 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.	<input checked="" type="checkbox"/> Parking lots of 5,000 ft <sup>2</sup> or more exposed to storm water	<input type="checkbox"/> Retail gasoline outlets that are either 5,000 ft <sup>2</sup> or more, or have a projected average daily traffic of 100 or more vehicles per day		
<input type="checkbox"/> Non-Priority / Non-Category Project <i>May require source control LID BMPs and other LIP requirements. Please consult with local jurisdiction on specific requirements.</i>					
<b><sup>2</sup> Project Area (ft<sup>2</sup>):</b>	156,290	<b><sup>3</sup> Number of Dwelling Units:</b>	N/A	<b><sup>4</sup> SIC Code:</b>	1541, 4214, & 4225
<b><sup>5</sup> Is Project going to be phased?</b> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> <i>If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.</i>					
<b><sup>6</sup> Does Project include roads?</b> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> <i>If yes, ensure that applicable requirements for transportation projects are addressed (see Appendix A of TGD for WQMP)</i>					

## Section 1 Discretionary Permit(s)

<b>Form 1-1 Project Information</b>					
Project Name		Philadelphia at East End Industrial			
Project Owner Contact Name:		Ryan Liu			
Mailing Address:	4900 Santa Anita Avenue, Suite 2C El Monte, CA 91731	E-mail Address:	ryan@goldenmgtinc.com	Telephone:	626-258-3374
Permit/Application Number(s):		PL20-0005	Tract/Parcel Map Number(s):		20174
Additional Information/ Comments:		N/A			
Description of Project:		The project is a new development of three (3) industrial warehouse facilities located at the northwest corner of Philadelphia Street and East End Avenue in the City of Chino, County of San Bernardino, CA. The proposed three buildings total approximately 60,000 square feet in size on approximately 3.6 acres of land. All on-site runoff will be collected by catch basins and conveyed to either of two underground infiltration systems located in the west truck yards.			
Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.		N/A			

## 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:

This property is being developed by PAMA Management. PAMA Management will be the entity responsible for long term maintenance of the WQMP Storm Water Facilities.

Name: Golden Management Services, Inc.

Address: 4900 Santa Anita, Suite 2C  
Santa Anita Avenue, CA 91731

Contact: Ryan Liu

Phone: 626-258-3374

## 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).

<b>Form 2.3-1 Pollutants of Concern</b>			
Pollutant	Please check: E=Expected, N=Not Expected		Additional Information and Comments
Pathogens (Bacterial / Virus)	E <input checked="" type="checkbox"/>	N <input type="checkbox"/>	Pathogens are typically caused by the transport of animal or human fecal wastes from the watershed, and are common in parking lot runoff.
Nutrients - Phosphorous	E <input checked="" type="checkbox"/>	N <input type="checkbox"/>	Primary sources of nutrients in urban runoff are fertilizers and eroded soils.
Nutrients - Nitrogen	E <input checked="" type="checkbox"/>	N <input type="checkbox"/>	Primary sources of nutrients in urban runoff are fertilizers and eroded soils.
Noxious Aquatic Plants	E <input type="checkbox"/>	N <input checked="" type="checkbox"/>	Not expected.
Sediment	E <input checked="" type="checkbox"/>	N <input type="checkbox"/>	Sediments are solid materials that are eroded from the land surface, roofs, and parking lot surfaces.
Metals	E <input checked="" type="checkbox"/>	N <input type="checkbox"/>	The primary source of metal pollution in stormwater is typically commercially available metals and metal products, as well as emissions from brake pad and tire tread wear associated with vehicles.
Oil and Grease	E <input checked="" type="checkbox"/>	N <input type="checkbox"/>	Primary sources of oil and grease are petroleum hydrocarbon products, motor products from leaking vehicles, esters, oils, fats, waxes, and high molecular-weight fatty acids.
Trash/Debris	E <input checked="" type="checkbox"/>	N <input type="checkbox"/>	Trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic matter (such as leaves, grass cuttings, and food waste) are general waste from human or animals
Pesticides / Herbicides	E <input checked="" type="checkbox"/>	N <input type="checkbox"/>	Pesticides and herbicides can be washed off urban landscapes during storm events.
Organic Compounds	E <input checked="" type="checkbox"/>	N <input type="checkbox"/>	Sources of organic compounds may include waste handling areas and vehicle parking or landscape maintenance areas.
Other:	E <input type="checkbox"/>	N <input type="checkbox"/>	
Other:	E <input type="checkbox"/>	N <input type="checkbox"/>	
Other:	E <input type="checkbox"/>	N <input type="checkbox"/>	
Other:	E <input type="checkbox"/>	N <input type="checkbox"/>	
Other:	E <input type="checkbox"/>	N <input type="checkbox"/>	



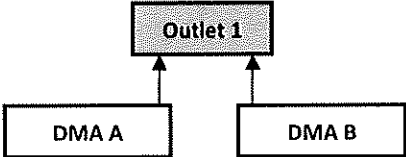
## 2.4 Water Quality Credits

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.

<b>Form 2.4-1 Water Quality Credits</b>			
<sup>1</sup> Project Types that Qualify for Water Quality Credits: <i>Select all that apply</i>			
<input type="checkbox"/> Redevelopment projects that reduce the overall impervious footprint of the project site. [Credit = % impervious reduced]	Higher density development projects <input type="checkbox"/> Vertical density [20%] <input type="checkbox"/> 7 units/ acre [5%]	<input type="checkbox"/> 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%]	<input type="checkbox"/> Brownfield redevelopment (redevelop real property complicated by presence or potential of hazardous contaminants) [25%]
<input type="checkbox"/> Redevelopment projects in established historic district, historic preservation area, or similar significant core city center areas [10%]	<input type="checkbox"/> Transit-oriented developments (mixed use residential or commercial area designed to maximize access to public transportation) [20%]	<input type="checkbox"/> 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%]	<input type="checkbox"/> Live-Work developments (variety of developments designed to support residential and vocational needs) [20%]
<sup>2</sup> Total Credit % 0 (Total all credit percentages up to a maximum allowable credit of 50 percent)			
Description of Water Quality Credit Eligibility (if applicable)	Not Applicable		

## 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.***

<b>Form 3-1 Site Location and Hydrologic Features</b>			
Site coordinates <i>take GPS measurement at approximate center of site</i>	Latitude 34° 2' 4.4" N	Longitude 117° 43' 31.5" W	Thomas Bros Map page 641
<sup>1</sup> San Bernardino County climatic region: <input checked="" type="checkbox"/> Valley <input type="checkbox"/> Mountain			
<sup>2</sup> Does the site have more than one drainage area (DA): Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> <i>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</i>			
 <pre>                     graph BT                         DMA_A[DMA A] --&gt; Outlet_1[Outlet 1]                         DMA_B[DMA B] --&gt; Outlet_1                     </pre>			
Conveyance	All water is retained within the DA.		
DA1 flows to Outlet 1	Runoff from area DA1 will be directed to one of two proposed hydrodynamic separators and underground infiltration systems located on the west side of the proposed site then discharged to the Philadelphia Avenue 33" storm drain, which connects to the San Antonio Creek Channel located to the west of the property.		

<b>Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1</b>				
For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA C	DMA D
<b>1</b> DMA drainage area (ft <sup>2</sup> )	106,828	65,480	N/A	N/A
<b>2</b> Existing site impervious area (ft <sup>2</sup> )	0	20,450	N/A	N/A
<b>3</b> Antecedent moisture condition <i>For desert areas, use <a href="http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf">http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf</a></i>	AMC I	AMC I	N/A	N/A
<b>4</b> Hydrologic soil group <i>Refer to Watershed Mapping Tool – <a href="http://permitrack.sbcounty.gov/wap/">http://permitrack.sbcounty.gov/wap/</a></i>	B	B	N/A	N/A
<b>5</b> Longest flowpath length (ft)	462	196	N/A	N/A
<b>6</b> Longest flowpath slope (ft/ft)	0.010	0.014	N/A	N/A
<b>7</b> Current land cover type(s) <i>Select from Fig C-3 of Hydrology Manual</i>	Barren	Barren/ Residential	N/A	N/A
<b>8</b> Pre-developed pervious area condition: <i>Based on the extent of wet season vegetated cover good &gt;75%; Fair 50-75%; Poor &lt;50% Attach photos of site to support rating</i>	Fair	Poor	N/A	N/A

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

### Form 3-3 Watershed Description for Drainage Area

<p>Receiving waters</p> <p>Refer to Watershed Mapping Tool - <a href="http://permitrack.sbcounty.gov/wap/">http://permitrack.sbcounty.gov/wap/</a></p> <p>See "Drainage Facilities" link at this website</p>	<p>San Antonio Creek, Chino Creek Reach 2, 1A and 1B, Santa Ana River Reach 3,</p>
<p>Applicable TMDLs</p> <p>Refer to Local Implementation Plan</p>	<p>Per: 2016 303(d) list:</p> <p>Chino Creek Reach 1A &amp; 1B: Indicator Bacteria.</p> <p>Chino Creek Reach 2: Indicator Bacteria.</p> <p>Santa Ana River Reach 3: Indicator Bacteria</p>
<p>303(d) listed impairments</p> <p>Refer to Local Implementation Plan and Watershed Mapping Tool - <a href="http://permitrack.sbcounty.gov/wap/">http://permitrack.sbcounty.gov/wap/</a> and State Water Resources Control Board website - <a href="http://www.waterboards.ca.gov/santaana/water_issues/proqrams/tmdl/index.shtml">http://www.waterboards.ca.gov/santaana/water_issues/proqrams/tmdl/index.shtml</a></p>	<p>Copper, Lead, Nutrients, COD, Indicator Bacteria &amp; pH</p>
<p>Environmentally Sensitive Areas (ESA)</p> <p>Refer to Watershed Mapping Tool - <a href="http://permitrack.sbcounty.gov/wap/">http://permitrack.sbcounty.gov/wap/</a></p>	<p>No</p>
<p>Unlined Downstream Water Bodies</p> <p>Refer to Watershed Mapping Tool - <a href="http://permitrack.sbcounty.gov/wap/">http://permitrack.sbcounty.gov/wap/</a></p>	<p>Chino Creek, Santa Ana River</p>
<p>Hydrologic Conditions of Concern</p>	<p><input checked="" type="checkbox"/> 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</p> <p><input type="checkbox"/> No</p>
<p>Watershed-based BMP included in a RWQCB approved WAP</p>	<p><input type="checkbox"/> Yes Attach verification of regional BMP evaluation criteria in WAP</p> <ul style="list-style-type: none"> <li>• More Effective than On-site LID</li> <li>• Remaining Capacity for Project DCV</li> <li>• Upstream of any Water of the US</li> <li>• Operational at Project Completion</li> <li>• Long-Term Maintenance Plan</li> </ul> <p><input checked="" type="checkbox"/> No</p>

## 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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Property owners shall review and become familiar with the site specific WQMP. Educational materials for day to day operations can be found in Attachment C. Additional materials can be obtained from a local water pollution prevention agency. Education of property owners begin with the review/preparation of the site specific WQMP and continues through the review of additional educational material as it applies to their project.
N2	Activity Restrictions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<p>Activity restriction shall be stated in the owners lease terms prior to occupancy;</p> <ul style="list-style-type: none"> <li>Fueling areas, air/water supply areas, maintenance bays, vehicle washing areas, outdoor material storage areas, outdoor work areas, outdoor processing areas, wash water from food preparation areas within the project site will not be allowed on the project site.</li> <li>Outside storage of hazardous materials will not be allowed on the project site.</li> <li>All pesticide applications shall be performed by a licensed contractor certified by the California Department of Pesticide Regulation.</li> <li>All dumpster lids shall be kept closed at all times.</li> <li>Blowing, Sweeping or hosing of debris (leaf, litter, grass clippings, trash or debris) into the streets, underground stormdrain facilities or other storm water conveyance areas shall be strictly prohibited</li> </ul> <p>A landscape architect will provide design plans for the on-site landscaping and irrigation system. The design shall incorporate the use of native and drought tolerant trees and shrubs throughout the project site, along with 1-2" recessed finish grading of all landscaping to reduce rainfall/irrigation runoff.</p>
N3	Landscape Management BMPs	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Property owners shall maintain the designated on-site BMP areas, see Section 5 for self inspection and maintenance form
N4	BMP Maintenance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	If materials regulated by Title 22 CCR (California Code of Regulations) are stored on site by future building occupants, these materials shall be stored and disposed of in compliance with all Title 22 regulations.
N5	Title 22 CCR Compliance (How development will comply)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

Water Quality Management Plan (WQMP)

**Form 4.1-1 Non-Structural Source Control BMPs**

N6	Local Water Quality Ordinances	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Local Water Quality Ordinances will be addressed by implementation of this WQMP
N7	Spill Contingency Plan	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Industrial Warehouse buildings and truck dock areas have potential for spills and therefore each tenant shall be required to prepare a spill contingency plan and it shall be implemented in accordance with section 6.95 of the California Health and Safety Code. The spill contingency plan shall identify responsible persons in the event of a spill, an action item list identifying how the spill should be contained, cleaned up and who should be contacted in the event of a spill. Documentation of any spill event and cleanup process shall be kept on site, in perpetuity.
N8	Underground Storage Tank Compliance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No underground storage tanks are proposed for this site.
N9	Hazardous Materials Disclosure Compliance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No hazardous materials are currently planned to be stored on this site at this time but in the future, if tenants store these materials inside buildings all required disclosure shall be provided in compliance with federal, state, and local CUPA requirements.



### Form 4.1-1-1 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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Underground fire protection service and fire sprinklers will be provided per the uniform fire code and the requirements of the County of San Bernardino Fire Department.
N11	Litter/Debris Control Program	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Trash enclosures will be designed with solid roofs and will have adjacent areas drain away from the trash enclosure areas. The trash storage areas shall be inspected and maintained on a weekly basis. Collection of trash from the trash storage areas shall occur on a regular basis to ensure that the trash receptacles are not overflowing. Documentation of such inspection/maintenance and trash collection shall be kept by the owner in perpetuity. See the WQMP site map in Attachment A for anticipated location of trash storage areas.
N12	Employee Training	<input checked="" type="checkbox"/>	<input type="checkbox"/>	The following shall be provided to the tenant by the owner; an Employee Training/Education program shall be provided annually to help educate employees about storm water quality management and practices that help prevent storm water pollution. Documentation of such training/education program implementation shall be kept by the owner for a minimum of ten years. Sample educational materials have been provided in Section 6.4, Attachment C. Additional educational materials can be obtained from the County of San Bernardino storm water program.
N13	Housekeeping of Loading Docks	<input checked="" type="checkbox"/>	<input type="checkbox"/>	The project site will have truck docks. The truck docks shall be inspected on a weekly/daily basis to help ensure that any trash and debris are collected prior to being washed into the underground storm drain system. All storm water runoff from the loading dock areas will be discharged into the gravity separators and underground infiltration pipes and/or underground infiltration chambers, prior to conveyance to the public storm drain system. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.
N14	Catch Basin Inspection Program	<input checked="" type="checkbox"/>	<input type="checkbox"/>	The on-site catch basins shall be inspected on a quarterly basis. Inspection of the on-site catch basins shall consist of visual inspection for evidence of illegal discharges or for any sediment, trash or debris collected in the bottom of each catch basin. Any sediment, trash or debris found shall be removed from the catch basins and disposed of

Water Quality Management Plan (WQMP)

					in a legal manner. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.
N15	Vacuum Sweeping of Private Streets and Parking Lots	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The on-site parking lots, drive aisles, and loading dock areas shall be vacuum swept on a monthly basis. Documentation of such sweeping shall be kept by the owner in perpetuity. Frequency of sweeping shall be adjusted as needed to maintain a clean site.
N16	Other Non-structural Measures for Public Agency Projects	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
N17	Comply with all other applicable NPDES permits	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	All requirements of the statewide General Construction Permit "SWRCB Orders No. 2009-009-DWQ as amended by Order 2010-0014-DWQ" shall be adhered to during the construction phase of this 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	
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	The on-site storm drain catch basins shall be stencilled with the phrase "No Dumping -Drains to River" or other approved language. The signage shall be inspected on an annual basis. Missing or faded signage shall be replaced. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No outdoor material storage areas are proposed for this site
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Trash storage areas will be designed to have adjacent areas drain away from the trash storage areas. The trash storage areas shall be inspected and maintained on a monthly basis. Collection of trash from the trash storage areas shall occur on a regular basis to ensure that the trash receptacles are not overflowing. Documentation of such inspection/maintenance and trash collection shall be kept by the owner in perpetuity. See the WQMIP site map in Attachment A for anticipated location of trash storage areas.
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)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	The landscape architect will follow CASQA SD-12 for design and provide design plans for the on-site irrigation system. The irrigation system shall be inspected on a monthly basis to ensure proper operation. Any broken sprinkler heads shall be repaired immediately to ensure that the system continues to operate efficiently. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	<input checked="" type="checkbox"/>	<input type="checkbox"/>	The landscape architect will provide design plans for the on-site landscaping and irrigation system. The design shall incorporate that finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement throughout the project site.
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No designed slope and channel are planned for this site.

**Water Quality Management Plan (WQMP)**

S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Docks are not covered but are equipped with 'Dock High' roll-up doors which allow for inside building transfer of materials.
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No maintenance bays are planned for this site.
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No vehicle wash areas are planned for this site.
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No outdoor processing areas are planned for this site.

**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)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No equipment wash areas are planned for this site.
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No fueling areas are planned for this site.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No hillside landscaping areas are planned for this site.
S14	Wash water control for food preparation areas	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No food preparation areas are planned for this site.
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No community car wash racks are planned for this site.

### 4.1.2 Preventative LID Site Design Practices

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

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

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

Form 4.1-3 Preventative LID Site Design Practices Checklist	
Site Design Practices <i>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</i>	
Minimize impervious areas: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	
Explanation: The developer has chosen to maximize the building and parking footprint. The underground infiltration system is sized accordingly	
Maximize natural infiltration capacity: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
Explanation: The entire site drains to the underground infiltration system thereby maximizing the natural infiltration capacity.	
Preserve existing drainage patterns and time of concentration: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	
Explanation: The proposed site runoff will drain to an on-site UG Infiltration System. All overflow will discharge to San Antonio Creek Channel. The UG. Infiltr. system will lengthen the time of concentration thus mimicking the existing conditions.	
Disconnect impervious areas: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	
Explanation: The site layout does not allow for roof drains to discharge to pervious areas.	
Protect existing vegetation and sensitive areas: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	
Explanation: The site has no sensitive vegetation to protect. The planting of new vegetation will be occur throughout the site.	
Re-vegetate disturbed areas: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
Explanation: All landscape areas will be vegetated. Building and pavement areas will not be re-vegetated.	
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
Explanation: The soils in the proposed infiltration system area will be uncompacted in-place native material.	
Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
Explanation: Due to the site layout and grades, vegetated drainage swales will be utilized in the east and south landscaped areas of the project site.	
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
Explanation: All landscaped areas will be staked by designation of curb throughout the project site, to minimize compaction or shall be decompacted, as necessary, to support healthy plant growth.	

## 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<sub>6</sub> 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<sup>2</sup>), 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.

<b>Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1 – DMA A)</b>		
<b>1</b> Project area DA 1 (ft <sup>2</sup> ): 94,524	<b>2</b> Imperviousness after applying preventative site design practices (Imp%): 0.79	<b>3</b> Runoff Coefficient (Rc): 0.59 $R_c = 0.858(\text{Imp}\%)^3 - 0.78(\text{Imp}\%)^2 + 0.774(\text{Imp}\%) + 0.04$
<b>4</b> Determine 1-hour rainfall depth for a 2-year return period P <sub>2yr-1hr</sub> (in): 0.598 <a href="http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html">http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html</a>		
<b>5</b> Compute P <sub>6</sub> , Mean 6-hr Precipitation (inches): 0.89 <i>P<sub>6</sub> = Item 4 * C<sub>1</sub>, where C<sub>1</sub> is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)</i>		
<b>6</b> Drawdown Rate <i>Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.</i>		24-hrs <input type="checkbox"/> 48-hrs <input checked="" type="checkbox"/>
<b>7</b> Compute design capture volume, DCV (ft <sup>3</sup> ): 8,096 $DCV = 1/12 * [\text{Item 1} * \text{Item 3} * \text{Item 5} * C_2]$ , where C <sub>2</sub> is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963) <i>Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2</i>		



Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1 – DMA B)		
<b>1</b> Project area DA 1 (ft <sup>2</sup> ): 61,766	<b>2</b> Imperviousness after applying preventative site design practices (Imp%): 0.87	<b>3</b> Runoff Coefficient (Rc): 0.69 $R_c = 0.858(\text{Imp}\%)^{0.3} - 0.78(\text{Imp}\%)^{0.2} + 0.774(\text{Imp}\%) + 0.04$
<b>4</b> Determine 1-hour rainfall depth for a 2-year return period $P_{2\text{yr-1hr}}$ (in): 0.598 <a href="http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html">http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html</a>		
<b>5</b> Compute $P_6$ , Mean 6-hr Precipitation (inches): 0.89 $P_6 = \text{Item 4} * C_1$ , 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)		
<b>6</b> 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 <input type="checkbox"/> 48-hrs <input checked="" type="checkbox"/>
<b>7</b> Compute design capture volume, DCV (ft <sup>3</sup> ): 6,177 $DCV = 1/12 * [\text{Item 1} * \text{Item 3} * \text{Item 5} * C_2]$ , 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://permitrack.sbcounty.gov/wap/>

If "Yes", then complete HCOC assessment of site hydrology for 2yr storm event using Forms 4.2-3 through 4.2-5 and insert results below  
(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual)

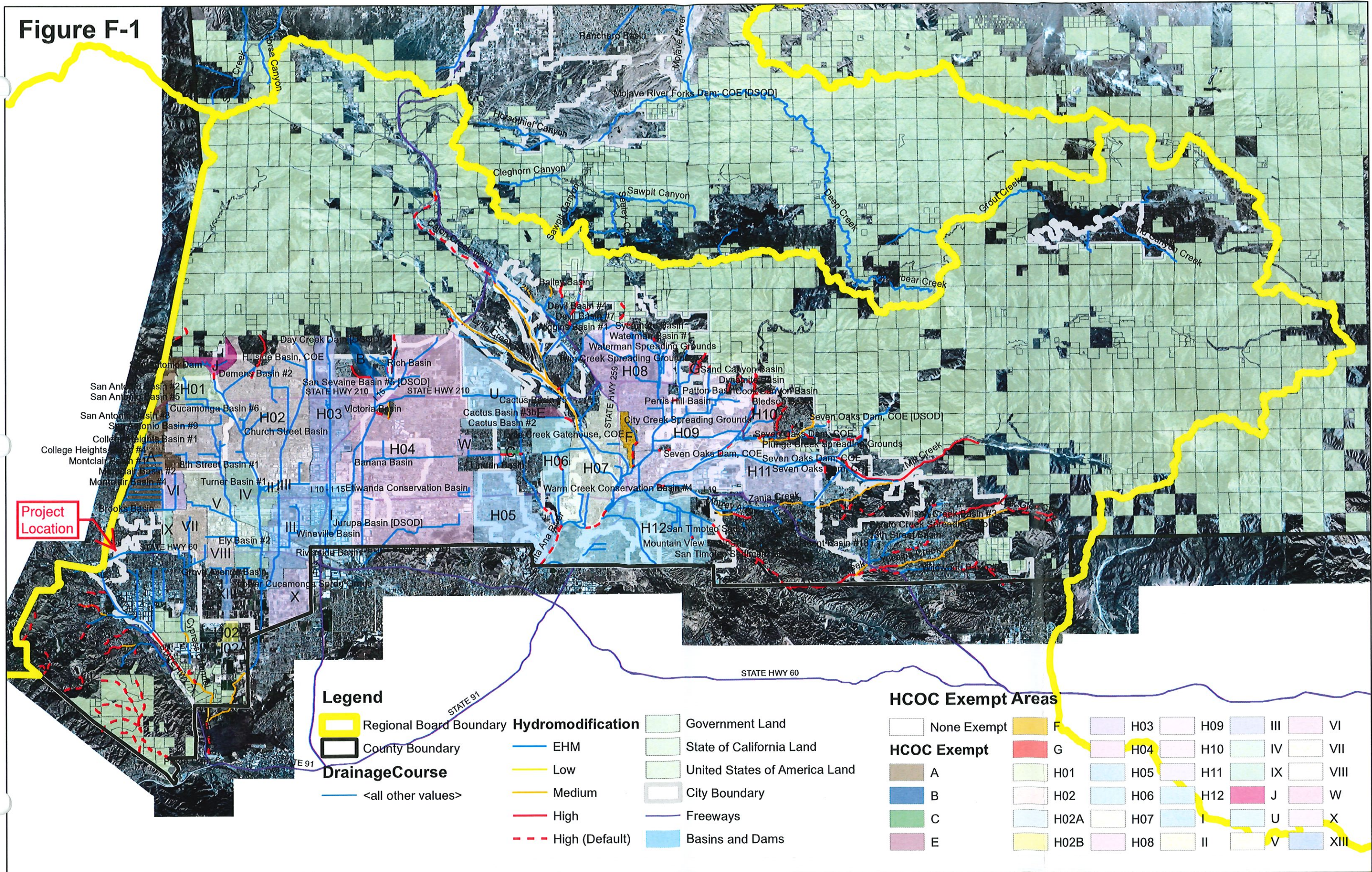
If "No," then proceed to Section 4.3 Project Conformance Analysis

Condition	Runoff Volume (ft <sup>3</sup> )	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	<sup>1</sup> 10,909 <i>Form 4.2-3 Item 12</i>	<sup>2</sup> 10.5 <i>Form 4.2-4 Item 13</i>	<sup>3</sup> 2.73 <i>Form 4.2-5 Item 10</i>
Post-developed	<sup>4</sup> 14,351 <i>Form 4.2-3 Item 13</i>	<sup>5</sup> 6.5 <i>Form 4.2-4 Item 14</i>	<sup>6</sup> 6.61 <i>Form 4.2-5 Item 14</i>
Difference	<sup>7</sup> 3,442 <i>Item 4 – Item 1</i>	<sup>8</sup> 4 <i>Item 2 – Item 5</i>	<sup>9</sup> 3.88 <i>Item 6 – Item 3</i>
Difference (as % of pre-developed)	<sup>10</sup> 31.6 % <i>Item 7 / Item 1</i>	<sup>11</sup> 38.1 % <i>Item 8 / Item 2</i>	<sup>12</sup> 142.1% <i>Item 9 / Item 3</i>

**Note: \* HCOC will be mitigated by infiltrating the Design Capture Volume and therefore not negatively impact downstream channels. Values will be less than 5% after detention, routing and infiltration by on-site underground infiltration system.**



**Figure F-1**



**Project Location**

**Legend**

- Regional Board Boundary
- County Boundary

**Drainage Course**

- <all other values>

**Hydromodification**

- EHM
- Low
- Medium
- High
- High (Default)

- Government Land
- State of California Land
- United States of America Land
- City Boundary
- Freeways
- Basins and Dams

**HCOC Exempt Areas**

- |  |   |  |  |  |   |
|--|---|--|--|--|---|
| <span style="background-color: #fff2cc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> None Exempt | <span style="background-color: #f4cccc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> F    | <span style="background-color: #e6f2ff; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H03 | <span style="background-color: #fce4d6; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H09 | <span style="background-color: #d9ead3; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> III | <span style="background-color: #f4cccc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> VI   |
| <span style="background-color: #f4cccc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> HCOC Exempt | <span style="background-color: #f4cccc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> G    | <span style="background-color: #fce4d6; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H04 | <span style="background-color: #fce4d6; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H10 | <span style="background-color: #d9ead3; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> IV  | <span style="background-color: #f4cccc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> VII  |
| <span style="background-color: #fff2cc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> A           | <span style="background-color: #fff2cc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H01  | <span style="background-color: #fce4d6; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H05 | <span style="background-color: #fce4d6; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H11 | <span style="background-color: #d9ead3; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> IX  | <span style="background-color: #f4cccc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> VIII |
| <span style="background-color: #fff2cc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> B           | <span style="background-color: #fff2cc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H02  | <span style="background-color: #fce4d6; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H06 | <span style="background-color: #fce4d6; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H12 | <span style="background-color: #d9ead3; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> J   | <span style="background-color: #f4cccc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> W    |
| <span style="background-color: #fff2cc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> C           | <span style="background-color: #fff2cc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H02A | <span style="background-color: #fce4d6; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H07 | <span style="background-color: #fce4d6; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> I   | <span style="background-color: #d9ead3; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> U   | <span style="background-color: #f4cccc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> X    |
| <span style="background-color: #fff2cc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> E           | <span style="background-color: #fff2cc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H02B | <span style="background-color: #fce4d6; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> H08 | <span style="background-color: #fff2cc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> II  | <span style="background-color: #d9ead3; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> V   | <span style="background-color: #f4cccc; border: 1px solid black; display: inline-block; width: 15px; height: 10px; margin-right: 5px;"></span> XIII |



## Hydromodification

### A.1 Hydrologic Conditions of Concern (HCOC) Analysis

#### HCOC Exemption:

1. **Sump Condition:** All downstream conveyance channel to an adequate sump (for example, Prado Dam, Santa Ana River, or other Lake, Reservoir or naturally erosion resistant feature) that will receive runoff from the project are engineered and regularly maintained to ensure design flow capacity; no sensitive stream habitat areas will be adversely affected; or are not identified on the Co-Permittees Hydromodification Sensitivity Maps.
2. **Pre = Post:** The runoff flow rate, volume and velocity for the post-development condition of the Priority Development Project do not exceed the pre-development (i.e, naturally occurring condition for the 2-year, 24-hour rainfall event utilizing latest San Bernardino County Hydrology Manual.
  - a. Submit a substantiated hydrologic analysis to justify your request.
3. **Diversion to Storage Area:** The drainage areas that divert to water storage areas which are considered as control/release point and utilized for water conservation.
  - a. See Appendix F for the HCOC Exemption Map and the on-line Watershed Geodatabase (<http://sbcounty.permitrack.com/wap>) for reference.
4. **Less than One Acre:** The Priority Development Project disturbs less than one acre. The Co-permittee has the discretion to require a Project Specific WQMP to address HCOCs on projects less than one acre on a case by case basis. The project disturbs less than one acre and is not part of a common plan of development.
5. **Built Out Area:** The contributing watershed area to which the project discharges has a developed area percentage greater than 90 percent.
  - a. See Appendix F for the HCOC Exemption Map and the on-line Watershed Geodatabase (<http://sbcounty.permitrack.com/wap>) for reference.

Summary of HCOC Exempted Area

Area	HCOC Exemption reasoning				
	1	2	3	4	5
A			X		X
B			X		
C					X
E			X		
F					X
G			X		X
H01	X		X		
H02	X		X		
H02A	X		X		
H02B			X		
H03			X		
H04	X		X		
H05	X				
H06			X		
H07	X				
H08	X		X		
H09	X				
H10	X		X		
H11	X		X		
H12	X				
J			X		
U			X		
W			X		
I			X		
II			X		
III					X
IV			X		X
V			X*		
VI					X
VII					X
VIII			X		
IX					X
X			X		
XIII			X		

\*Detention/Conservation Basin

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

Weighted Curve Number Determination for: <u>Pre-developed DA</u>	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H
1a Land Cover type	A GRASS-FAIR COVER	A GRASS-POOR COVER	N/A	N/A	N/A	N/A	N/A	N/A
2a Hydrologic Soil Group (HSG)	B	B	N/A	N/A	N/A	N/A	N/A	N/A
3a DMA Area, ft <sup>2</sup> sum of areas of DMA should equal area of DA	106,828	65,480	N/A	N/A	N/A	N/A	N/A	N/A
4a Curve Number (CN) use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP	69	78	N/A	N/A	N/A	N/A	N/A	N/A
Weighted Curve Number Determination for: <u>Post-developed DA</u>	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H
1b Land Cover type	COMM	COMM	N/A	N/A	N/A	N/A	N/A	N/A
2b Hydrologic Soil Group (HSG)	B	B	N/A	N/A	N/A	N/A	N/A	N/A
3b DMA Area, ft <sup>2</sup> sum of areas of DMA should equal area of DA	94,495	61,766	N/A	N/A	N/A	N/A	N/A	N/A
4b Curve Number (CN) use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP	80	80	N/A	N/A	N/A	N/A	N/A	N/A
5 Pre-Developed area-weighted CN: 73.5	7 Pre-developed soil storage capacity, S (in): 3.61 $S = (1000 / \text{Item 5}) - 10$				9 Initial abstraction, I <sub>a</sub> (in): 0.721 $I_a = 0.2 * \text{Item 7}$			
6 Post-Developed area-weighted CN: 80	8 Post-developed soil storage capacity, S (in): 2.50 $S = (1000 / \text{Item 6}) - 10$				10 Initial abstraction, I <sub>a</sub> (in): 0.500 $I_a = 0.2 * \text{Item 8}$			
11 Precipitation for 2 yr, 24 hr storm (in): 2.80 Go to: <a href="http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html">http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html</a>								
12 Pre-developed Volume (ft <sup>3</sup> ): 10,909 $V_{pre} = (1 / 12) * (\text{Item sum of Item 3}) * [(\text{Item 11} - \text{Item 9})^2 / ((\text{Item 11} - \text{Item 9} + \text{Item 7}))]$								
13 Post-developed Volume (ft <sup>3</sup> ): 14,351 $V_{pre} = (1 / 12) * (\text{Item sum of Item 3}) * [(\text{Item 11} - \text{Item 10})^2 / ((\text{Item 11} - \text{Item 10} + \text{Item 8}))]$								
14 Volume Reduction needed to meet HCOC Requirement, (ft <sup>3</sup> ): 2,724 $V_{HCOC} = (\text{Item 13} * 0.95) - \text{Item 12}$								

### 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 <i>Use additional forms if there are more than 4 DMA</i>				Post-developed DA1 <i>Use additional forms if there are more than 4 DMA</i>			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
<b>1</b> Length of flowpath (ft) <i>Use Form 3-2 Item 5 for pre-developed condition</i>	462	196	N/A	N/A	205	258	N/A	N/A
<b>2</b> Change in elevation (ft)	4.69	2.70	N/A	N/A	1.89	4.31	N/A	N/A
<b>3</b> Slope (ft/ft), $S_o = \text{Item 2} / \text{Item 1}$	0.010	0.014	N/A	N/A	0.010	0.017	N/A	N/A
<b>4</b> Land cover	Grass Fair Cover	Grass Poor Cover	N/A	N/A	COMM	COMM	N/A	N/A
<b>5</b> Initial DMA Time of Concentration (min) <i>Appendix C-1 of the TGD for WQMP</i>	21	10.5	N/A	N/A	6.5	6.5	N/A	N/A
<b>6</b> Length of conveyance from DMA outlet to project site outlet (ft) <i>May be zero if DMA outlet is at project site outlet</i>	0	0	N/A	N/A	0	0	N/A	N/A
<b>7</b> Cross-sectional area of channel (ft <sup>2</sup> )	0	0	N/A	N/A	0	0	N/A	N/A
<b>8</b> Wetted perimeter of channel (ft)	0	0	N/A	N/A	0	0	N/A	N/A
<b>9</b> Manning's roughness of channel (n)	0	0	N/A	N/A	0	0	N/A	N/A
<b>10</b> Channel flow velocity (ft/sec) $V_{fs} = (1.49 / \text{Item 9}) * (\text{Item 7} / \text{Item 8})^{0.67} * (\text{Item 3})^{0.5}$	0	0	N/A	N/A	0	0	N/A	N/A
<b>11</b> Travel time to outlet (min) $T_t = \text{Item 6} / (\text{Item 10} * 60)$	0	0	N/A	N/A	0	0	N/A	N/A
<b>12</b> Total time of concentration (min) $T_c = \text{Item 5} + \text{Item 11}$	21	10.5	N/A	N/A	6.5	6.5	N/A	N/A
<b>13</b> Pre-developed time of concentration (min): 10.5 <i>Minimum of Item 12 pre-developed DMA</i>								
<b>14</b> Post-developed time of concentration (min): 6.5 <i>Minimum of Item 12 post-developed DMA</i>								
<b>15</b> Additional time of concentration needed to meet HCOC requirement (min): 3.5 $T_{c-HCOC} = (\text{Item 13} * 0.95) - \text{Item 14}$								

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

Compute peak runoff for pre- and post-developed conditions							
Variables	Pre-developed DA to Project Outlet (Use additional forms if more than 3 DMA)			Post-developed DA to Project Outlet (Use additional forms if more than 3 DMA)			
	DMA A	DMA B	DMA C	DMA A	DMA B	DMA C	
<b>1</b> Rainfall Intensity for storm duration equal to time of concentration <i><math>I_{peak} = 10^{(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 / 60)}</math></i>	1.12	1.70	N/A	2.27	2.27	N/A	
<b>2</b> Drainage Area of each DMA (Acres) <i>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)</i>	2.45	1.50	N/A	2.17	1.42	N/A	
<b>3</b> Ratio of pervious area to total area <i>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)</i>	1.0	0.69	N/A	0.20	0.20	N/A	
<b>4</b> Pervious area infiltration rate (in/hr) <i>Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP</i>	0.74	0.66	N/A	1.1	1.1	N/A	
<b>5</b> Maximum loss rate (in/hr) <i><math>F_m = Item 3 * Item 4</math>                      Use area-weighted <math>F_m</math> 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)</i>	0.74	0.46	N/A	0.22	0.22	N/A	
<b>6</b> Peak Flow from DMA (cfs) <i><math>Q_p = Item 2 * 0.9 * (Item 1 - Item 5)</math></i>	0.84	1.67	N/A	4.00	2.61	N/A	
<b>7</b> Time of concentration adjustment factor for other DMA to site discharge point <i>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)</i>	DMA A	1	N/A	<i>n/a</i>	1	N/A	N/A
	DMA B	<i>n/a</i>	1	N/A	<i>n/a</i>	1	N/A
	DMA C	N/A	<i>n/a</i>	N/A	N/A	<i>n/a</i>	<i>n/a</i>
<b>8</b> Pre-developed $Q_p$ at $T_c$ for DMA A: 1.28 <i><math>Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB}) / (Item 1_{DMAB} - Item 5_{DMAA}) * Item 7_{DMAA/2}] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC}) / (Item 1_{DMAC} - Item 5_{DMAC}) * Item 7_{DMAA/3}]</math></i>	<b>9</b> Pre-developed $Q_p$ at $T_c$ for DMA B: 2.73 <i><math>Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA}) / (Item 1_{DMAA} - Item 5_{DMAB}) * Item 7_{DMAB/1}] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC}) / (Item 1_{DMAC} - Item 5_{DMAC}) * Item 7_{DMAB/3}]</math></i>		<b>10</b> Pre-developed $Q_p$ at $T_c$ for DMA C: N/A <i><math>Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA}) / (Item 1_{DMAA} - Item 5_{DMAC}) * Item 7_{DMAC/1}] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB}) / (Item 1_{DMAB} - Item 5_{DMAB}) * Item 7_{DMAC/2}]</math></i>				
<b>10</b> Peak runoff from pre-developed condition confluence analysis (cfs): 2.73 Maximum of Item 8, 9, and 10 (including additional forms as needed)							
<b>11</b> Post-developed $Q_p$ at $T_c$ for DMA A: 6.61 <i>Same as Item 8 for post-developed values</i>	<b>12</b> Post-developed $Q_p$ at $T_c$ for DMA B: 6.61 <i>Same as Item 9 for post-developed values</i>		<b>13</b> Post-developed $Q_p$ at $T_c$ for DMA C: N/A <i>Same as Item 10 for post-developed values</i>				
<b>14</b> Peak runoff from post-developed condition confluence analysis (cfs): 6.61 Maximum of Item 11, 12, and 13 (including additional forms as needed)							
<b>15</b> Peak runoff reduction needed to meet HCOC Requirement (cfs): 3.88 <i><math>Q_{p,HCOC} = (Item 14 * 0.95) - Item 10</math></i>							



## 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

<sup>1</sup> 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)

<sup>2</sup> 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)

<sup>3</sup> Would infiltration of runoff on a Project site violate downstream water rights? Yes  No

If Yes, Provide basis: (attach)

<sup>4</sup> 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)

<sup>5</sup> 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)

<sup>6</sup> 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)

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

<sup>8</sup> 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.*

<sup>9</sup> 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.

<b>Form 4.3-2 Site Design Hydrologic Source Control BMPs (DA 1)</b>			
<b>1</b> 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 <input type="checkbox"/> No <input checked="" type="checkbox"/> If yes, complete Items 2-5; If no, proceed to Item 6	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>
<b>2</b> Total impervious area draining to pervious area (ft <sup>2</sup> )			
<b>3</b> Ratio of pervious area receiving runoff to impervious area			
<b>4</b> Retention volume achieved from impervious area dispersion (ft <sup>3</sup> ) $V = \text{Item 2} * \text{Item 3} * (0.5/12)$ , assuming retention of 0.5 inches of runoff			
<b>5</b> Sum of retention volume achieved from impervious area dispersion (ft <sup>3</sup> ):		<i>V<sub>retention</sub> = Sum of Item 4 for all BMPs</i>	
<b>6</b> Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>
<b>7</b> Ponding surface area (ft <sup>2</sup> )			
<b>8</b> Ponding depth (ft)			
<b>9</b> Surface area of amended soil/gravel (ft <sup>2</sup> )			
<b>10</b> Average depth of amended soil/gravel (ft)			
<b>11</b> Average porosity of amended soil/gravel			
<b>12</b> Retention volume achieved from on-lot infiltration (ft <sup>3</sup> ) <i>V<sub>retention</sub> = (Item 7 * Item 8) + (Item 9 * Item 10 * Item 11)</i>			
<b>13</b> Runoff volume retention from on-lot infiltration (ft <sup>3</sup> ): 0		<i>V<sub>retention</sub> = Sum of Item 12 for all BMPs</i>	

<b>Form 4.3-2 cont. Site Design Hydrologic Source Control BMPs (DA 1)</b>			
<b>14</b> Implementation of evapotranspiration BMP (green, brown, or blue roofs): Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> <i>If yes, complete Items 15-20. If no, proceed to Item 21</i>	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>
<b>15</b> Rooftop area planned for ET BMP (ft <sup>2</sup> )			
<b>16</b> Average wet season ET demand (in/day) <i>Use local values, typical ~ 0.1</i>			
<b>17</b> Daily ET demand (ft <sup>3</sup> /day) <i>Item 15 * (Item 16 / 12)</i>			
<b>18</b> Drawdown time (hrs) <i>Copy Item 6 in Form 4.2-1</i>			
<b>19</b> Retention Volume (ft <sup>3</sup> ) <i>V<sub>retention</sub> = Item 17 * (Item 18 / 24)</i>			
<b>20</b> Runoff volume retention from evapotranspiration BMPs (ft <sup>3</sup> ): <span style="float: right;"><i>V<sub>retention</sub> = Sum of Item 19 for all BMPs</i></span>			
<b>21</b> Implementation of Street Trees: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> <i>If yes, complete Items 22-25. If no, proceed to Item 26</i>	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>
<b>22</b> Number of Street Trees			
<b>23</b> Average canopy cover over impervious area (ft <sup>2</sup> )			
<b>24</b> Runoff volume retention from street trees (ft <sup>3</sup> ) <i>V<sub>retention</sub> = Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches</i>			
<b>25</b> Runoff volume retention from street tree BMPs (ft <sup>3</sup> ): <span style="float: right;"><i>V<sub>retention</sub> = Sum of Item 24 for all BMPs</i></span>			
<b>26</b> Implementation of residential rain barrel/cisterns: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> <i>If yes, complete Items 27-29; If no, proceed to Item 30</i>	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>
<b>27</b> Number of rain barrels/cisterns			
<b>28</b> Runoff volume retention from rain barrels/cisterns (ft <sup>3</sup> ) <i>V<sub>retention</sub> = Item 27 * 3</i>			
<b>29</b> Runoff volume retention from residential rain barrels/Cisterns (ft <sup>3</sup> ): 0 <span style="float: right;"><i>V<sub>retention</sub> = Sum of Item 28 for all BMPs</i></span>			
<b>30</b> Total Retention Volume from Site Design Hydrologic Source Control BMPs: 0 <span style="float: right;"><i>Sum of Items 5, 13, 20, 25 and 29</i></span>			

### **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)**

<b>1</b> Remaining LID DCV not met by site design HSC BMP (ft <sup>3</sup> ): 14,273 $V_{unmet} = \text{Form 4.2-1 Item 7} - \text{Form 4.3-2 Item 30}$			
BMP Type <i>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</i>	DA 1 - DMA A BMP Type Infiltration System	DA 1 - DMA B BMP Type Infiltration System	DA - DMA - BMP Type -
<b>2</b> Infiltration rate of underlying soils (in/hr) <i>See Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods</i>	3.0	3.6	N/A
<b>3</b> Infiltration safety factor <i>See TGD Section 5.4.2 and Appendix D</i>	3	3	N/A
<b>4</b> Design percolation rate (in/hr) $P_{design} = \text{Item 2} / \text{Item 3}$	1.0	1.2	N/A
<b>5</b> Pondered water drawdown time (hr) <i>Copy Item 6 in Form 4.2-1</i>	48	48	N/A
<b>6</b> Maximum ponding depth (ft) <i>BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details</i>	4.0	4.0	N/A
<b>7</b> Ponding Depth (ft) $d_{BMP} = \text{Minimum of } (1/12 * \text{Item 4} * \text{Item 5}) \text{ or Item 6}$	4.0	4.0	N/A
<b>8</b> Infiltrating surface area, $SA_{BMP}$ (ft <sup>2</sup> ) <i>the lesser of the area needed for infiltration of full DCV or minimum space requirements from Table 5.7 of the TGD for WQMP</i>	23' x 115' See Attachment B	23' x 87' See Attachment B	N/A
<b>9</b> Amended soil depth, $d_{media}$ (ft) <i>Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details</i>	0	0	N/A
<b>10</b> Amended soil porosity	0	0	N/A
<b>11</b> Gravel depth, $d_{media}$ (ft) <i>Only included in certain BMP types, see Table 5-4 of the TGD for WQMP for BMP design details</i>	0	0	N/A
<b>12</b> Gravel porosity	0	0	N/A
<b>13</b> Duration of storm as basin is filling (hrs) <i>Typical ~ 3hrs</i>	0	0	N/A
<b>14</b> Above Ground Retention Volume (ft <sup>3</sup> ) $V_{retention} = \text{Item 8} * [\text{Item 7} + (\text{Item 9} * \text{Item 10}) + (\text{Item 11} * \text{Item 12}) + (\text{Item 13} * (\text{Item 4} / 12))]$	0	0	N/A
<b>15</b> Underground Retention Volume (ft <sup>3</sup> ) <i>Volume determined using manufacturer's specifications and calculations</i>	8,200	6,203	N/A
<b>16</b> Total Retention Volume from LID Infiltration BMPs: 14,403 <i>(Sum of Items 14 and 15 for all infiltration BMP included in plan)</i>			
<b>17</b> Fraction of DCV achieved with infiltration BMP: 101% $\text{Retention\%} = \text{Item 16} / \text{Form 4.2-1 Item 7}$			
<b>18</b> Is full LID DCV retained onsite with combination of hydrologic source control and LID retention/infiltration BMPs? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> <i>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.</i>			

### 4.3.3 Harvest and Use BMP (N/A)

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).

<b>Form 4.3-4 Harvest and Use BMPs (DA 1) (N/A)</b>			
<b>1</b> Remaining LID DCV not met by site design HSC or infiltration BMP (ft <sup>3</sup> ): 0 <i>V<sub>unmet</sub> = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 - Form 4.3-3 Item 16</i>			
BMP Type(s) <i>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</i>	DA BMP Type	DMA BMP Type	DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>
<b>2</b> Describe cistern or runoff detention facility			
<b>3</b> Storage volume for proposed detention type (ft <sup>3</sup> ) <i>Volume of cistern</i>			
<b>4</b> Landscaped area planned for use of harvested stormwater (ft <sup>2</sup> )			
<b>5</b> Average wet season daily irrigation demand (in/day) <i>Use local values, typical ~ 0.1 in/day</i>			
<b>6</b> Daily water demand (ft <sup>3</sup> /day) <i>Item 4 * (Item 5 / 12)</i>			
<b>7</b> Drawdown time (hrs) <i>Copy Item 6 from Form 4.2-1</i>			
<b>8</b> Retention Volume (ft <sup>3</sup> ) <i>V<sub>retention</sub> = Minimum of (Item 3) or (Item 6 * (Item 7 / 24))</i>			
<b>9</b> Total Retention Volume (ft <sup>3</sup> ) from Harvest and Use BMP <span style="float: right;"><i>Sum of Item 8 for all harvest and use BMP included in plan</i></span>			
<b>10</b> Is the full DCV retained with a combination of LID HSC, retention and infiltration, and harvest & use BMPs? Yes <input type="checkbox"/> No <input type="checkbox"/> <i>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.</i>			

### 4.3.4 Biotreatment BMP (N/A)

Biotreatment BMPs may be considered if the full LID DCV cannot be met by maximizing retention and infiltration, 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)

<b>Form 4.3-5 Selection and Evaluation of Biotreatment BMP (DA 1) (N/A)</b>		
<sup>1</sup> Remaining LID DCV not met by site design HSC, infiltration, or harvest and use BMP for potential biotreatment (ft <sup>3</sup> ): <i>Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9</i>		List pollutants of concern <i>Copy from Form 2.3-1.</i>
<sup>2</sup> Biotreatment BMP Selected <i>(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)</i>	Volume-based biotreatment <i>Use Forms 4.3-6 and 4.3-7 to compute treated volume</i>	Flow-based biotreatment <i>Use Form 4.3-8 to compute treated volume</i>
	<input type="checkbox"/> Bioretention with underdrain <input type="checkbox"/> Planter box with underdrain <input type="checkbox"/> Constructed wetlands <input type="checkbox"/> Wet extended detention <input type="checkbox"/> Dry extended detention	<input type="checkbox"/> Vegetated swale <input type="checkbox"/> Vegetated filter strip <input type="checkbox"/> Proprietary biotreatment
<sup>3</sup> Volume biotreated in volume based biotreatment BMP (ft <sup>3</sup> ): <i>Form 4.3-6 Item 15 + Form 4.3-7 Item 13</i>	<sup>4</sup> Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft <sup>3</sup> ): <i>Item 1 – Item 3</i>	<sup>5</sup> Remaining fraction of LID DCV for sizing flow based biotreatment BMP: % <i>Item 4 / Item 1</i>
<sup>6</sup> Flow-based biotreatment BMP capacity provided (cfs): <i>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)</i>		
<sup>7</sup> Metrics for MEP determination: <ul style="list-style-type: none"> <li>• 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: <input type="checkbox"/> <i>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.</i></li> </ul>		

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

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

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

Biotreatment BMP Type <i>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.</i>	DA    DMA BMP Type		DA    DMA BMP Type <i>(Use additional forms for more BMPs)</i>	
	Forebay	Basin	Forebay	Basin
<b>1</b> Pollutants addressed with BMP forebay and basin <i>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</i>				
<b>2</b> Bottom width (ft)				
<b>3</b> Bottom length (ft)				
<b>4</b> Bottom area (ft <sup>2</sup> ) $A_{bottom} = \text{Item 2} * \text{Item 3}$				
<b>5</b> Side slope (ft/ft)				
<b>6</b> Depth of storage (ft)				
<b>7</b> Water surface area (ft <sup>2</sup> ) $A_{surface} = (\text{Item 2} + \{2 * \text{Item 5} * \text{Item 6}\}) * (\text{Item 3} + \{2 * \text{Item 5} * \text{Item 6}\})$				
<b>8</b> Storage volume (ft <sup>3</sup> ) <i>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</i> $V = \text{Item 6} / 3 * \{\text{Item 4} + \text{Item 7} + (\text{Item 4} * \text{Item 7})^{0.5}\}$				
<b>9</b> Drawdown Time (hrs) <i>Copy Item 6 from Form 2.1</i>				
<b>10</b> Outflow rate (cfs) $Q_{BMP} = (\text{Item 8}_{forebay} + \text{Item 8}_{basin}) / (\text{Item 9} * 3600)$				
<b>11</b> Duration of design storm event (hrs)				
<b>12</b> Biotreated Volume (ft <sup>3</sup> ) $V_{biotreated} = (\text{Item 8}_{forebay} + \text{Item 8}_{basin}) + (\text{Item 10} * \text{Item 11} * 3600)$				
<b>13</b> Total biotreated volume from constructed wetlands, extended dry detention, or extended wet detention : <i>(Sum of Item 12 for all BMP included in plan)</i>				



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

### 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.

<b>Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DA 1)</b>	
<b>1</b>	Total LID DCV for the Project DA-1 (ft <sup>3</sup> ): 14,403 <i>Copy Item 7 in Form 4.2-1</i>
<b>2</b>	On-site retention with site design hydrologic source control LID BMP (ft <sup>3</sup> ): 0 <i>Copy Item 30 in Form 4.3-2</i>
<b>3</b>	On-site retention with LID infiltration BMP (ft <sup>3</sup> ): 14,403 <i>Copy Item 16 in Form 4.3-3</i>
<b>4</b>	On-site retention with LID harvest and use BMP (ft <sup>3</sup> ): 0 <i>Copy Item 9 in Form 4.3-4</i>
<b>5</b>	On-site biotreatment with volume based biotreatment BMP (ft <sup>3</sup> ): 0 <i>Copy Item 3 in Form 4.3-5</i>
<b>6</b>	Flow capacity provided by flow based biotreatment BMP (cfs): 0 <i>Copy Item 6 in Form 4.3-5</i>
<b>7</b>	<p>LID BMP performance criteria are achieved if answer to any of the following is "Yes":</p> <ul style="list-style-type: none"> <li>• Full retention of LID DCV with site design HSC, infiltration, or harvest and use BMP: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> <i>If yes, sum of Items 2, 3, and 4 is greater than Item 1</i></li> <li>• 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 <input checked="" type="checkbox"/> No <input type="checkbox"/> <i>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</i></li> <li>• 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 <input type="checkbox"/> No <input checked="" type="checkbox"/> <i>If yes, Form 4.3-1 Items 7 and 8 were both checked yes</i></li> </ul>
<b>8</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• Combination of HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: <input type="checkbox"/> <i>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, <math>V_{alt} = (Item\ 1 - Item\ 2 - Item\ 3 - Item\ 4 - Item\ 5) * (100 - Form\ 2.4-1\ Item\ 2)\%</math></i></li> <li>• 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: <input type="checkbox"/> <i>Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed</i></li> </ul>

### 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.

<b>Form 4.3-10 Hydromodification Control BMPs (DA 1)</b>	
<p><sup>1</sup> Volume reduction needed for HCOC performance criteria (ft<sup>3</sup>): <b>2,724</b> (Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1</p>	<p><sup>2</sup> On-site retention with site design hydrologic source control, infiltration, and harvest and use LID BMP (ft<sup>3</sup>): <b>14,403</b> <i>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</i></p>
<p><sup>3</sup> Remaining volume for HCOC volume capture (ft<sup>3</sup>): <b>0</b> <i>Item 1 – Item 2</i></p>	<p><sup>4</sup> Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft<sup>3</sup>): <b>0</b> <i>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)</i></p>
<p><sup>5</sup> If Item 4 is less than Item 3, incorporate in-stream controls on downstream waterbody segment to prevent impacts due to hydromodification <input type="checkbox"/> <i>Attach in-stream control BMP selection and evaluation to this WQMP</i></p>	
<p><sup>6</sup> Is Form 4.2-2 Item 11 less than or equal to 5%: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>  <i>If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:</i></p> <ul style="list-style-type: none"> <li>• Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site or off-site retention BMP <input checked="" type="checkbox"/>  <i>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)</i></li> <li>• 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 <input type="checkbox"/></li> <li>• 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 <input type="checkbox"/></li> </ul>	
<p><sup>7</sup> Form 4.2-2 Item 12 less than or equal to 5%: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>  <i>If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:</i></p> <ul style="list-style-type: none"> <li>• Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site or off-site retention BMPs <input checked="" type="checkbox"/>  <i>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)</i></li> <li>• 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 <input type="checkbox"/></li> </ul>	

**Note: \* Items 6 and 7 will be addressed with Basin Routing Analysis.**

## 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.

<b>Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)</b>			
BMP	Responsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
UG Infil. System	Owner	<ul style="list-style-type: none"> <li>Inspect/Maintain UG-Infiltration Basin Systems, via access manholes.</li> <li>Remove trash, sediment and debris by jet-vac whenever materials accumulate to a level greater than 6" and pump and dispose of trash, sediments and debris in a legal manner.</li> <li>Inspect system for standing water. If system has standing water, perform re-inspection within 48 hours. If system still has standing water then the system shall be jet-vacuumed and pumped and removed debris shall be disposed of in a legal manner.</li> </ul>	Inspect Bi-annually and prior to a major forecasted storm event and 48 hours after storm has passed
Parking Lot Sweeping	Owner	<ul style="list-style-type: none"> <li>Vacuum sweep parking lot, drive aisles and spaces, and truck courts.</li> </ul>	Monthly / As needed.
Landscaped Areas	Owner & Maintenance Contractor	<ul style="list-style-type: none"> <li>Inspect health of plantings and erosion of landscape areas.</li> <li>Properly apply any herbicides, pesticides.</li> <li>Trim trees and bushes when needed.</li> <li>Properly collect and dispose of all mowings, cuttings, and landscape maintenance waste.</li> </ul>	Quarterly

Water Quality Management Plan (WQMP)

Storm drain system signage	Owner	<ul style="list-style-type: none"> <li>Inspect Catch basin signage for faded or lost signs / repair or replace as needed.</li> </ul>	Annually
Trash Storage Areas and Litter Control (SD-32)	Owner	<ul style="list-style-type: none"> <li>Inspect trash enclosure areas including containers, lids, screens and clean trash storage enclosures.</li> </ul>	Weekly
Efficient Irrigation	Owner	<ul style="list-style-type: none"> <li>Inspect irrigation system general operation and controller settings to optimize water conservation.</li> <li>Repair damaged sprinkler heads/lines and drip irrigation lines, as needed.</li> <li>Reduce cycle durations during all seasons to prevent over-irrigation.</li> </ul>	Monthly
Truck Dock	Owner	<ul style="list-style-type: none"> <li>Inspect loading dock for trash debris and sediment and sweep/maintain as needed.</li> <li>Inspect loading dock for evidence of spills and broken containers. Clean up spills by dry cleanup methods and dispose of collected material in a legal manner. If pressure washing is necessary, collect all runoff wastewater for proper disposal.</li> </ul>	Weekly / Daily
Roof Runoff Controls (SD-11)	Owner	<ul style="list-style-type: none"> <li>Inspect / repair roof drains</li> </ul>	Quarterly
Gravity Separator	Owner	<ul style="list-style-type: none"> <li>Inspect and maintain Gravity Separators, as required.</li> <li>Inspect Gravity Separators for debris, oils, and sediment. Remove debris whenever accumulations exceed 25% of the holding capacity of the unit or vector breeding becomes an issue.</li> </ul>	Inspect Quarterly and Maintain as Needed

## Section 6 WQMP Attachments

### 6.1. Site Plan and Drainage Plan

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

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

### 6.2 Electronic Data Submittal

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

### 6.3 Post Construction

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

### 6.4 Other Supporting Documentation

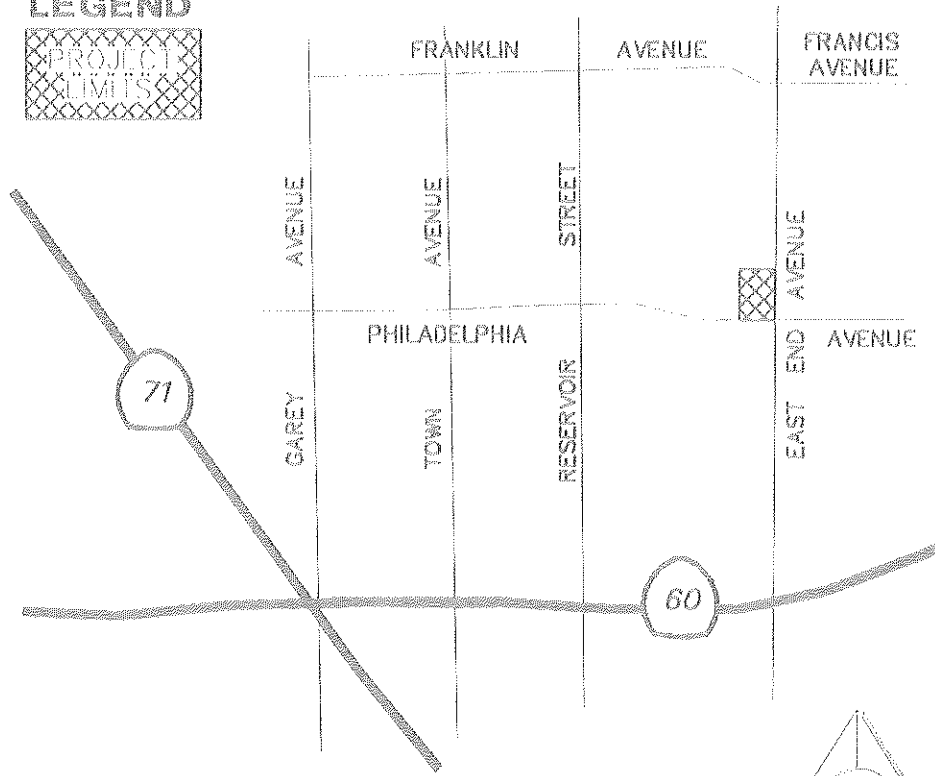
- BMP Educational Materials
- Activity Restriction – C, C&R's & Lease Agreements





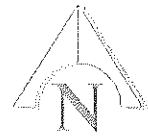
# **6.1 Attachment A WQMP Site Plan**

**LEGEND**



**VICINITY MAP**

NOT TO SCALE





**Attachment B**  
**BMP Details, Support Calc's**  
**& Manufacture's Details**





For design assistance, drawings, and pricing send completed worksheet to:  
[dyods@contech-cpi.com](mailto:dyods@contech-cpi.com)

**Project Summary**

Date:	2/24/2021
Project Name:	PAMA CHINO SYSTEM A
City / County:	Chino/San Bernardino County
State:	California
Designed By:	David White
Company:	Huitt-Zollars, Inc.
Telephone:	909-941-7799

**Enter Information in Blue Cells**

<b>Corrugated Metal Pipe Calculator</b>	
Storage Volume Required (cf):	16,000
Limiting Width (ft):	30.00
Invert Depth Below Asphalt (ft):	10.00
Solid or Perforated Pipe:	Perforated
Shape Or Diameter (in):	96
Number Of Headers:	2
Spacing between Barrels (ft):	3.00
Stone Width Around Perimeter of System (ft):	2
Depth A: Porous Stone Above Pipe (in):	6
Depth C: Porous Stone Below Pipe (in):	6
Stone Porosity (0 to 40%):	40
	50.27 ft <sup>2</sup> Pipe Area

**System Sizing**

Pipe Storage:	11,461 cf	
Porous Stone Storage:	4,938 cf	
Total Storage Provided:	16,398 cf	102.5% Of Required Storage
Number of Barrels:	2 barrels	
Length per Barrel:	95.0 ft	
Length Per Header:	19.0 ft	
Rectangular Footprint (W x L):	23. ft x 115. ft	

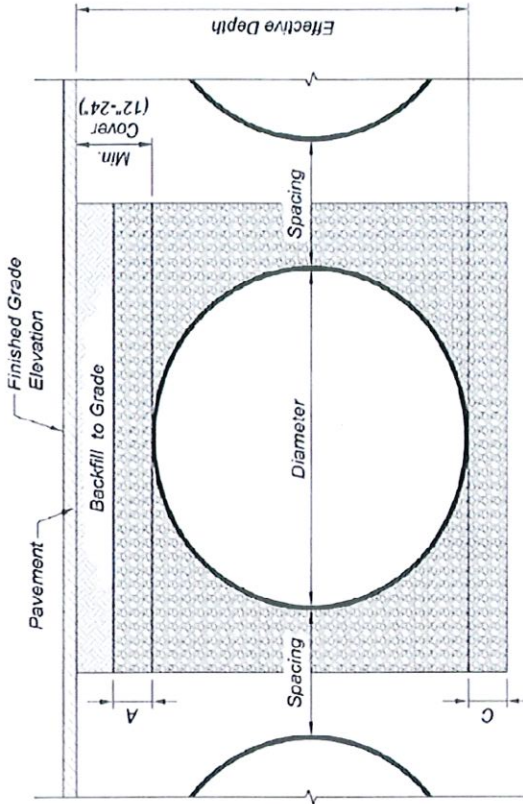
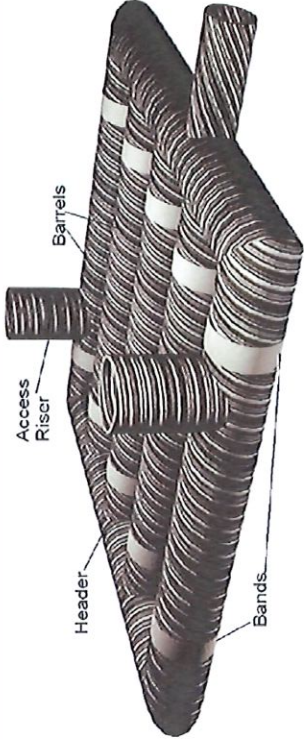
**CONTECH Materials**

Total CMP Footage:	228 ft
Approximate Total Pieces:	10 pcs
Approximate Coupling Bands:	10 bands
Approximate Truckloads:	5 trucks

**Construction Quantities\*\***

Total Excavation:	980 cy
Porous Stone Backfill For Storage:	457 cy stone
Backfill to Grade Excluding Stone:	98 cy fill

\*\*Construction quantities are approximate and should be verified upon final design



**System Layout**

Barrel 12	0
Barrel 11	0
Barrel 10	0
Barrel 9	0
Barrel 8	0
Barrel 7	0
Barrel 6	0
Barrel 5	0
Barrel 4	0
Barrel 3	0
Barrel 2	95
Barrel 1	95
<b>Barrel Footage (w/o headers)</b>	





For design assistance, drawings, and pricing send completed worksheet to:  
dyods@contech-cpi.com

**Project Summary**

Date:	2/24/2021
Project Name:	PAMA - CHINO SYSTEM B
City / County:	Chino/San Bernardino County
State:	California
Designed By:	David White
Company:	Huitt-Zollars, Inc.
Telephone:	909-941-7799

**Enter Information in Blue Cells**

<b>Corrugated Metal Pipe Calculator</b>	
Storage Volume Required (cf):	12,000
Limiting Width (ft):	30.00
Invert Depth Below Asphalt (ft):	12.00
Solid or Perforated Pipe:	Perforated
Shape Or Diameter (in):	96
Number Of Headers:	2
Spacing between Barrels (ft):	3.00
Stone Width Around Perimeter of System (ft):	2
Depth A: Porous Stone Above Pipe (in):	6
Depth C: Porous Stone Below Pipe (in):	6
Stone Porosity (0 to 40%):	40
<b>50.27 ft<sup>2</sup> Pipe Area</b>	

**System Sizing**

Pipe Storage:	8,646 cf	
Porous Stone Storage:	3,745 cf	
Total Storage Provided:	12,391 cf	103.3% Of Required Storage
Number of Barrels:	2 barrels	
Length per Barrel:	67.0 ft	
Length Per Header:	19.0 ft	
Rectangular Footprint (W x L):	23. ft x 87. ft	

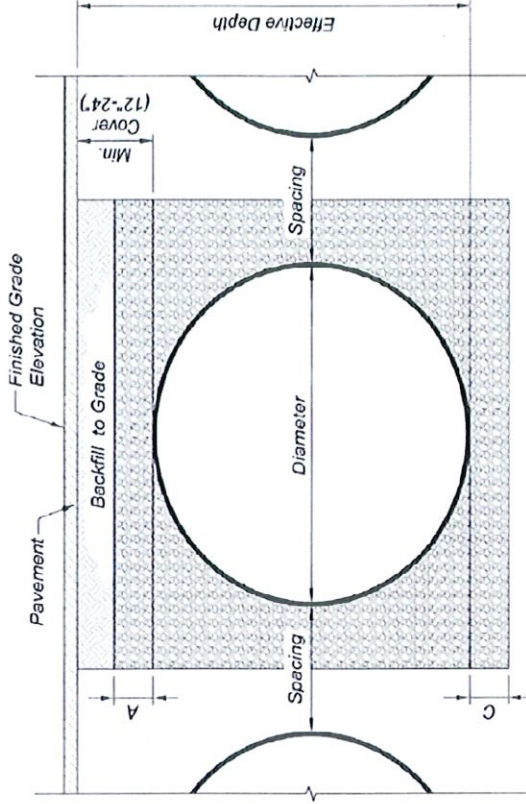
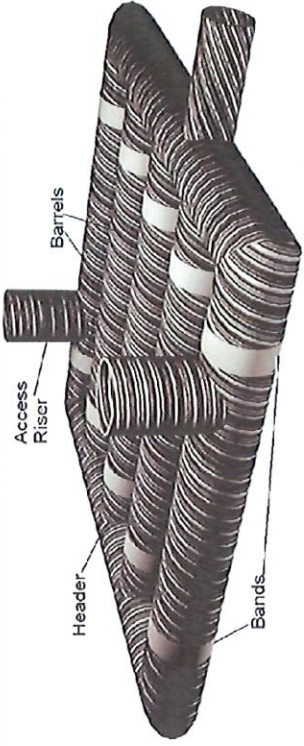
**CONTECH Materials**

Total CMP Footage:	172 ft
Approximate Total Pieces:	8 pcs
Approximate Coupling Bands:	8 bands
Approximate Truckloads:	4 trucks

**Construction Quantities\*\***

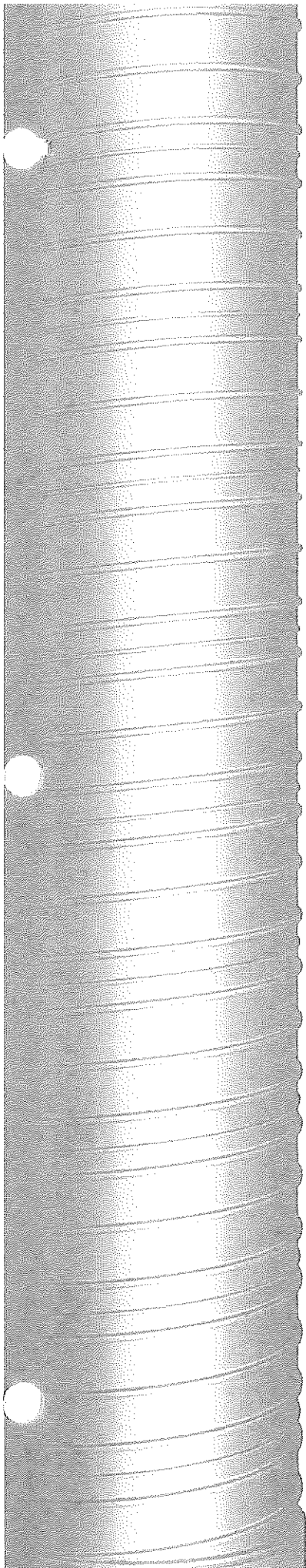
Total Excavation:	890 cy
Porous Stone Backfill For Storage:	347 cy stone
Backfill to Grade Excluding Stone:	223 cy fill

\*\*Construction quantities are approximate and should be verified upon final design



**System Layout**

Barrel 12	0
Barrel 11	0
Barrel 10	0
Barrel 9	0
Barrel 8	0
Barrel 7	0
Barrel 6	0
Barrel 5	0
Barrel 4	0
Barrel 3	0
Barrel 2	67
Barrel 1	67
<b>Barrel Footage (w/o headers)</b>	



**CONTECH**<sup>®</sup>  
ENGINEERED SOLUTIONS

# Corrugated Metal Pipe Design Guide

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## Durability Design Guide for Drainage Products

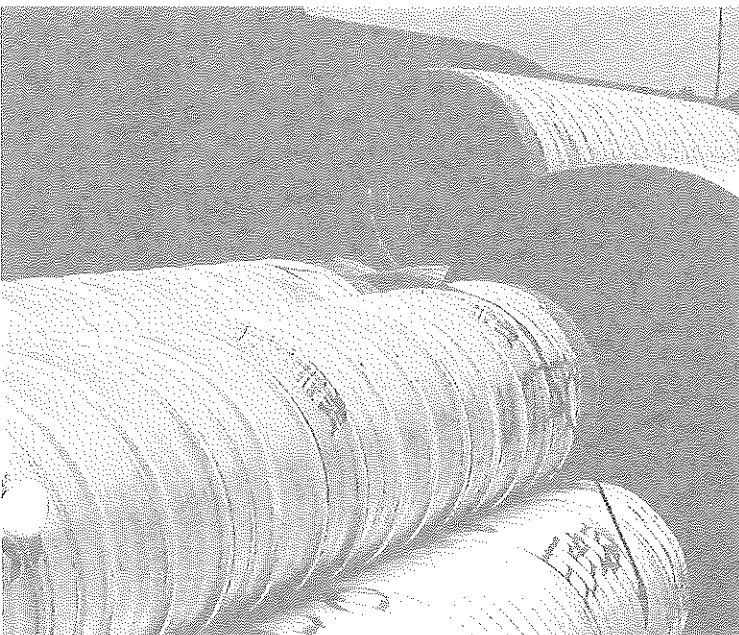
Proper design of culverts and storm sewers requires structural, hydraulic and durability considerations. While most designers are comfortable with structural and hydraulic design, the mechanics of evaluating abrasion, corrosion and water chemistry to perform a durability design are not commonly found in most civil engineering handbooks.

The durability and service life of a drainage pipe installation is directly related to the environmental conditions encountered at the site and the type of materials and coatings from which the culvert is fabricated. Two principle causes of early failure in drainage pipe materials are corrosion and abrasion.

Service life can be affected by the corrosive action of the backfill in contact with the outside of a drainage pipe or more commonly by the corrosive and abrasive action of the flow in the invert of the drainage pipe. The design life analysis should include a check for both the water side and soil side environments to determine which is more critical— or which governs service life.

The potential for metal loss in the invert of a drainage pipe due to abrasive flows is often overlooked by designers and its effects are often mistaken for corrosion. An estimate for potential abrasion is required at each pipe location in order to determine the appropriate material and gage.

This manual is intended to guide specifiers through the mechanics of selecting appropriate drainage products to meet service life requirements. The information contained in the following pages is a composite of several national guidelines.



## Using the Design Guide

The choice of material, gage and product type can be extremely important to service life. The following steps describe the procedure for selecting the appropriate drainage product, material and gage to meet a specific service life requirement.

### Design Sequence

1. Select pipe or structure based on hydraulic and clearance requirements. Use Tables 4 and 5 as reference for size limits and hydraulic properties of all drainage products.
2. Use Height of Cover tables for the chosen pipe or structure to determine the material gage required for the specific loading condition.
3. Use Table 1 to select the appropriate material for the site-specific environmental conditions. Whenever possible, existing installations of drainage structures along the same water course offer the most reliable estimate of long-term performance for specific environment conditions. In many cases, there will be more than one material that is appropriate for the project environmental conditions. Generally speaking, the metal material types increase in price as you move from top down on Table 1. Please contact your local CONTECH Sales Representative for pricing.
4. Use Table 2 to determine which abrasion level most accurately describes the typical storm event (2 year storm). The expected stream velocity and associated abrasion conditions should be based on a typical flow and not a 10 or 50-year design flood.
5. Use Table 3 to determine whether the structural gage for the selected material is sufficient for the design service life. If the structural gage is greater than or equal to the gage required for a particular abrasion condition and service life, use the structural gage. Conversely, if the structural gage is less than the gage required for a particular abrasion condition and service life, use the gage required by Table 3.

### Note:

*Both Contech round pipe and pipe-arch are available with either helical or annular corrugations. Contech HEL-COR® pipe (helical corrugations) is furnished with continuous lock seams and annular re-rolled ends. Contech riveted pipe is furnished with annular corrugations only. The height of cover tables in this guide are helical corrugations only. Consult your Contech representative for Height of Cover tables on riveted pipe.*

Table 1 — Recommended Environments

Material Type	Soil* and Water pH											
	3	4	5	6	7	8	9	10	11	12	Minimum	Maximum
Galvanized Steel*											2000	8000
Aluminized Steel Type 2											1500	N/A
Polymer Coated											250	N/A
Aluminum Alloy											500	N/A

\*Appropriate pH range for Galvanized Steel is 6.0 to 10

Table 2 — FHWA Abrasion Guidelines

Abrasion Level	Abrasion Condition	Bed Load	Flow Velocity (fps)
1	Non-Abrasive	None	Minimal
2	Low Abrasion	Minor	< 5
3	Moderate Abrasion	Moderate	5 - 15
4	Severe Abrasion	Heavy	> 15

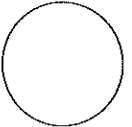

"Interim Direct Guidelines on Drainage Pipe Alternative Selection," FHWA, 2005.

Table 3 — Drainage Product Usage Guide<sup>1</sup>

Application	Culverts, Storm Drain, Cross Drain, Median Drain, Side Drain													
	Rural	Urban	Major	Minor	Rural	Urban	Major	Minor	Rural	Urban	Major	Minor		
<b>Roadway Classification</b>	25	100	75	50	25	100	75	50	25	100	75	50		
<b>Design Service Life</b>	Abrasion Level 1 & 2													
<b>Abrasion Level</b>	Abrasion Level 3													
<b>CMP (1/2" &amp; 1" deep corrugations, ULTRA FLO<sup>®</sup> &amp; Smooth Cor<sup>2,3</sup>)</b>	Minimum gage required to meet design service life, assuming that structural design has been met.													
Galvanized (2 oz.)	16	12	10	10	14	8 <sup>4</sup>	10	10	14 <sup>5</sup>	N/A	8	70 <sup>5</sup>	8 <sup>5</sup>	N/A
Galvanized and Asphalt Coated	16	14	10	10	14	8	12	12	14 <sup>5</sup>	N/A	8	12 <sup>5</sup>	8 <sup>5</sup>	N/A
Galv., Asphalt Coated and Paved Invert	16	16	14	14	16	10	14	14	14	8	10	12	10	N/A
Aluminized Type 2	16	16	16	16	14	14	14	14	14 <sup>6</sup>	12	14	14 <sup>6</sup>	14 <sup>6</sup>	12 <sup>6</sup>
Polymer Coated	16	16	16 <sup>8</sup>	16 <sup>8</sup>	16	16 <sup>9</sup>	16	16	14 <sup>7</sup>	16 <sup>9</sup>	14 <sup>7</sup>	14 <sup>7</sup>	14 <sup>7,9</sup>	14 <sup>7,9</sup>
Aluminum Alloy	16	16	16	16	14	16	14	14	14 <sup>5</sup>	14	14	14 <sup>5</sup>	14 <sup>5</sup>	14 <sup>5</sup>

1. Based on Table 1 - Recommended Environments.
2. SmoothCor™ Steel Pipe combines a corrugated steel exterior shell with a hydraulically smooth interior liner.
3. Service life estimates for ULTRA FLO® and SmoothCor Pipe assume a storm sewer application. Storm sewers rarely achieve abrasion levels 3 or 4. For applications other than storm sewers or abrasion conditions above Abrasion Level 2, please contact your Contech Sales Representative for gage and coating recommendations.
4. Design service life for 8 gage galvanized is 97 years.
5. Invert protection to consist of velocity reduction structures.
6. Asphalt coated and paved invert or velocity reduction structures are needed.
7. Requires a field applied concrete paved invert with minimum thickness 1" above corrugation crests.
8. 75 year service life for polymer coated is based on a pH range of 4-9 and resistivity greater than 750 ohm-cm.
9. 100 year service life for polymer coated is based on a pH range of 5-9 and resistivity greater than 1500 ohm-cm.

**Table 4 - Product Dimensions**

	Drainage Product	Common Uses	Size Limits*		Manning's "n" Value	
			Minimum	Maximum		
 Round Pipe	Corrugated Steel (1/2" deep corrugation)	Culverts, small bridges, storm water detention/retention systems, conduits, tunnels, storm sewers.	12"	84"	0.011 - 0.021	
	Corrugated Steel with Paved Invert (1/2" deep corrugation)		12"	84"	0.014 - 0.020	
	Corrugated Steel (1" deep corrugation)		54"	144"	0.022 - 0.027	
	Corrugated Steel with Paved Invert (1" deep corrugation)		54"	144"	0.019 - 0.023	
	Corrugated Aluminum (1/2" deep corrugation)		12"	72"	0.011 - 0.021	
	Corrugated Aluminum (1" deep corrugation)		30"	120"	0.023 - 0.027	
	ULTRA FLO <sup>3</sup> Steel		Storm sewers, culverts, storm water detention/retention systems.	18"	102"	0.012
	ULTRA FLO Aluminum			18"	84"	0.012
SmoothCor <sup>™</sup> Steel (1/2" deep corrugation)	18"	66"		0.012		
SmoothCor Steel (1" deep corrugation)	48"	126"		0.012		
 Pipe-Arch	Corrugated Steel (1/2" deep corrugation)	Culverts, small bridges, storm water detention/retention systems, conduits, tunnels, storm sewers.	17" x 13"	83" x 57"	0.011 - 0.021	
	Corrugated Steel with Paved Invert (1/2" deep corrugation)		17" x 13"	83" x 57"	0.014 - 0.019	
	Corrugated Steel (1" deep corrugation)		53" x 41"	142" x 91"	0.023 - 0.027	
	Corrugated Steel with Paved Invert (1" deep corrugation)		53" x 41"	142" x 91"	0.019 - 0.022	
	Corrugated Aluminum (1/2" deep corrugation)		17" x 13"	71" x 47"	0.011 - 0.021	
	Corrugated Aluminum (1" deep corrugation)		60" x 46"	112" x 75"	0.023 - 0.027	
	ULTRA FLO Steel		Storm sewers, culverts, storm water detention/retention systems.	20" x 16"	66" x 51"	0.012
	ULTRA FLO Aluminum			20" x 16"	66" x 51"	0.012
SmoothCor Steel (1/2" deep corrugation)	21" x 15"	77" x 52"		0.012		
SmoothCor Steel (1" deep corrugation)	53" x 41"	137" x 87"		0.012		

\* For sizes outside of these limits, please contact your Contech representative.

**Table 5 — Corrugated Steel Pipe—Values of Coefficient of Roughness (n)**

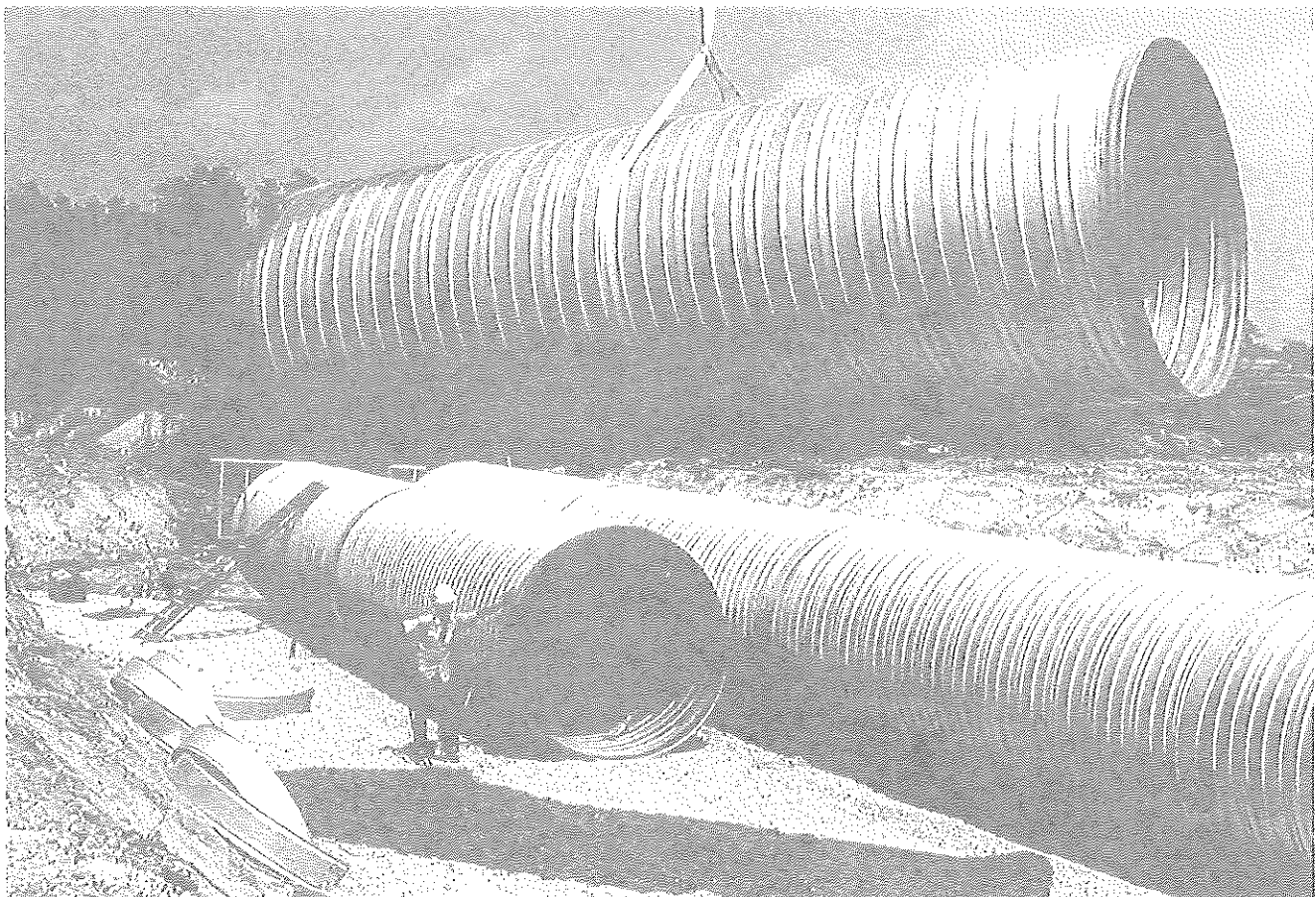
	All Diameters	1-1/2" x 1/4"		Helical* Corrugation							
		1-1/2" x 1/4"		Helical—2-2/3" x 1/2"							
2-2/3" x 1/2"	Annular	8 in.	10 in.	12 in.	15 in.	18 in.	24 in.	36 in.	48 in.	60 in. +	
Unpaved	0.024	0.012	0.014	0.011	0.012	0.013	0.015	0.018	0.020	0.021	
PAVED-INVERT	0.021						0.014	0.017	0.020	0.019	
SmoothCor	N/A					0.012	0.012	0.012	0.012	0.012	
3" x 1"	Annular			Helical*—3" x 1"							
Unpaved	0.027			36 in.	42 in.	48 in.	54 in.	60 in.	66 in.	72 in.	78 in. +
PAVED-INVERT	0.023			0.022	0.022	0.023	0.023	0.024	0.025	0.026	0.027
SmoothCor	N/A			0.019	0.019	0.020	0.020	0.021	0.022	0.022	0.023
						0.012	0.012	0.012	0.012	0.012	
5" x 1"	Annular					Helical*—5" x 1"					
Unpaved	N/A					48 in.	54 in.	60 in.	66 in.	72 in.	78 in. +
PAVED-INVERT	N/A					0.022	0.022	0.023	0.024	0.024	0.025
ULTRA FLO	N/A					0.019	0.019	0.020	0.021	0.021	0.022
						3/4" x 3/4" x 7-1/2" All diameters n = 0.012					

\* Tests on helically corrugated pipe demonstrate a lower coefficient of roughness than for annularly corrugated steel pipe. Pipe-arches approximately have the same roughness characteristics as their equivalent round pipes.

Table 6 - AASHTO Reference Specifications

	Material Type	Material	Pipe	Design*	Installation*
Pipe & Pipe-Arch	<b>CMP (1/2" or 1" deep corrugations)</b>				
	Galvanized (2 oz.)	M218	M36	Section 12	Section 26
	Asphalt Coated	M190	M36	Section 12	Section 26
	Asphalt Coated and Paved Invert	M190	M36	Section 12	Section 26
	Aluminized Type 2	M274	M36	Section 12	Section 26
	Polymer Coated	M246	M36 & M245	Section 12	Section 26
	Aluminum Alloy	M197	M196	Section 12	Section 26
	<b>ULTRA FLO</b>				
	<b>(3/4" x 3/4" x 7-1/2" corrugation)</b>				
	Galvanized (2 oz.)	M218	M36	Section 12	Section 26
	Aluminized Type 2	M274	M36	Section 12	Section 26
	Polymer Coated	M246	M36 & M245	Section 12	Section 26
	Aluminum Alloy	M197	M196	Section 12	Section 26
	<b>SmoothCor</b>				
	Polymer Coated	M246	M36 & M245	Section 12	Section 26

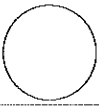
\* AASHTO LRFD Bridge Design Specification and AASHTO Standard Specification for Highway Bridges



# Corrugated Steel Pipe

## Heights of Cover


### 2-2/3" x 1/2" Height of Cover Limits for Corrugated Steel Pipe



**H 20 and H 25 Live Loads**

Diameter or Span, Inches	Minimum Cover, Inches	Maximum Cover, Feet <sup>(2)</sup>					
		Specified Thickness, Inches					
		0.052	0.064	0.079	0.109	0.138	0.168
6 <sup>10</sup>	12	388	486				
8 <sup>10</sup>		291	365				
10 <sup>10</sup>		233	392				
12		197	248	310			
15		158	198	248			
18		131	165	206			
21		113	141	177	248		
24		98	124	155	217		
30			99	124	173		
36			83	103	145	186	
42			71	88	124	159	195
48			62	77	108	139	171
54				67	94	122	150
60					80	104	128
66					68	88	109
72						75	93
78							79
84	12						66

### H 20 and H 25 Live Loads, Pipe-Arch



Size		Minimum Structural Thickness, Inches	Minimum Cover, Inches	Maximum <sup>(7)</sup> Cover, Feet
Round Equivalent, Inches	Span x Rise, Inches			
15	17 x 13	0.064	12	16
18	21 x 15	0.064		15
21	24 x 18	0.064		
24	28 x 20	0.064		
30	35 x 24	0.064		
36	42 x 29	0.064		
42	49 x 33	0.064*		
48	57 x 38	0.064*		
54	64 x 43	0.079*		
60	71 x 47	0.109*		
66	77 x 52	0.109*		
72	83 x 57	0.138*	12	15

### E 80 Live Loads

Diameter or Span, Inches	Minimum Cover, Inches	Maximum Cover, Feet <sup>(2)</sup>					
		Specified Thickness, Inches					
		0.052	0.064	0.079	0.109	0.138	0.168
12	12	197	248	310			
15		158	198	248			
18		131	165	206			
21		113	141	177	248		
24		98	124	155	217		
30			99	124	173		
36			83	103	145	186	
42			71	88	124	159	195
48	12		62	77	108	139	171
54	18			67	94	122	150
60					80	104	128
66					68	88	109
72	18					75	93
78	24						79
84	24						66

### E 80 Live Loads, Pipe-Arch

Size		Minimum Structural Thickness, Inches	Minimum Cover, Inches	Maximum <sup>(8)</sup> Cover, Feet
Round Equivalent, Inches	Span x Rise, Inches			
15	17 x 13	0.079	24	22
18	21 x 15	0.079		
21	24 x 18	0.109		
24	28 x 20	0.109		
30	35 x 24	0.138		
36	42 x 29	0.138		
42	49 x 33	0.138*		
48	57 x 38	0.138*		
54	64 x 43	0.138*		
60	71 x 47	0.138*	24	22

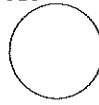
\* These values are based on the AISI Flexibility Factor limit (0.0433 x 1.5) for pipe-arch.

#### Heights of Cover Notes:

- These tables are for lock-seam or welded-seam construction. They are not for riveted construction. Consult your Cortech Sales Representative for Height of Cover tables on riveted pipe.
- These values, where applicable, were calculated using a load factor of K=0.86 as adopted in the NCSA CSP Design Manual, 2008.
- The haunch areas of a pipe-arch are the most critical zone for backfilling. Extra care should be taken to provide good material and compaction to a point above the spring line.
- E 80 minimum cover is measured from top of pipe to bottom of tie.
- H 20 and H 25 minimum cover is measured from top of pipe to bottom of flexible pavement or top of rigid pavement.
- The H 20 and H 25 pipe-arch tables are based on 2 tons per square foot corner bearing pressures.
- The E 80 pipe-arch tables minimum and maximum covers are based on the corner bearing pressures shown. These values may increase or decrease with changes in allowable corner bearing pressures.
- 0.052" is 18 gage.  
0.064" is 16 gage.  
0.079" is 14 gage.  
0.109" is 12 gage.  
0.138" is 10 gage.  
0.168" is 8 gage.
- For construction loads, see Page 15.
- 1-1/2" x 1/4" corrugation. H20, H25 and E80 loading.
- SmoothCor has same Height of Cover properties as corrugated steel pipe. The exterior shell of SmoothCor is manufactured in either 2-3/4" x 1/2" or 3" x 1" corrugations; maximum exterior shell gage is 12.
- Sewer gage (trench conditions) tables for corrugated steel pipe can be found in the AISI book "Modern Sewer Design," 4th Edition, 1999. These tables may reduce the minimum gage due to a higher flexibility factor allowed for a trench condition.



**5" x 1" or 3" x 1" Height of Cover Limits for Corrugated Steel Pipe**



**H 20 and H 25 Live Loads**

Diameter or Span, Inches	Minimum Cover Inches	Maximum Cover, Feet <sup>(2)</sup>				
		Specified Thickness, Inches				
		0.064	0.079	0.109	0.138	0.168
54	12	56	70	98	127	155
60		50	63	88	114	139
66		46	57	80	103	127
72		42	52	74	95	116
78		39	48	68	87	107
84		36	45	63	81	99
90		33	42	59	76	93
96	12	31	39	55	71	87
102	18	29	37	52	67	82
108			35	49	63	77
114			32	45	58	72
120			30	42	54	66
126				39	50	61
132				36	46	58
138				33	43	53
144	18				39	49

Maximum cover heights shown are for 5" x 1".

To obtain maximum cover for 3" x 1", increase these values by 12%

**E 80 Live Loads**

Diameter or Span, Inches	Minimum Cover Inches	Maximum Cover, Feet <sup>(2)</sup>				
		Specified Thickness, Inches				
		0.064	0.079	0.109	0.138	0.168
54	18	56	70	98	127	155
60		50	63	88	114	139
66		46	57	80	103	127
72	18	42	52	74	95	116
78	24	39	48	68	87	107
84		36	45	63	81	99
90		33 <sup>(1)</sup>	42	59	76	93
96	24	31 <sup>(1)</sup>	39	55	71	87
102	30	29 <sup>(1)</sup>	37	52	67	82
108			35	49	63	77
114			32 <sup>(1)</sup>	45	58	72
120	30		30 <sup>(1)</sup>	42	54	66
126	36			39	50	61
132				36	46	58
138				33 <sup>(1)</sup>	43	53
144	36				39	49

Maximum cover heights shown are for 5" x 1".

To obtain maximum cover for 3" x 1", increase these values by 12%.

<sup>(1)</sup> These diameters in these gages require additional minimum cover.

**Heights of Cover Notes:**

1. These tables are for lock-seam or welded-seam construction. They are not for riveted construction. Consult your Contech Sales Representative for Height of Cover tables on riveted pipe.
2. These values, where applicable, were calculated using a load factor of K=0.86 as adopted in the NCSA CSP Design Manual, 2008.
3. The span and rise shown in these tables are nominal. Typically the actual rise that forms is greater than the specified nominal. This actual rise is within the tolerances as allowed by the AASHTO & ASTM specifications. The minimum covers shown are more conservative than required by the AASHTO and ASTM specifications to account for this anticipated increase in rise. Less cover height may be tolerated depending upon actual rise of supplied pipe arch.
4. The haunch areas of a pipe-arch are the most critical zone for backfilling. Extra care should be taken to provide good material and compaction to a point above the spring line.
5. E 80 minimum cover is measured from top of pipe to bottom of tie.

**5" x 1" Pipe-Arch Height of Cover Limits for Corrugated Steel Pipe**



**H 20 and H 25 Live Loads**

Equivalent Pipe Diameter	Size Span x Rise Inches <sup>(3)</sup>	Minimum Specified Thickness, Inches*	Minimum Cover Inches	Maximum <sup>(7)</sup> Cover, Feet
				2 Tons/Ft. <sup>2</sup> Corner Bearing Pressure
				72
78	87 x 63	0.109	18	20
84	95 x 67	0.109	18	20
90	103 x 71	0.109	18	20
96	112 x 75	0.109	21	20
102	117 x 79	0.109	21	19
108	128 x 83	0.109	24	19
114	137 x 87	0.109	24	19
120	142 x 91	0.138	24	19

Larger sizes are available in some areas of the United States. Check with your local Contech representative. Some minimum heights-of-cover for pipe-arches have been increased to take into account allowable "plus" tolerances on the manufactured rise.

**E 80 Live Loads**

Equivalent Pipe Diameter	Size Span x Rise Inches <sup>(3)</sup>	Minimum Specified Thickness, Inches*	Minimum Cover Inches	Maximum <sup>(8)</sup> Cover, Feet
				2 Tons/Ft. <sup>2</sup> Cover Bearing Pressure
				72
78	87 x 63	0.109	30	18
84	95 x 67	0.109	30	18
90	103 x 71	0.109	36	18
96	112 x 75	0.109	36	18
102	117 x 79	0.109	36	17
108	128 x 83	0.109	42	17
114	137 x 87	0.109	42	17
120	142 x 91	0.138	42	17

\* Some 3" x 1" and 5" x 1" minimum gages shown for pipe-arch are due to manufacturing limitations.

6. H 20 and H 25 minimum cover is measured from top of pipe to bottom of flexible pavement or top of rigid pavement.
7. The H 20 and H 25 pipe-arch tables are based on 2 tons per square foot corner bearing pressures.
8. The E 80 pipe-arch tables minimum and maximum covers are based on the corner bearing pressures shown. These values may increase or decrease with changes in allowable corner bearing pressures.
9. 0.052" is 18 gage. 0.064" is 16 gage. 0.079" is 14 gage. 0.109" is 12 gage. 0.138" is 10 gage. 0.168" is 8 gage.
10. For construction loads, see Page 15.
11. SmoothCor has some Height of Cover properties as corrugated steel pipe. The exterior shell of SmoothCor is manufactured in either 2-<sup>2</sup>/<sub>3</sub>" x 1/2" or 3"x1" corrugations; maximum exterior shell gage is 12.
12. Sewer gage (trench conditions) tables for corrugated steel pipe can be found in the AISI book "Modern Sewer Design," 4th Edition, 1999. These tables may reduce the minimum gage due to a higher flexibility factor allowed for a trench condition.

**3" x 1" Pipe-Arch Height of Cover Limits for Corrugated Steel Pipe-Arch**

**H 20 and H 25 Live Loads**



Equivalent Pipe Diameter	Size		Minimum Specified Thickness, Inches*	Minimum Cover Inches	Maximum <sup>(7)</sup> Cover, Feet
	Pipe Span x Rise Inches	Span x Rise Inches			
48	53 x 41		0.079	12	25
54	60 x 46		0.079	15	25
60	66 x 51		0.079	15	25
66	73 x 55		0.079	18	24
72	81 x 59		0.079	18	21
78	87 x 63		0.079	18	20
84	95 x 67		0.079	18	20
90	103 x 71		0.079	18	20
96	112 x 75		0.079	21	20
102	117 x 79		0.109	21	19
108	128 x 83		0.109	24	19
114	137 x 87		0.109	24	19
120	142 x 91		0.138	24	19

Larger sizes are available in some areas of the United States. Check with your local Contech Sales Representative.

Some minimum heights-of-cover for pipe-arches have been increased to take into account allowable "plus" tolerances on the manufactured rise.

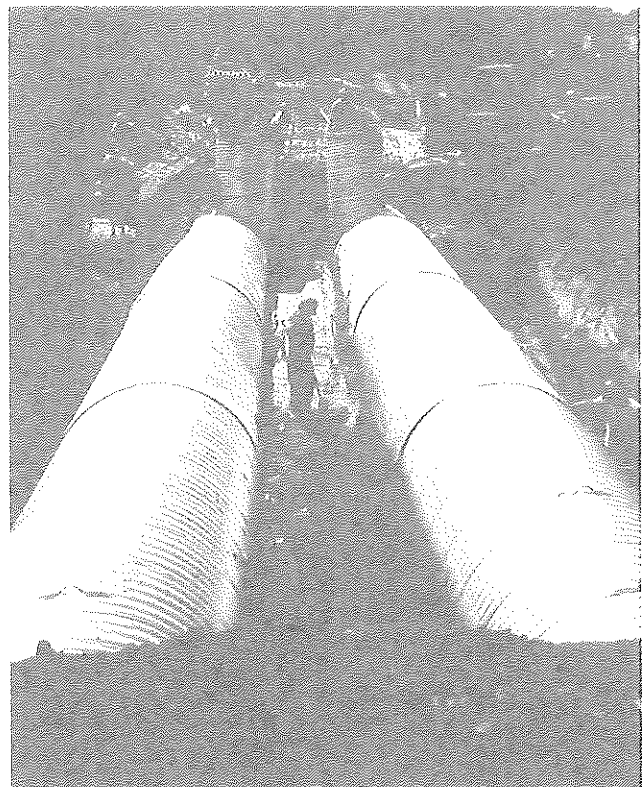
**E 80 Live Loads**

Equivalent Pipe Diameter	Size		Minimum Specified Thickness, Inches*	Minimum Cover Inches	Maximum <sup>(8)</sup> Cover, Feet
	Pipe Span x Rise Inches	Span x Rise Inches			
48	53 x 41		0.079	24	25
54	60 x 46		0.079	24	25
60	66 x 51		0.079	24	25
66	73 x 55		0.079	30	24
72	81 x 59		0.079	30	21
78	87 x 63		0.079	30	18
84	95 x 67		0.079	30	18
90	103 x 71		0.079	36	18
96	112 x 75		0.079	36	18
102	117 x 79		0.109	36	17
108	128 x 83		0.109	42	17
114	137 x 87		0.109	42	17
120	142 x 91		0.138	42	17

\* Some 3" x 1" and 5" x 1" minimum gages shown for pipe-arch are due to manufacturing limitations.

**Heights of Cover Notes:**

1. These tables are for lock-seam or welded-seam construction. They are not for riveted construction. Consult your Contech Sales Representative for Height of Cover tables on riveted pipe.
2. These values, where applicable, were calculated using K=0.86 as adopted in the NCSA CSP Design Manual, 2008.
3. The span and rise shown in these tables are nominal. Typically the actual rise that forms is greater than the specified nominal. This actual rise is within the tolerances as allowed by the AASHTO & ASTM specifications. The minimum covers shown are more conservative than required by the AASHTO and ASTM specifications to account for this anticipated increase in rise. Less cover height may be tolerated depending upon actual rise of supplied pipe arch.
4. The haunch areas of a pipe-arch are the most critical zone for backfilling. Extra care should be taken to provide good material and compaction to a point above the spring line.
5. E 80 minimum cover is measured from top of pipe to bottom of tie.
6. H 20 and H 25 minimum cover is measured from top of pipe to bottom of flexible pavement or top of rigid pavement.
7. The H 20 and H 25 pipe-arch tables are based on 2 tons per square foot corner bearing pressures.
8. The E 80 pipe-arch tables minimum and maximum covers are based on the corner bearing pressures shown. These values may increase or decrease with changes in allowable corner bearing pressures.
9. 0.052" is 18 gage.  
0.064" is 16 gage.  
0.079" is 14 gage.  
0.109" is 12 gage.  
0.138" is 10 gage.  
0.168" is 8 gage.
10. For construction loads, see Page 15.
11. SmoothCor has same Height of Cover properties as corrugated steel pipe. The exterior shell of SmoothCor is manufactured in either 2-2/3" x 1/2" or 3" x 1" corrugations; maximum exterior shell gage is 15.
12. Sewer gage (trench conditions) tables for corrugated steel pipe can be found in the AISI book "Modern Sewer Design," 4th Edition, 1999. These tables may reduce the minimum gage due to a higher flexibility factor allowed for a trench condition.



# Approximate Weight (Pounds/Foot) Contech Corrugated Steel Pipe

(Estimated Average Weights—Not for Specification Use)

1-1/2" x 1/4" Corrugation			
Inside Diameter, in.	Specified Thickness, in.	Galvanized & ALUMINIZED	Full Coated
6	0.052	4	5
	0.064	5	6
8	0.052	5	6
	0.064	6	7
10	0.052	6	7
	0.064	7	8

Steel Thicknesses by Gage						
Gage	18	16	14	12	10	8
Thickness	.052	.064	.079	.109	.138	.168

2-2/3" x 1/2" Corrugation					
Inside Diameter, in.	Specified Thickness	Galvanized & ALUMINIZED	Full Coated	Coated & PAVED-INVERT	SmoothCor
12	0.052	8	10	13	
	0.064	10	12	15	
	0.079	12	14	17	
15	0.052	10	13	16	
	0.064	12	15	18	
	0.079	15	18	21	
18	0.052	12	16	19	
	0.064	15	19	22	25
	0.079	18	22	25	28
21	0.052	14	18	23	
	0.064	17	21	26	29
	0.079	21	25	30	33
	0.109	29	33	33	41
24	0.052	15	20	26	
	0.064	19	24	30	30
	0.079	24	29	35	38
	0.109	33	38	44	47
30	0.064	24	30	36	42
	0.079	30	36	42	48
	0.109	41	47	53	59
	0.138	49	56	64	71
36	0.064	29	36	44	51
	0.079	36	43	51	58
	0.109	49	56	64	71
	0.138	62	69	77	
42	0.064	34	42	51	60
	0.079	42	50	59	68
	0.109	57	65	74	82
	0.138	72	80	89	
48	0.064	38	48	57	67
	0.079	48	58	67	77
	0.109	65	75	84	94
	0.138	82	92	101	
54	0.064	100	110	119	
	0.079	54	65	76	87
	0.109	73	84	95	106
	0.138	92	103	114	
60	0.064	112	123	134	
	0.109	81	92	106	117
	0.138	103	114	128	
	0.168	124	135	149	
66	0.109	89	101	117	129
	0.138	113	125	141	
	0.168	137	149	165	
72	0.138	123	137	154	(2)
	0.168	149	163	180	
78	0.168	161	177	194	(2)
84	0.168	173	190	208	(2)

3" x 1" or 5" x 1" Corrugation					
Inside Diameter, in.	Specified Thickness	Galvanized & ALUMINIZED	Full Coated	Coated & PAVED-INVERT	SmoothCor
54	0.064	50	66	84	84
	0.079	61	77	95	95
	0.109	83	100	118	118
	0.138	106	123	140	
	0.168	129	146	163	
60	0.064	55	73	93	93
	0.079	67	86	105	105
	0.109	92	110	130	130
	0.138	118	136	156	
	0.168	143	161	181	
66	0.064	60	80	102	102
	0.079	74	94	116	116
	0.109	101	121	143	145
	0.138	129	149	171	
	0.168	157	177	199	
72	0.064	66	88	111	112
	0.079	81	102	126	127
	0.109	110	132	156	157
	0.138	140	162	186	
	0.168	171	193	217	
78	0.064	71	95	121	120
	0.079	87	111	137	136
	0.109	119	143	169	168
	0.138	152	176	202	
	0.168	185	209	235	
84	0.064	77	102	130	130
	0.079	94	119	147	147
	0.109	128	154	182	181
	0.138	164	189	217	
	0.168	199	224	253	
90	0.064	82	109	140	139
	0.079	100	127	158	157
	0.109	137	164	195	194
	0.138	175	202	233	
	0.168	213	240	271	
96	0.064	87	116	149	148
	0.079	107	136	169	168
	0.109	147	176	209	208
	0.138	188	217	250	
	0.168	228	257	290	
102	0.064	93	124	158	158
	0.079	114	145	179	179
	0.109	155	186	220	222
	0.138	198	229	263	
108	0.168	241	272	306	
	0.079	120	153	188	189
	0.109	165	198	233	235
	0.138	211	244	279	
114	0.168	256	289	324	
	0.079	127	162	199	200
	0.109	174	209	246	248
	0.138	222	257	294	
120	0.168	271	306	343	
	0.079	134	171	210	211
	0.109	183	220	259	260
	0.138	234	271	310	
126	0.168	284	321	360	
	0.109	195	233	274	276
	0.138	247	285	326	
	0.168	299	338	378	
132	0.109	204	244	287	289
	0.138	259	299	342	
	0.168	314	354	397	
	0.109	213	255	300	300
138	0.138	270	312	357	
	0.168	328	370	415	
	0.138	282	326	373	
144	0.168	344	388	435	(2)

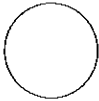
- Weights for polymer coated pipe are 1% to 4% higher, varying by gage.
- Please contact your Contech Sales Representative.
- Weights listed in the 3" x 1" or 5" x 1" table are for 3" x 1" pipe. Weights for 5" x 1" are approximately 12% less than those used in this table, for metallic coated pipe.

## Corrugated Aluminum Pipe

### Heights of Cover

#### 2-2/3" X 1/2" Height of Cover Limits for Corrugated Aluminum Pipe


##### HL 93 Live Load



Diameter or Span (In.)	Minimum Cover (In.)	Maximum Cover, (Ft.) <sup>(2)</sup> Equiv. Standard Gage					
		18	16	14	12	10	8 <sup>(3)</sup>
6 <sup>(4)</sup>	12	197	247				
8 <sup>(4)</sup>		147	185				
10 <sup>(4)</sup>		119	148				
12			125	157			
15			100	125			
18			83	104			
21			71	89			
24			62	78	109		
27				69	97		
30				62	87		
36				51	73	94	
42					62	80	
48	12				54	70	85
54	15				48	62	76
60	15					52	64
66	18						52
72	18						43

#### 2 2/3" x 1/2" Height of Cover Limits for Corrugated Aluminum Pipe-Arch

##### HL 93 Live Load



Round Pipe Dia. (Inches)	Size, (In.) Span x Rise	Minimum Gage	Minimum Cover (Inches) <sup>(2)</sup>	Maximum Cover, (Ft.) Aluminum Pipe-Arch <sup>(2)</sup> 2 Tons/Ft. <sup>2</sup> for Corner Bearing Pressures
15	17x13	16	12	13
18	21x15	16	12	12
21	24x18	16	12	12
24	28x20	14	12	12
30	35x24	14	12	12
36	42x29	12	12	12
42	49x33	12	15	12
48	57x38	10	15	12
54	64x43	10	18	12
60	71x47	8 <sup>(3)</sup>	18	12


##### Notes:

1. Height-of-cover is measured to top of rigid pavement or to bottom of flexible pavement.
2. Maximum cover meets AASHTO LRFD design criteria.
3. Minimum cover meets AASHTO and ASTM B 790 design criteria.
4. 1 1/2" x 1/4" corrugation.
5. 8-gage pipe has limited availability.
6. For construction loads, see page 15.

### Heights of Cover

#### 3" x 1" Height of Cover Limits for Corrugated Aluminum Pipe


##### HL 93 Live Load



Diameter or Span (In.)	Minimum <sup>(2)</sup> Cover (In.)	Maximum Cover, (Ft.) <sup>(2)</sup> Equiv. Standard Gage				
		16	14	12	10	8 <sup>(6)</sup>
30	12	57	72	101	135	159
36		47	60	84	112	132
42		40	51	72	96	113
48	12	35	44	62	84	99
54	15	31	39	55	74	88
60	15	28	35	50	67	79
66	18	25	32	45	61	72
72	18	23	29	41	56	66
78	21		27	38	51	61
84	21			35	48	56
90	24			33	44	52
96	24			31	41	49
102	24				39	46
108	24				37	43
114	24					39
120	24					36

#### 3" x 1" Height of Cover Limits for Corrugated Aluminum Pipe-Arch

##### HL 93 Live Load



Round Pipe Dia. (Inches)	Size, (In.) Span x Rise	Minimum Gage	Minimum Cover (Inches) <sup>(2)</sup>	Maximum Cover, (Ft.) Aluminum Pipe-Arch <sup>(2)</sup> 2 Tons/Ft. <sup>2</sup> for Corner Bearing Pressures
54	60x46	14	15	20
60	66x51	14	18	20
66	73x55	14	21	20
72	81x59	12	21	16
78 <sup>(4)</sup>	87x63	12	24	16
84 <sup>(4)</sup>	95x67	12	24	16
90 <sup>(4)</sup>	103x71	10	24	16
96 <sup>(4)</sup>	112x75	8 <sup>(3)</sup>	24	16

##### Notes:

1. Height-of-cover is measured to top of rigid pavement or to bottom of flexible pavement.
2. Maximum cover meets AASHTO LRFD design criteria.
3. Minimum cover meets ASTM B 790 design criteria.
4. Limited availability on these sizes.
5. 8-gage pipe has limited availability.
6. For construction loads, see page 15.

## Approximate Weight/Foot Contech Corrugated Aluminum Pipe

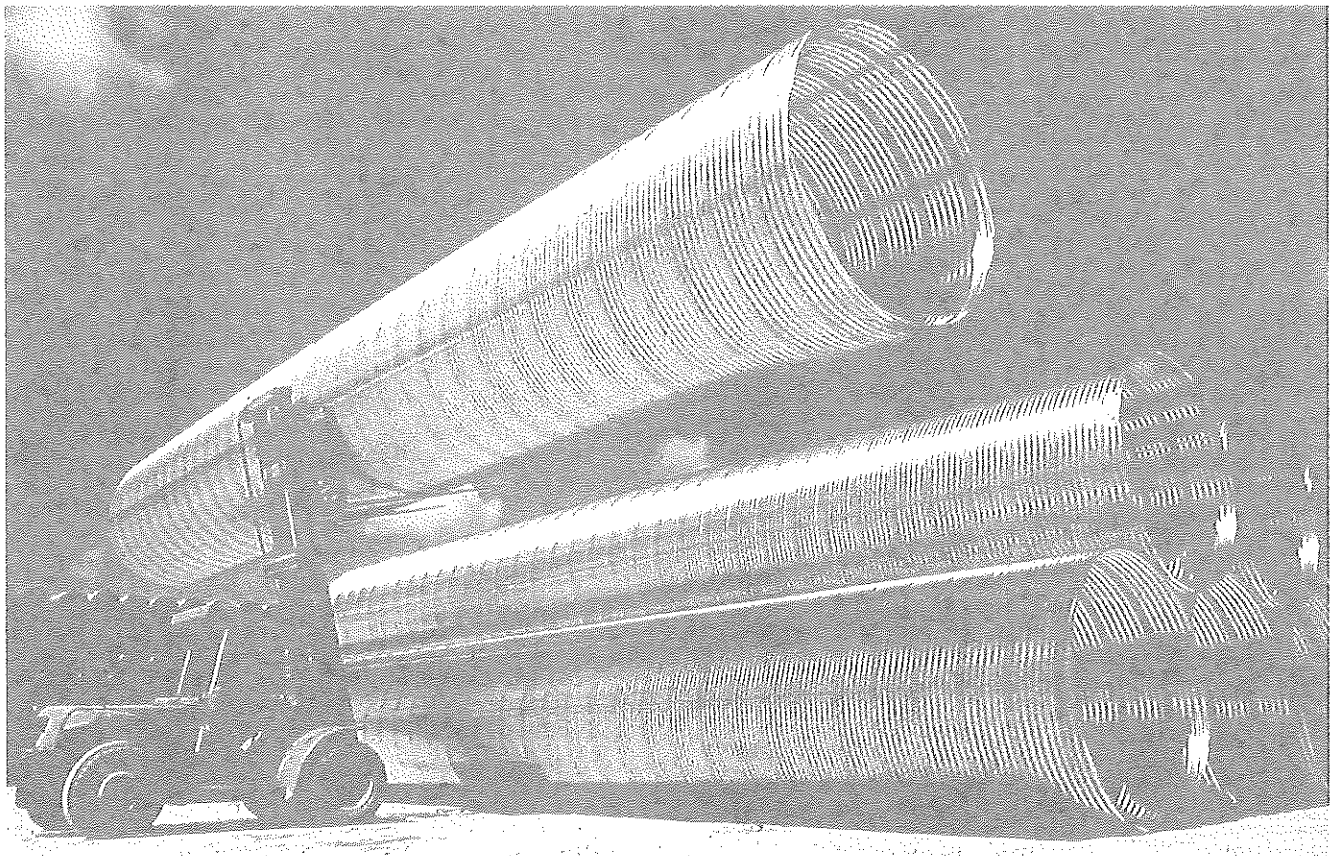
(Estimated Average Weights—Not for Specification Use)

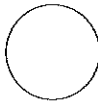
2 2/3" x 1/2" Corrugation Aluminum Pipe						
Diameter or Span (Inches)	Weight (Lb./Lineal Ft.) Equiv. Standard Gage					
	(.048) 18	(.060) 16	(.075) 14	(.105) 12	(.135) 10	(.164) 8 <sup>(3)</sup>
6 <sup>(2)</sup>	1.3	1.6				
8 <sup>(2)</sup>	1.7	2.1				
10 <sup>(2)</sup>	2.1	2.6				
12		3.2	4.0			
15		4.0	4.9			
18		4.8	5.9			
21		5.6	6.9			
24		6.3	7.9	10.8		
27			8.8	12.2		
30			9.8	13.5		
36			11.8	16.3	20.7	
42				19.0	24.2	
48				21.7	27.6	33.5
54				24.4	31.1	37.7
60					34.6	41.9
66						46.0
72						50.1

3" x 1" Corrugation Aluminum Pipe					
Diameter or Span (Inches)	Weight (Lb./Lineal Ft.) Equiv. Standard Gage				
	(.060) 16	(.075) 14	(.105) 12	(.135) 10	(.164) 8 <sup>(3)</sup>
30	9.3	11.5	15.8	20.2	
36	11.1	13.7	18.9	24.1	
42	12.9	16.0	22.0	28.0	
48	14.7	18.2	25.1	32.0	38.8
54	16.5	20.5	28.2	35.9	43.6
60	18.3	22.7	31.3	40.0	48.3
66	20.2	24.9	34.3	43.7	53.0
72	22.0	27.1	37.4	47.6	57.8
78		29.3	40.4	51.5	62.5
84			43.5	55.4	67.2
90			46.6	59.3	71.9
96			49.6	63.2	76.7
102				66.6	80.8
108				71.0	86.1
114					90.9
120					95.6

**Notes:**

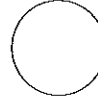
1. Helical lockseam pipe only. Annular riveted pipe weights will be higher.
2. 1 1/2" x 1/2" Corrugation.
3. 8-gage pipe has limited availability.





**Galvanized, ALUMINIZED STEEL Type 2 or  
Polymer Coated\*\* Steel ULTRA FLO H 20 and H 25 Live Load**

Diameter (Inches)	Minimum/Maximum Cover (Feet)			
	Specified Thickness and Gage			
	(0.064) 16	(0.079) 14	(0.109) 12	(0.138) 10
18	1.0/108	1.0/151		
21	1.0/93	1.0/130	1.0/216	
24	1.0/81	1.0/113	1.0/189	
30	1.0/65	1.0/91	1.0/151	
36	1.0/54	1.0/75	1.0/126	
42	1.0/46	1.0/65	1.0/108	
48	1.0/40	1.0/56	1.0/94	1.0/137
54	1.25/36	1.25/50	1.0/84	1.0/122
60	1.25*/32*	1.25/45	1.0/75	1.0/109
66		1.5/41	1.25/68	1.25/99
72		1.5*/37*	1.25/63	1.25/91
78		1.75*/34*	1.5/58	1.5/84
84			1.75/54	1.75/78
90			2.0*/50*	2.0/73
96			2.0*/47*	2.0/68
102			2.5*/43*	2.5/61
108				2.5*/54*
114				2.5*/49*
120				2.5*/43*



**Galvanized, ALUMINIZED STEEL Type 2 or  
Polymer Coated\*\* Steel ULTRA FLO E 80 Live Load**

Diameter (Inches)	(0.064)	(0.079)	(0.109)	(0.138)
	16	14	12	10
18	1.0 / 93	1.0 / 130		
21	1.0 / 79	1.0 / 111	1.0 / 186	
24	1.0 / 69	1.0 / 97	1.0 / 162	
30	1.0 / 55	1.0 / 78	1.0 / 130	
36	1.5 / 46	1.25 / 65	1.0 / 108	
42	1.5 / 39	1.5 / 55	1.25 / 93	
48	2.0 / 34	1.75 / 48	1.5 / 81	1.5 / 118
54	3.0* / 28*	2.0 / 43	1.5 / 72	1.5 / 104
60		2.0 / 39	1.75 / 65	1.75 / 94
66		2.5* / 35*	2.0 / 58	2.0 / 85
72			2.0 / 49	2.0 / 78
78			2.5 / 42	2.5 / 72
84			2.75* / 35*	2.5 / 67
90				2.5 / 62
96				2.5* / 58*
102				3.0* / 52*

**Notes:**

- The tables for Steel H 20 and H 25 loading are based on the NCSA CSP Design Manual, 2008 and were calculated using a load factor of K=0.86. The tables for Steel E 80 loading are based on the AREMA Manual. The tables for Aluminum HL 93 loading are based on AASHTO LRFD Design Criteria.
- The haunch areas of a pipe-arch are the most critical zone for backfilling. Extra care should be taken to provide good material and compaction to a point above the spring line.
- E 80 minimum cover is measured from top of pipe to bottom of tie.
- H 20, H 25 and HL 93 minimum cover is measured from top of pipe to bottom of flexible pavement or top of rigid pavement.
- The H 20, H 25 and HL 93 pipe-arch tables are based on 2 tons per square foot corner bearing pressures.
- The E 80 pipe-arch tables minimum and maximum covers are based on 3 tons per square foot corner bearing pressures shown.
- Larger size pipe-arches may be available on special order.
- M.L. (Heavier gage is required to prevent crimping at the haunches.)
- For construction loads, see Page 15.
- Sewer gage (trench conditions) tables for corrugated steel pipe can be found in the AISI book "Modern Sewer Design," 4th Edition, 1999. These tables may reduce the minimum gage due to a higher flexibility factor allowed for a trench condition.



**Galvanized, ALUMINIZED STEEL Type 2 or  
Polymer Coated\*\* Steel ULTRA FLO Pipe-Arch H 20 and H 25 Live Load**

Equiv. Pipe Dia. (Inches)	Span (Inches)	Rise (Inches)	Minimum/Maximum Cover (Feet)		
			Specified Thickness and Gage		
			(0.064) 16	(0.079) 14	(0.109) 12
18	20	16	1.0/16		
21	23	19	1.0/15		
24	27	21	1.0/13		
30	33	26	1.0/13	1.0/13	
36	40	31	1.0/13	1.0/13	
42	46	36	M.L. <sup>a</sup>	M.L. <sup>b</sup>	1.0/13
48	53	41	M.L. <sup>a</sup>	M.L. <sup>b</sup>	1.25/13
54	60	46	M.L. <sup>a</sup>	M.L. <sup>b</sup>	1.25/13
60	66	51	M.L. <sup>a</sup>	M.L. <sup>b</sup>	1.25/13



**Galvanized, ALUMINIZED STEEL Type 2 or  
Polymer Coated\*\* Steel ULTRA FLO Pipe-Arch E 80 Live Load**

Span x Rise (Inches)	Round Equivalent	Minimum Cover (Inches)	Minimum Gage	Max Cover (Feet)
20x16	18	24	16	22
23x19	21	24	16	21
27x21	24	24	16	18
33x26	30	24	16	18
40x31	36	24	16	17
46x36	42	24	12	18
53x41	48	24	12	18
60x46	54	24	12	18
66x51	60	24	12	18



ULTRA FLO can be manufactured from polymer coated steel for added durability.

- All heights of cover are based on trench conditions. If embankment conditions exist, there may be restriction on gages for the large diameters. Your Contech Sales Representative can provide further guidance for a project in embankment conditions.
- All steel ULTRA FLO is installed in accordance with ASTM A798 "Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications."

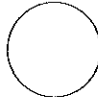
\* These sizes and gage combinations are installed in accordance with ASTM A796 paragraphs 18.2.3 and ASTM A798. For aluminum ULTRA FLO refer to ASTM B790 and B788.

\*\* Contact your local Contech representative for more specific information on Polymer Coated ULTRA FLO for gages 12 and 10.



## Heights of Cover

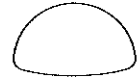
### Aluminum ULTRA FLO HL 93 Live Load



Diameter (Inches)	Minimum/Maximum Cover (Feet) Specified Thickness and Gage			
	(0.060)	(0.075)	(0.105)	(0.135)
	16	14	12	10
18	1.0/43	1.0/61		
21	1.0/38	1.0/52	1.0/84	
24	1.0/33	1.0/45	1.0/73	
30	1.0/26	1.25/36	1.25/58	
36	1.5*/21*	1.50/30	1.5/49	1.5/69
42		1.75*/25*	1.75/41	1.75/59
48			2.0/36	2.0/51
54			2.0/32	2.0/46
60			2.0*/29*	2.0/41
66				2.0/37
72				2.5*/34*

See previous page for height of cover notes.

### Aluminum ULTRA FLO Pipe-Arch HL 93 Live Load



Equiv. Pipe Dia. (Inches)	Span (Inches)	Rise (Inches)	Minimum/Maximum Cover (Feet) Specified Thickness and Gage			
			(0.060)	(0.075)	(0.105)	(0.135)
			16	14	12	10
18	20	16	1.0/16			
21	23	19	1.0/15			
24	27	21	1.25/13	1.25/13		
30	33	26	1.5/13	1.5/13	1.5/13	
36	40	31		1.75/13	1.75/13	
42	46	36			2.0/13	2.0/13
48	53	41			2.0/13	2.0/13
54	60	46			2.0*/13*	2.0/13
60	66	51				2.0/13

## Approximate Weight/Foot Contech ULTRA FLO Pipe

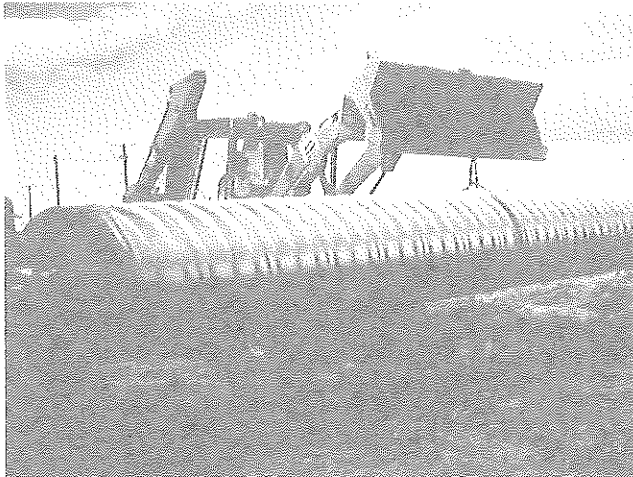
### Handling Weight for ALUMINIZED STEEL Type 2 or Galvanized Steel ULTRA FLO

Diameter (Inches)	Weight (Pounds/Lineal Foot) Specified Thickness and Gage			
	(0.064)	(0.079)	(0.109)	(0.138)
	16	14	12	10
18	15	18		
21	17	21	29	
24	19	24	36	
30	24	30	42	
36	29	36	50	
42	33	42	58	
48	38	48	66	80
54	45	54	75	90
60	48	60	83	99
66		66	91	109
72		72	99	119
78		78	108	129
84			116	139
90			124	149
96			132	158
102			141	168
108				175
114				196
120				206

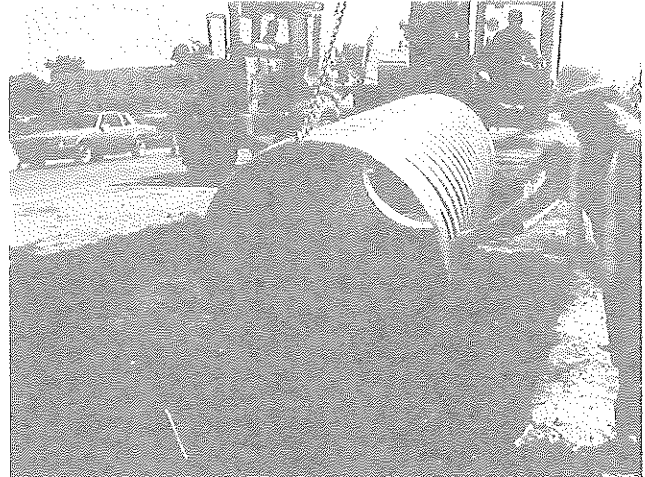
### Handling Weight for ALUMINUM ULTRA FLO

Diameter (Inches)	Weight (Pounds/Lineal Foot) Specified Thickness and Gage			
	(0.060)	(0.075)	(0.105)	(0.135)
	16	14	12	10
18	5	6		
21	6	8	11	
24	7	9	13	
30	9	11	15	
36	11	13	18	23
42	12	15	21	26
48		17	24	30
54		19	27	34
60			30	37
66			33	41
72			36	45
78				49
84				52

Weights for polymer coated pipe are 1% to 4% higher, varying by gage.



ULTRA FLO is available in long lengths. And, its light weight allows it to be unloaded and handled with small equipment.



Reduced excavation because of ULTRA FLO's smaller outside diameter.

## Installation Corrugated Metal Pipe

### Overview

Satisfactory site preparation, trench excavation, bedding and backfill operations are essential to develop the strength of any flexible conduit. In order to obtain proper strength while preventing settlement, it is necessary that the soil envelope around the pipe be of good granular material, properly placed and carefully compacted.

### Bedding

Bedding preparation is critical to both pipe performance and service life. The bed should be constructed to uniform line and grade to avoid distortions that may create undesirable stresses in the pipe and/or rapid deterioration of the roadway. The bed should be free of rock formations, protruding stones, frozen lumps, roots and other foreign matter that may cause unequal settlement.

### Placing the pipe

Corrugated metal pipe weighs much less than other commonly used drainage structures. This is due to the efficient strength of the metal, further improved with carefully designed and formed corrugations. Even the heaviest sections of Contech pipe can be handled with relatively light equipment compared with equipment required for much heavier reinforced concrete pipe.

### Backfill

Satisfactory backfill material, proper placement and compaction are key factors in obtaining maximum strength and stability. Backfill should be a well-graded granular material and should be free of large stones, frozen lumps and other debris.

Backfill materials should be placed in layers about six inches deep, deposited alternately on opposite sides of the pipe. Each layer should be compacted carefully. Select backfill is placed and compacted until minimum cover height is reached, at which point, standard road embankment backfill procedures are used.

### Installation References

For more information, see AASHTO Bridge Construction Specification Section 26, the Installation Manual of the National Corrugated Steel Pipe Association, ASTM A798 for steel and ASTM B788 for aluminum ULTRA FLO.

### Additional Considerations for ULTRA FLO Installations Bedding and Backfill

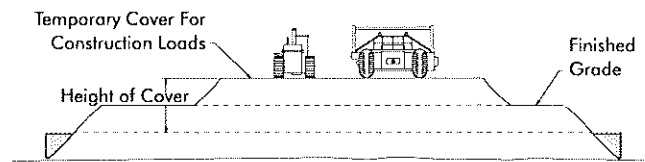
Typical ULTRA FLO installation requirements are the same as for any other corrugated metal pipe installed in a trench. Bedding and backfill materials for ULTRA FLO follow the requirements of the CMP installation specifications mentioned above, and must be free from stones, frozen lumps or other debris. When ASTM A796 (steel) or B790 (aluminum) designs are to be followed for condition III requirements, indicated by asterisk (\*) in the tables on page 13 and 14, use clean, easily compacted granular backfill materials.

### Embankment Conditions

ULTRA FLO is a superior CMP storm sewer product that is normally installed in a trench condition. In those unusual embankment installation conditions, pipe sizes and gages may be restricted. Your Contech Sales Representative can provide you with further guidance.

### Construction Loads

For temporary construction vehicle loads, an extra amount of compacted cover may be required over the top of the pipe. The Height of Cover shall meet minimum requirements shown in the table below. The use of heavy construction equipment necessitates greater protection for the pipe than finished grade cover minimums for normal highway traffic.



Min. Height of Cover Requirements for Construction Loads On  
Corrugated Steel Pipe\*

Diameter/ Span, (Inches)	Minimum Cover (feet) for Indicated Axle Loads (kips)			
	18-50	50-75	75-110	110-150
12-42	2.0	2.5	3.0	3.0
48-72	3.0	3.0	3.5	4.0
78-120	3.0	3.5	4.0	4.0
126-144	3.5	4.0	4.5	4.5

Min. Height of Cover Requirements for Construction Loads On  
Corrugated Aluminum Pipe\*

Diameter/ Span (Inches)	Axle Load (Kips)			
	18-50	50-75	75-110	110-150
12-42	3.0'	3.5'	4.0'	4.0'
48-72	4.0'	4.0'	5.0'	5.5'
78-120	4.0'	5.0'	5.5'	5.5'

Min. Height of Cover Requirements for Construction Loads On  
ULTRA FLO Pipe\*

Diameter/ Span (Inches)	Axle Load (Kips)			
	18-50	50-75	75-110	110-150
	<b>Steel 3/4" x 3/4" x 7-1/2"</b>			
15-42	2.0'	2.5'	3.0'	3.0'
48-72	3.0'	3.0'	3.5'	4.0'
78-108	3.0'	3.5'	4.0'	4.5'
	<b>Aluminum 3/4" x 3/4" x 7-1/2"</b>			
15-42	3.0'	3.5'	4.0'	4.0'

\* Minimum cover may vary depending on local conditions. The contractor must provide the additional cover required to avoid damage to the pipe. Minimum cover is measured from the top of the pipe to the top of the maintained construction roadway surface.

# SmoothCor™ Pipe

## Excellent Hydraulics, Long Lengths and Easy Installation

### Corrugated Steel Shell

SmoothCor pipe has a smooth interior steel liner that provides a Manning's "n" of 0.012. Its rugged, corrugated steel shell supplies the structural strength to outperform rigid pipe. SmoothCor pipe is both the economical and performance alternate to concrete.

### Superior hydraulics

SmoothCor, with its smooth interior surface, is hydraulically superior to conventional corrugated steel pipe and with fewer joints and better interior surface, outperforms reinforced concrete pipe.

SmoothCor, with its long lengths, light weight and beam strength, is superior to concrete pipe in many difficult situations such as poor soils, poor subsurface drainage conditions, steep slopes and high fills. SmoothCor should be specified as an alternate under normal site conditions, and specified exclusively under very difficult situations that demand the strength of CSP with positive joints and a hydraulically efficient smooth liner.

### Two Pipe Shapes

In addition to full-round pipe, SmoothCor comes in a pipe-arch shape for limited headroom conditions. The low, wide pipe-arch design distributes the flow area horizontally, enabling it to be installed with lower head room than a round pipe.

### Reference specifications

Material	Polymer Coated	ASTM A 929 AASHTO M246 ASTM A 742
Pipe	Polymer	AASHTO M245 ASTM A 762 & A 760
Design	Steel Pipe	AASHTO Section 12 ASTM A 796
Installation	Steel Pipe	AASHTO Section 26 ASTM A 798

### Structural Design

SmoothCor is lined with either 18 or 20 gage steel. Contech has taken a conservative approach to the Height of Cover. The maximum heights-of-cover are based on the shell thickness with no additional structural allowance for the liner as provided for in the AASHTO and ASTM design specifications. Using this approach, the Height of Cover tables for 2 2/3" x 1/2" and 3"x1" steel corrugations can be used for SmoothCor.

### Diameters

SmoothCor is available in diameters ranging from 18 inches to 66 inches in 2 2/3" x 1/2" corrugation. The 3" x 1" corrugation is available in diameters of 48 inches to 126 inches.

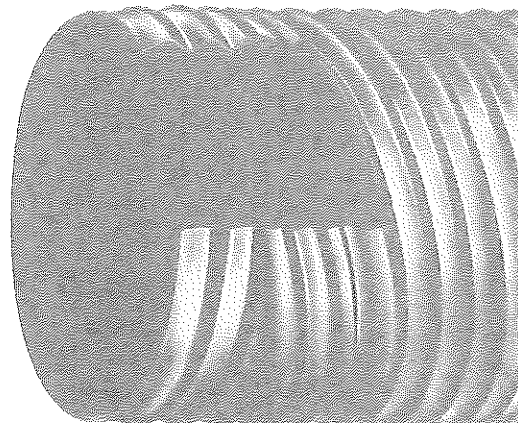
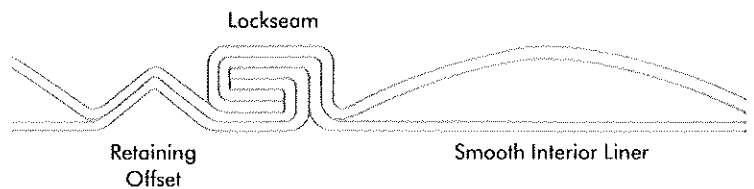
Pipe-arch sizes range from 21" x 15" through 77" x 52" for 2 2/3" x 1/2" corrugations, and 53" x 41" through 137" x 87" for 3"x1" corrugations.

### Materials

SmoothCor is available with Dow's TRENCHCOAT® that allows the engineer to design for long service life. TRENCHCOAT is a tough, heavy-gage polymer film laminated to both sides of the steel coil, providing a barrier to corrosion and mild abrasion. TRENCHCOAT is particularly effective for protection in corrosive soils.

### Fittings

SmoothCor can be fabricated into any type of structure including tees, elbows, laterals, catch basins, manifolds and reducers. Pre-fabricated fittings are more economical and have superior hydraulic characteristics when compared to concrete structures.



## QUICK STAB® Joint

### Save Time and Money With Faster Pipe Bell and Spigot Coupling

The Contech QUICK STAB Bell and Spigot joint speeds installation of corrugated metal pipe (CMP), reducing your costs. With the QUICK STAB coupling system, installation of CMP storm sewers and culverts has never been easier or faster.

The QUICK STAB joint creates a bell and spigot joining system with the bell only 1-1/2" larger than the pipe's O.D. Assembled at the factory, the QUICK STAB bell is shipped to the job site ready for installation. The only field operation is placing a special fluted gasket onto the spigot end of the pipe, applying lubricant and pushing it into the bell end of the preceding pipe. Without bands, bolts and wrenches to work and worry with, you can join pipe segments 50% to 90% faster—saving time, money and aggravation.

### Soil Tight Joint

Contech's QUICK STAB joint provides the same soil tightness as conventional CMP bands. Each QUICK STAB joint uses a double sealing fluted gasket to seal the spigot against the bell. A flat gasket is installed at the plant between the pipe and the corrugated end of the bell. With the deep bell, you gain maximum soil tightness with minimal installation effort.

### Wide Variety of Coatings and Materials

- Plain galvanized
- Aluminized Steel Type 2
- Aluminum
- Polymeric coated

### Four Times Faster Installation Than Concrete

The QUICK STAB's bell and spigot joining system allows pipe segments to be joined quicker than reinforced concrete pipe. Next, add in Contech's corrugated metal pipe's length advantage—each segment is four times longer than standard concrete pipe lengths. That means fewer joints and faster installation—up to four times faster! Plus, with the bell only 1-1/2" larger than the pipe, trench excavation is considerably less compared with concrete—again, saving time and money.

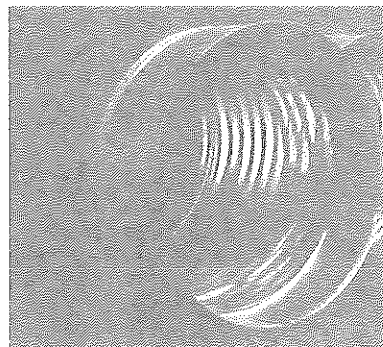
### Field Installation Instructions

The spigot and bell ends must be cleaned of any dirt or debris prior to assembly. The fluted gasket shall be placed in the first corrugation with the lower flute nearest the end of the pipe. The bell & gasket shall be thoroughly lubed just

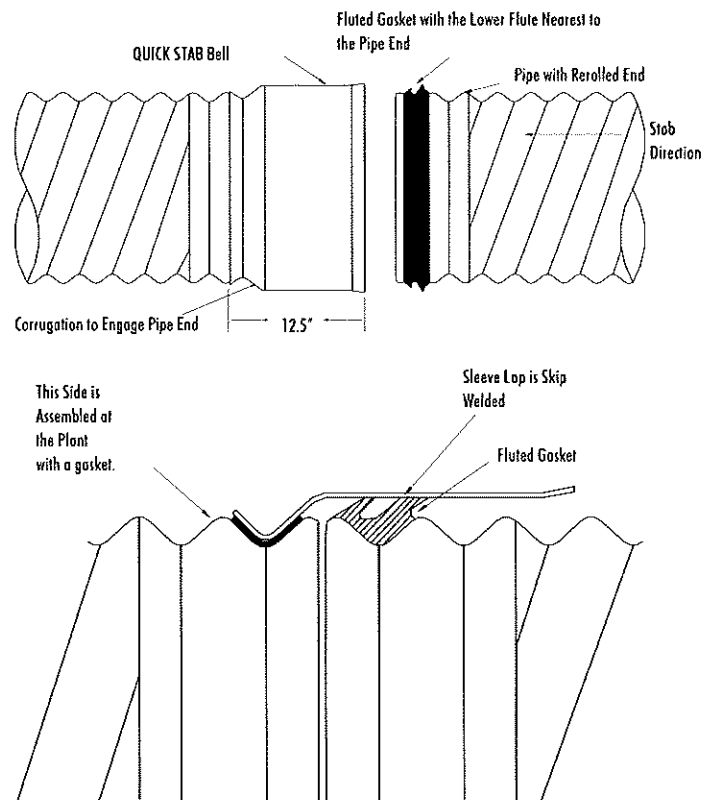
before stabbing in the bell. Do not place hands, fingers, or any other body parts between bell and spigot during assembly. If it is necessary to pull the joint apart, the bell, spigot and gasket shall be inspected and cleaned of any dirt or debris prior to re-stabbing.

### Corrugated Metal Pipe Bell and Spigot Joint Specification

The joints shall be of such design and the ends of the corrugated metal pipe sections so formed that the pipe can be laid together to make a continuous line of pipe. The joint shall be made from the same material as the pipe and shall prevent infiltration of the fill material.



### Bell and Spigot Coupling System for CMP



The Bell and Spigot joint is available on ULTRA FLO and 2-2/3" x 1/2" corrugation in 15" through 60" diameter.

## End Sections

### Easily installed, easily maintained culvert end treatments for corrugated metal pipe, reinforced concrete pipe and HDPE Pipe

Contech End Sections provide a practical, economical and hydraulically superior method of finishing a variety of culvert materials.

The lightweight, flexible metal construction of Contech End Sections creates an attractive, durable and erosion-preventing treatment for all sizes of culvert inlets and outlets. They can be used with corrugated metal pipe having either annular or helical corrugations, and both reinforced concrete and plastic pipes. End sections can be salvaged when lengthening or relocating the culvert.

Standard End Sections are fabricated from pregalvanized steel. For added corrosion resistance, Aluminized Type II or Aluminum End Sections are available in smaller sizes. Special End Sections for multiple pipe installations may be available on a specific inquiry basis.

### Better hydraulics

Flow characteristics are greatly improved by the exacting design of Contech End Sections. Scour and sedimentation conditions are improved, and headwater depth can be better controlled. Culverts aligned with the stream flow and finished with Contech End Sections generally require no additional hydraulic controls.

### Improved appearance

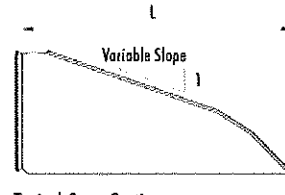
Contech End Sections blend well with the surroundings. The tapered sides of an End Section merge with slope design to improve roadside appearance. Unsightly weeds and debris collection at the culvert end are reduced.

### Economical installation

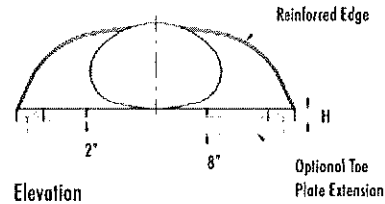
Lightweight equipment and simple crew instructions result in smooth and easy installation. Contech End Sections are easily joined to culvert barrels, forming a continuous, one-piece structure. For easiest installation, End Sections should be installed at the same time as the culvert. Installation is completed by tamping soil around the End Section.

### Low maintenance

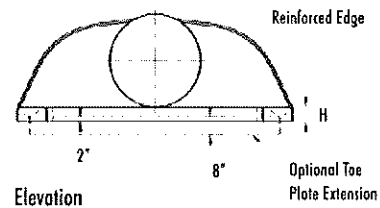
Contech End Sections reduce maintenance expense because their tapered design promotes easier mowing and snow removal. There is no obstruction to hamper weed cutting.



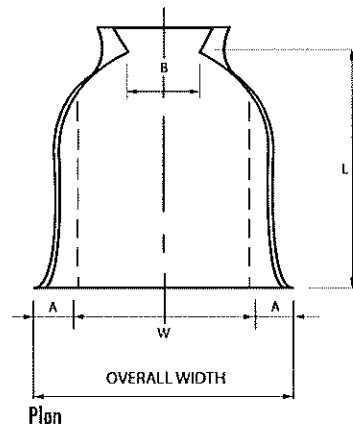
Typical Cross Section



Elevation



Elevation



Plan

#### Notes for all End Sections:

1. All three-piece bodies to have 12-gage sides and 10-gage center panels. Multiple panel bodies to have lap seams which are to be tightly joined by galvanized rivets or bolts.
2. For 60" through 84" sizes, reinforced edges are supplemented with stiffener angles. The angles are attached by galvanized nuts and bolts. For the 66" and 72" equivalent round pipe-arch sizes, reinforced edges are supplemented by angles. The angles are attached by galvanized nuts and bolts.
3. Angle reinforcements are placed under the center panel seams on the 66" and 72" equivalent round pipe-arch sizes.
4. Toe plate is available as an accessory, when specified on the order, and will be same gage as the End Section.
5. Stiffener angles, angle reinforcement, and toe plates are the same base metal as end section body.
6. End sections with 6:1 and 4:1 slopes are available in 12" through 24" diameters.
7. Actual dimensions may vary slightly.
8. During manufacturing, a slight invert slope may result along the length of the end section to be accommodated in the field.

**End Sections for Round Pipe (2-2/3" x 1/2", 3" x 1" and 5" x 1")**

**Approximate Dimensions, Inches <sup>(7)</sup>**

Pipe Diameter (Inches)	Gage	A (+/- 1") (Inches)	B (Max) (Inches)	H (Min) (Inches)	L (+/- 2") (Inches)	W (+/- 2") (Inches)	Overall Width (+/- 4") (Inches)
12	16	6	6	6	21	24	36
15	16	7	8	6	26	30	44
18	16	8	10	6	31	36	52
21	16	9	12	6	36	42	60
24	16	10	13	6	41	48	68
30	14	12	16	8	51	60	84
36	14	14	19	9	60	72	100
42	12	16	22	11	69	84	116
48	12	18	27	12	78	90	126
54	12	18	30	12	84	102	138
60	12/10	18	33	12	87	114	150
66	12/10	18	36	12	87	120	156
72	12/10	18	39	12	87	126	162
78	12/10	18	42	12	87	132	168
84	12/10	18	45	12	87	138	174

**End Sections for Pipe-Arch (2-2/3" x 1/2")**

**Approximate Dimensions, Inches <sup>(7)</sup>**

Span/Rise	Equiv. Round (Inches)	Gage	A (+/- 1") (Inches)	B (Max) (Inches)	H (+/- 1") (Inches)	L (+/- 2") (Inches)	W (+/- 2") (Inches)	Overall Width (+/- 4") (Inches)
17"x13"	15	16	7	9	6	19	30	44
21"x15"	18	16	7	10	6	23	36	50
24"x18"	21	16	8	12	6	28	42	58
28"x20"	24	16	9	14	6	32	48	66
35"x24"	30	14	10	16	6	39	60	80
42"x29"	36	14	12	18	8	46	75	99
49"x33"	42	12	13	21	9	53	85	111
57"x38"	48	12	18	26	12	63	90	126
64"x43"	54	12	18	30	12	70	102	138
71"x47"	60	12/10	18	33	12	77	114	150
77"x52"	66	12/10	18	36	12	77	126	162
83"x57"	72	12/10	18	39	12	77	138	174

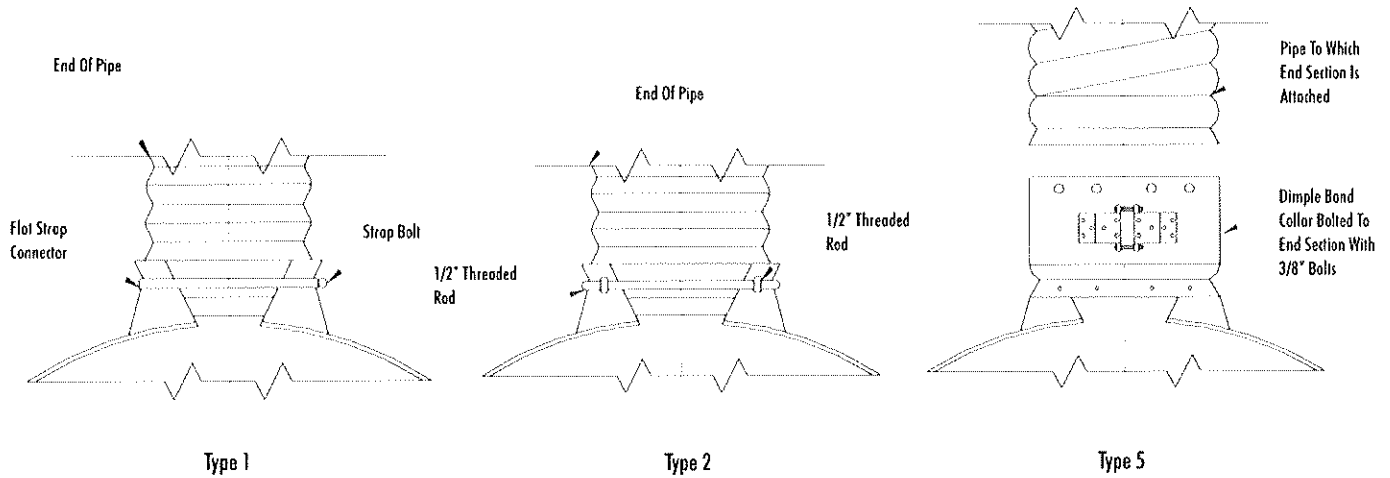
**End Sections for Pipe-Arch (3" x 1" and 5" x 1")**

**Approximate Dimensions, Inches <sup>(7)</sup>**

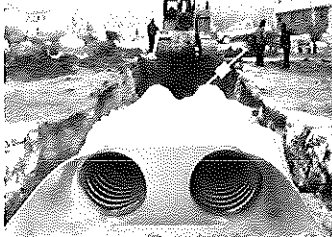
Span/Rise	Equiv. Round (Inches)	Gage	A (+/- 1") (Inches)	B (Max) (Inches)	H (+/- 1") (Inches)	W (+/- 2") (Inches)	L (+/- 2") (Inches)	Overall Width (+/- 4") (Inches)
53"x41"	48	12	18	25	12	90	63	126
60"x46"	54	12	18	34	12	102	70	138
66"x51"	60	12/10	18	33	12	116	77	152
73"x55"	66	12/10	18	36	12	126	77	162
81"x59"	72	12/10	18	39	12	138	77	174
87"x63"	78	12/10	20	38	12	148	77	188
95"x67"	84	12/10	20	34	12	162	87	202
103"x71"	90	12/10	20	38	12	174	87	214
112"x75"	96	12/10	20	40	12	174	87	214



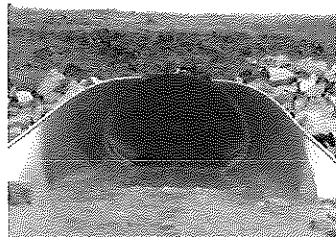
## Contech End Sections attach to corrugated metal pipe, reinforced concrete and plastic pipe.



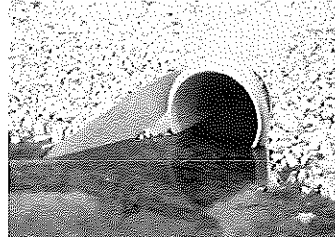
**Note:** The Type 3 connection is not illustrated. This connection is a one-foot length of pipe attached to the end section.



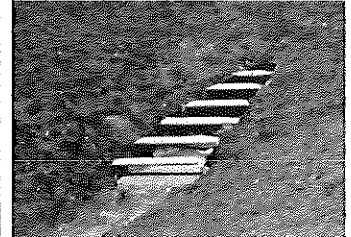
End Section on Round CSP



End Sections are available for CSP Pipe-Arch



Contech End Sections are often used on concrete pipe. They can be used on both the bell and spigot end.



Low-slope End Sections—Contech manufactures 4:1 and 6:1 low-slope End Sections for corrugated metal pipe. This photo shows the optional field-attached safety bars.

Contech Engineered Solutions LLC is a leading provider of site solution products and services for the civil engineering industry. Contech's product portfolio includes bridges, drainage, retaining walls, sanitary sewer, stormwater, erosion control, soil stabilization and wastewater products.

**For more information, call one of Contech's Regional Offices located in the following cities:**

**Ohio (Corporate Office) 513-645-7000**

Colorado (Denver) 720-587-2700

Florida (Orlando) 321-348-3520

Maine (Scarborough) 207-885-9830

Maryland (Baltimore) 410-740-8490

Oregon (Portland) 503-258-3180

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# AQUA-SWIRL ™

HYDRODYNAMIC SEPARATION



- 1** Floatable debris, oils, and grease enter the storm drain
- 2** Contaminated water enters the Aqua-Swirl™ via the main conveyance storm pipe
- 3** The Aqua-Swirl™ is constructed of durable, lightweight, and high performance materials
- 4** Vortex separation is used to remove the gross sediment, floating debris and free-oil
- 5** Independent validation for TSS removal into sensitive receiving waters

INNOVATING GOOD CLEAN WATER



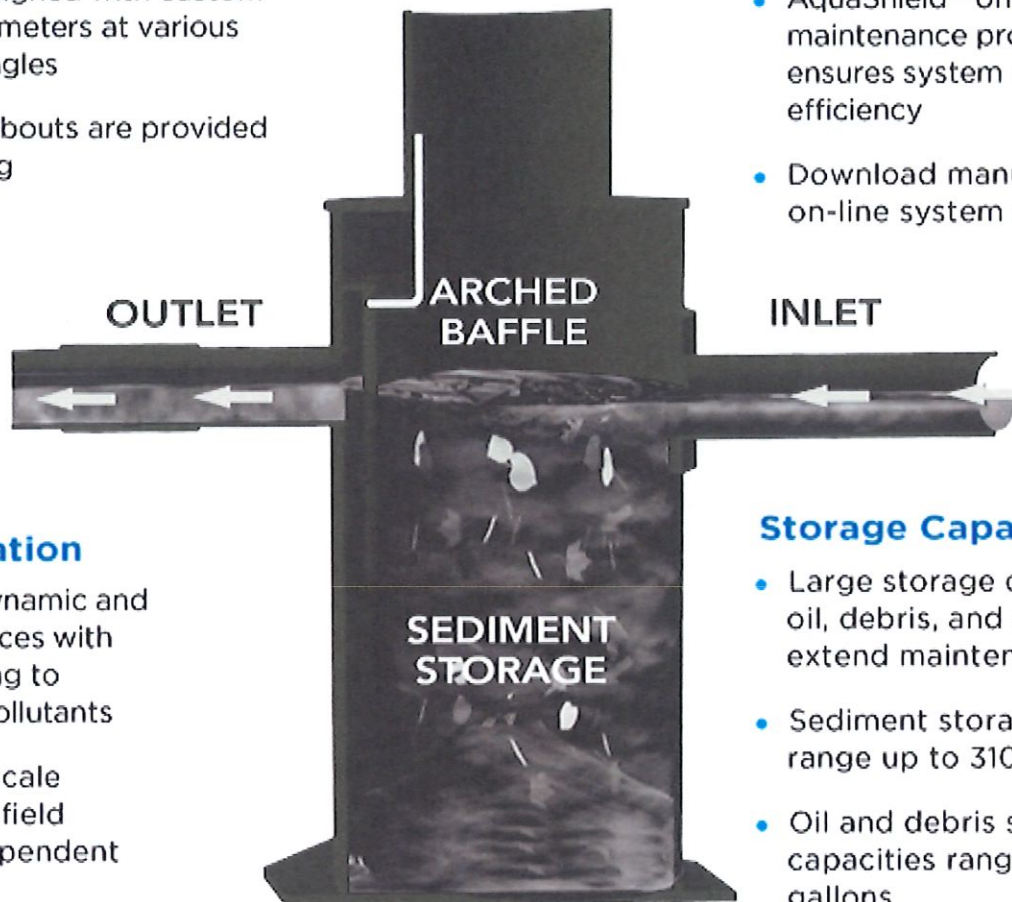
# AQUA-SWIRL

## Pipe Connections

- Systems are designed with custom inlet / outlet diameters at various configuration angles
- Inlet / outlet stubouts are provided for easy coupling

## Inspection & Maintenance

- AquaShield™ offers an extensive maintenance program that ensures system performance efficiency
- Download manuals from the on-line system catalog



## Vortex Separation

- Utilizes hydrodynamic and gravitational forces with quiescent settling to remove gross pollutants
- Extensive full-scale laboratory and field testing by independent third parties

## Storage Capacities

- Large storage capacities for oil, debris, and sediment extend maintenance cycles
- Sediment storage capacities range up to 310 ft<sup>3</sup>
- Oil and debris storage capacities range up to 1986 gallons

## Bypass

- Systems are designed to treat water quality flow rates and bypass peak storm events
- Internal and external bypass configurations are available

## Installation Benefits

- Quick and simple installation, resulting in measurable project cost savings
- H<sub>2</sub>O loading capabilities
- Small footprint design reduces excavation costs
- Lightweight and durable construction
- Lifting supports & cables provided

## Aqua-Swirl™ System

- Provides customized solutions for project specific requirements
- Systems designed for specific water quality treatment flows
- Modular sizes from 2.5 - 13 ft diameters with attached risers to finish grade
- On-line project and system design tool at <http://pda.aquashieldinc.com>

# CALIFORNIA CERTIFIED FULL TRASH CAPTURE



## Aqua-Swirl® Sizing Chart

Aqua-Swirl® Model	Swirl Chamber Diameter (ft.)	Maximum Stub-Out Pipe Nominal Diameter (in.)		Water Quality Treatment Flow <sup>2</sup> (cfs)	Trash/Debris Storage Capacity (ft <sup>3</sup> )
		On/Offline	BYP <sup>1</sup>		
AS-2s	2.50	8	15	1.1	1.0
AS-3s	3.50	10	21	2.1	2.1
AS-4s	4.50	12	27	3.5	3.4
AS-5s	5.00	12	30	4.4	4.3
AS-6s	6.00	15	36	6.3	6.3
AS-7s	7.00	18	42	8.6	8.6
AS-8s	8.00	18	48	11.2	11.4
AS-9s	9.00	21	54	14.2	14.5
AS-10s	10.0	24	60	17.5	17.9
AS-11s	11.0	24	60*	21.2	21.8
AS-12s	12.0	24	60*	25.2	26.0
AS-13s	13.0	27	60*	29.6	30.6
AS-XX	Custom	--	--	>29.6**	--

\* See AquaShield representative for more information on pipe sizes available.

\*\* Higher water quality treatment flow rates can be designed with multiple swirls.

- 1) The **Aqua-Swirl® Internal Bypass (BYP)** provides full treatment of the "first flush," specifically the 1-year, 1-hour storm event while the peak storm is diverted and bypassed through the main conveyance pipe.
- 2) In accordance with the Trash Amendments, all trash treatment control devices installed after December 2, 2015 shall meet the Full Capture System definition and be certified by the State Water Resources Control Board (State Water Board) Executive Director, or designee, prior to installation. **The Aqua-Swirl device meets the Full Capture System definition and is certified for installation by the State Water Board Executive Director designee.** For more info:  
[https://www.waterboards.ca.gov/water\\_issues/programs/stormwater/docs/trash\\_implementation/a1\\_certified\\_fcd.pdf](https://www.waterboards.ca.gov/water_issues/programs/stormwater/docs/trash_implementation/a1_certified_fcd.pdf)

The design and orientation of the Aqua-Swirl® generally entails some degree of customization. For assistance in design and specific layouts, please refer to an AquaShield™ representative or visit our website at [www.AquaShieldinc.com](http://www.AquaShieldinc.com). CAD details and specifications are available upon request.





## **6.2 Electronic Data Submittal**

**(not required until Final WQMP is submitted and approved)**





## 6.3 Post Construction

AND WHEN RECORDED MAIL TO

City Clerk  
City of Chino  
P.O. Box 667  
Chino, CA 91708

SPACE ABOVE THIS LINE FOR RECORDER'S USE

**WATER QUALITY MANAGEMENT PLAN AND STORMWATER BMP  
TRANSFER, ACCESS AND MAINTENANCE AGREEMENT**

**CITY OF CHINO, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA**

This Agreement is made and entered into this \_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_, by and between the CITY OF CHINO, a municipal corporation, hereinafter referred to as CITY, and \_\_\_\_\_ hereinafter referred to as OWNER.

WHEREAS, the Owner is the legal property owner of the real property situated in the State of California, County of San Bernardino, located at \_\_\_\_\_ in the City of Chino, more commonly referred to as San Bernardino County Tax Assessor Parcel No. \_\_\_\_\_ described in Exhibit A and depicted in Exhibit B attached hereto and incorporated herein by this reference; and

WHEREAS, at the time of initial approval of the development project known as \_\_\_\_\_ within the Property described herein, the City required the project to employ Best Management Practices, hereinafter referred to as "BMPs," to minimize pollutants in urban runoff; and

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

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

WHEREAS, said BMPs, with installation and/or implementation on private property and draining only private property, are part of a private facility with all maintenance or replacement therefore, the sole responsibility of the Owner in accordance with the terms of this Agreement;

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

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

1. The Owner hereby provides the City or the City's designee complete access, of any duration, to the BMPs and their immediate vicinity at any time, upon reasonable notice, or in the event of emergency, as determined by City's Director of Public Works with no advance notice, for the purpose of inspection, sampling, testing of the BMPs, and in case of emergency, to undertake all necessary repairs or other preventative measures at the owner's expense as provided in paragraph 3 below. The City shall make every effort at all times to minimize or avoid interference with the Owner's use of the Property.
2. The Owner shall use its best efforts diligently to maintain all BMPs in a manner assuring peak performance at all times. All reasonable precautions shall be exercised by the Owner and the Owner's representative or contractor in the removal and extraction of any material(s) from the BMPs and the ultimate disposal of the material(s) in a manner consistent with all relevant laws and regulations in effect at the time. As may be requested from time to time by the City, the Owner shall provide the City with documentation identifying the material(s) removed, the quantity, and disposal destination.
3. In the event the Owner, or its successors or assigns, fails to accomplish the necessary maintenance contemplated by this Agreement, within five (5) days of being given written notice by the City, the City is hereby authorized to cause any maintenance necessary to be done and charge the entire cost and expense to the Owner or the Owner's successors or assigns, including administrative costs, attorneys fees and interest thereon at the maximum rate authorized by the Civil Code from the date of the notice of expense until paid in full.
4. The City may require the Owner to post security in form and for a time period satisfactory to the City to guarantee the performance of the obligations stated herein. Should the Owner fail to perform the obligations under this Agreement, the City may, in the case of a cash bond, act for the Owner using the proceeds from it, or in the case of a surety bond, require the sureties to perform the obligations of this Agreement. As an additional remedy, the Director may withdraw any previous stormwater-related approval with respect to the property on which BMPs have been installed and/or implemented until such time as the Owner repays to the City its reasonable costs incurred in accordance with paragraph 3 above.
5. This Agreement shall be recorded in the Office of the Recorder of San Bernardino County, California, at the expense of the Owner and shall constitute notice to all successors and assigns of the title to said Property of the obligation herein set forth, and also a lien in such amount as will fully reimburse the City, including interest as herein above set forth, subject to foreclosure in event of default in payment.
6. In event of legal action occasioned by any default or action of the Owner, or its successors or assigns, then the Owner and its successors or assigns agree(s) to pay all costs incurred by the City in enforcing the terms of this Agreement, including reasonable attorney's fees and costs, and that the same shall become a part of the lien against said Property.
7. It is the intent of the parties hereto that burdens and benefits herein undertaken shall constitute covenants that run with said Property and constitute a lien against the Property.
8. The obligations herein undertaken shall be binding upon the heirs, successors, executors, administrators and assigns of the parties hereto. The term "Owner" shall include not only the present Owner, but also its heirs, successors, executors, administrators, and assigns. The Owner shall notify any successor to title of all or part of the Property about the existence of this Agreement. The Owner shall provide such notice prior to such successor obtaining an interest in all or part of the Property. The Owner shall provide a copy of such notice to the City at the same time such notice is provided to the successor.

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

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

IF TO CITY:

IF TO OWNER:

Amer Jakher

Director of Public Works

13220 Central Avenue

Chino, CA 91710

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

APPROVED AS TO FORM:

APPROVED AS TO CONTENT:

By: (Signature Not Required)  
City Attorney

By: Amer Jakher  
Director of Public Works  
City of Chino

City of Chino

Owner: \_\_\_\_\_  
(Company)

By: Matthew C. Ballantyne  
City Manager

By: \_\_\_\_\_  
(Signature and Date)

ATTEST:

Name: \_\_\_\_\_  
(Please Print or Type Name)

Angela Robles, City Clerk

Title: \_\_\_\_\_  
(Please Print or Type Title)

**NOTE: OWNER'S SIGNATURE MUST BE NOTARIZED FOR RECORDATION**







# **6.4 Attachment C Educational Materials**



# A Citizen's Guide to Understanding Stormwater



EPA 833-B-03-002  
February 2003  
EPA  
Environmental Protection Agency

## After the Storm

or visit  
[www.epa.gov/nps/stormwater](http://www.epa.gov/nps/stormwater)  
[www.epa.gov/nps](http://www.epa.gov/nps)

For more information contact:



### What is stormwater runoff?



Stormwater runoff occurs when precipitation from rain or snowmelt flows over the ground. Impervious surfaces like driveways, sidewalks, and streets prevent stormwater from naturally soaking into the ground.

### Why is stormwater runoff a problem?



Stormwater can pick up debris, chemicals, dirt, and other pollutants and flow into a storm sewer system or directly to a lake, stream, river, wetland, or coastal water. Anything that enters a storm sewer system is discharged untreated into the waterbodies we use for swimming, fishing, and providing drinking water.

### The effects of pollution

Polluted stormwater runoff can have many adverse effects on plants, fish, animals, and people.

- ◆ Sediment can cloud the water and make it difficult or impossible for aquatic plants to grow. Sediment also can destroy aquatic habitats.
- ◆ Excess nutrients can cause algae blooms. When algae die, they sink to the bottom and decompose in a process that removes oxygen from the water. Fish and other aquatic organisms can't exist in water with low dissolved oxygen levels.
- ◆ Bacteria and other pathogens can wash into swimming areas and create health hazards, often making beach closures necessary.
- ◆ Debris—plastic bags, six-pack rings, bottles, and cigarette butts—washed into waterbodies can choke, suffocate, or disable aquatic life like ducks, fish, turtles, and birds.
- ◆ Household hazardous wastes like insecticides, pesticides, paint, solvents, used motor oil, and other auto fluids can poison aquatic life. Land animals and people can become sick or die from eating diseased fish and shellfish or ingesting polluted water.



◆ Polluted stormwater often affects drinking water sources. This, in turn, can affect human health and increase drinking water treatment costs.





# Stormwater Pollution Solutions

## Residential

Recycle or properly dispose of household products that contain chemicals, such as insecticides, pesticides, paint, solvents, and used motor oil and other auto fluids.

Don't pour them onto the ground or into storm drains.

### Lawn care

Excess fertilizers and pesticides applied to lawns and gardens wash off and pollute streams. In addition, yard clippings and leaves can wash into storm drains and contribute nutrients and organic matter to streams.

- ◆ Don't overwater your lawn. Consider using a soaker hose instead of a sprinkler.
- ◆ Use pesticides and fertilizers sparingly. When use is necessary, use these chemicals in the recommended amounts. Use organic mulch or safer pest control methods whenever possible.
- ◆ Compost or mulch yard waste. Don't leave it in the street or sweep it into storm drains or streams.
- ◆ Cover piles of dirt or mulch being used in landscaping projects.



### Septic systems

Leaking and poorly maintained septic

systems release nutrients and pathogens (bacteria and viruses) that can be picked up by stormwater and discharged into nearby waterbodies. Pathogens can cause public health problems and environmental concerns.

- ◆ Inspect your system every 3 years and pump your tank as necessary (every 3 to 5 years).
- ◆ Don't dispose of household hazardous waste in sinks or toilets.



### Pet waste

Pet waste can be a major source of bacteria and excess nutrients in local waters.

- ◆ When walking your pet, remember to pick up the waste and dispose of it properly. Flushing pet waste is the best disposal method. Leaving pet waste on the ground increases public health risks by allowing harmful bacteria and nutrients to wash into the storm drain and eventually into local waterbodies.



Education is essential to changing people's behavior. Signs and markers near storm drains warn residents that pollutants entering the drains will be carried untreated into a local waterbody.

## Residential landscaping

**Permeable Pavement**—Traditional concrete and asphalt don't allow water to soak into the ground. Instead these surfaces rely on storm drains to divert unwanted water. Permeable pavement systems allow rain and snowmelt to soak through, decreasing stormwater runoff.

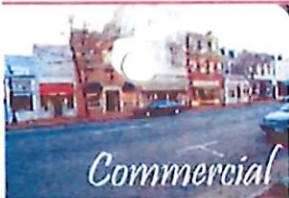
**Rain Barrels**—You can collect rainwater from rooftops in mosquito-proof containers. The water can be used later on lawn or garden areas.

**Rain Gardens and Grassy Swales**—Specially designed areas planted with native plants can provide natural places for



rainwater to collect and soak into the ground. Rain from rooftop areas or paved areas can be diverted into these areas rather than into storm drains.

**Vegetated Filter Strips**—Filter strips are areas of native grass or plants created along roadways or streams. They trap the pollutants stormwater picks up as it flows across driveways and streets.



## Commercial

Dirt, oil, and debris that collect in parking lots and paved areas can be washed into the storm sewer system and eventually enter local waterbodies.

- ◆ Sweep up litter and debris from sidewalks, driveways and parking lots, especially around storm drains.
- ◆ Cover grease storage and dumpsters and keep them clean to avoid leaks.
- ◆ Report any chemical spill to the local hazardous waste cleanup team. They'll know the best way to keep spills from harming the environment.

Erosion controls that aren't maintained can cause excessive amounts of sediment and debris to be washed into the stormwater system. Construction vehicles can leak fuel, oil, and other harmful fluids that can be picked up by stormwater and deposited into local waterbodies.

- ◆ Divert stormwater away from disturbed or exposed areas of the construction site.
- ◆ Install silt fences, vehicle mud removal areas, vegetative cover, and other sediment and erosion controls and properly maintain them, especially after rainstorms.
- ◆ Prevent soil erosion by minimizing disturbed areas during construction projects, and seed and mulch bare areas as soon as possible.



## Construction



## Agriculture

Lack of vegetation on streambanks can lead to erosion. Overgrazed pastures can also contribute excessive amounts of sediment to local waterbodies. Excess fertilizers and pesticides can poison aquatic animals and lead to destructive algae blooms. Livestock in streams can contaminate waterways with bacteria, making them unsafe for human contact.

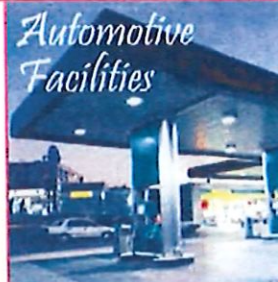
- ◆ Keep livestock away from streambanks and provide them a water source away from waterbodies.
- ◆ Store and apply manure away from waterbodies and in accordance with a nutrient management plan.
- ◆ Vegetate riparian areas along waterways.
- ◆ Rotate animal grazing to prevent soil erosion in fields.
- ◆ Apply fertilizers and pesticides according to label instructions to save money and minimize pollution.



## Forestry

Improperly managed logging operations can result in erosion and sedimentation.

- ◆ Conduct preharvest planning to prevent erosion and lower costs.
- ◆ Use logging methods and equipment that minimize soil disturbance.
- ◆ Plan and design skid trails, yard areas, and truck access roads to minimize stream crossings and avoid disturbing the forest floor.
- ◆ Construct stream crossings so that they minimize erosion and physical changes to streams.
- ◆ Expedite revegetation of cleared areas.



## Automotive Facilities

Uncovered fueling stations allow spills to be washed into storm drains. Cars waiting to be repaired can leak fuel, oil, and other harmful fluids that can be picked up by stormwater.

- ◆ Clean up spills immediately and properly dispose of cleanup materials.
- ◆ Provide cover over fueling stations and design or retrofit facilities for spill containment.
- ◆ Properly maintain fleet vehicles to prevent oil, gas, and other discharges from being washed into local waterbodies.
- ◆ Install and maintain oil/water separators.



# Help Protect Our Waterways!

Use these guidelines for Outdoor Cleaning Activities and Wash Water Disposal

**D**id you know that disposing of pollutants into the street, gutter, storm drain or body of water is **PROHIBITED** by law and can result in stiff penalties?

## Best Management Practices

Waste wash water from Mechanics, Plumbers, Window/Power Washers, Carpet Cleaners, Car Washing and Mobile Detailing activities may contain significant quantities of motor oil, grease, chemicals, dirt, detergents, brake pad dust, litter and other materials.

Best Management Practices, or BMPs as they are known, are guides to prevent pollutants from entering the storm drains. *Each of us* can do our part to keep stormwater clean by using the suggested BMPs below:

## Simple solutions for both light and heavy duty jobs:

**Do...**consider dry cleaning methods first such as a mop, broom, rag or wire brush. Always keep a spill response kit on site.

**Do...**prepare the work area before power cleaning by using sand bags, rubber mats, vacuum booms, containment pads or temporary berms to keep wash water away from the gutters and storm drains.

**Do...**use vacuums or other machines to remove and collect loose debris or litter before applying water.

**Do...**obtain the property owner's permission to dispose of *small amounts* of power washing waste water on to landscaped, gravel or unpaved surfaces.

**Do...**check your local sanitary sewer agency's policies on wash water disposal regulations before disposing of wash water into the sewer. (See list on reverse side)

**Do...**be aware that if discharging to landscape areas, soapy wash water may damage landscaping. Residual wash water may remain on paved surfaces to evaporate. Sweep up solid residuals and dispose of properly. Vacuum booms are another option for capturing and collecting wash water.

**Do...**check to see if local ordinances prevent certain activities.

**Do not let...**wash or waste water from sidewalk, plaza or building cleaning go into a street or storm drain.

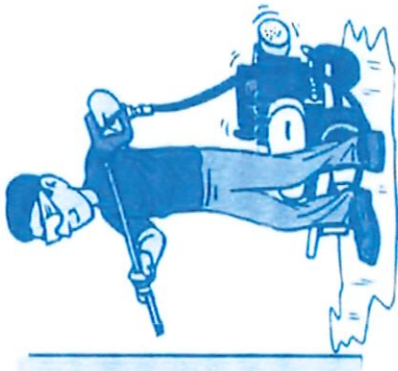


Report illegal storm drain disposal  
Call Toll Free

1-800-506-2555

## Using Cleaning Agents

Try using biodegradable/phosphate-free products. They are easier on the environment, but don't confuse them with being toxic free. Soapy water entering the storm drain system can impact the delicate aquatic environment.



When cleaning surfaces with a **high-pressure washer** or **steam cleaner**, additional precautions should be taken to prevent the discharge of pollutants into the storm drain system. These two methods of surface cleaning can loosen additional material that can contaminate local waterways.

## Think Water Conservation

Minimize water use by using high pressure, low volume nozzles. Be sure to check all hoses for leaks. Water is a precious resource, don't let it flow freely and be sure to shut it off in between uses.

## Screening Wash Water

Conduct thorough dry cleanup before washing exterior surfaces, such as buildings and decks with **loose paint**, sidewalks or plaza areas. Keep debris from entering the storm drain after cleaning by first passing the wash water through a "20 mesh" or finer screen to catch the solid materials, then dispose of the mesh in a refuse container. Do not let the remaining wash water enter a street, gutter or storm drain.

## Drain Inlet Protection & Collection of Wash Water

- Prior to any washing, block all storm drains with an impervious barrier such as sandbags or berms, or seal the storm drain with plugs or other appropriate materials.
- Create a containment area with berms and traps or take advantage of a low spot to keep wash water contained.
- Wash vehicles and equipment on grassy or gravel areas so that the wash water can seep into the ground.
- Pump or vacuum up all wash water in the contained area.

## Concrete/Coring/Saw Cutting and Drilling Projects

Protect any down-gradient inlets by using dry activity techniques whenever possible. If water is used, minimize the amount of water used during the coring/drilling or saw cutting process. Place a barrier of sandbags and/or absorbent berms to protect the storm drain inlet or watercourse. Use a shovel or wet vacuum to remove the residue from the pavement. Do not wash residue or particulate matter into a storm drain inlet or watercourse.



## Helpful telephone numbers and links:

### Riverside County Stormwater Protection Partners

Flood Control District	(951) 955-1200
County of Riverside	(951) 955-1000
City of Banning	(951) 922-3105
City of Beaumont	(951) 769-8520
City of Calimesa	(909) 795-9801
City of Canyon Lake	(951) 244-2955
Cathedral City	(760) 770-0327
City of Coachella	(760) 398-4978
City of Corona	(951) 736-2447
City of Desert Hot Springs	(760) 329-6411
City of Eastvale	(951) 361-0900
City of Hemet	(951) 765-2300
City of Indio	(760) 346-2489
City of Lake Elsinore	(760) 391-4000
City of La Quinta	(951) 674-3124
City of Menifee	(760) 777-7000
City of Moreno Valley	(951) 672-6777
City of Murrieta	(951) 413-3000
City of Norco	(951) 304-2489
City of Palm Desert	(951) 270-5607
City of Palm Springs	(760) 346-0611
City of Perris	(760) 323-8299
City of Rancho Mirage	(951) 943-6100
City of Riverside	(760) 324-4511
City of San Jacinto	(951) 361-0900
City of Temecula	(951) 654-7337
City of Wildomar	(951) 694-6444
	(951) 677-7751

### REPORT ILLEGAL STORM DRAIN DISPOSAL

1-800-506-2555 or e-mail us at  
[scndes@rcflood.org](mailto:scndes@rcflood.org)

- Riverside County Flood Control and Water Conservation District  
[www.rcflood.org](http://www.rcflood.org)

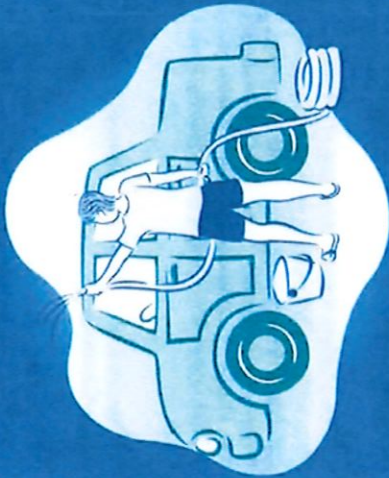
#### Online resources include:

- California Storm Water Quality Association  
[www.casqa.org](http://www.casqa.org)
- State Water Resources Control Board  
[www.waterboards.ca.gov](http://www.waterboards.ca.gov)
- Power Washers of North America  
[www.thepwna.org](http://www.thepwna.org)

## Stormwater Pollution

What you should know for...

### Outdoor Cleaning Activities and Professional Mobile Service Providers



#### Storm drain pollution prevention information for:

- Car Washing / Mobile Detailers
- Window and Carpet Cleaners
- Power Washers
- Waterproofers / Street Sweepers
- Equipment cleaners or degreasers and all mobile service providers

Do you know where street flows actually go?

Storm drains are **NOT** connected to sanitary sewer systems and treatment plants!



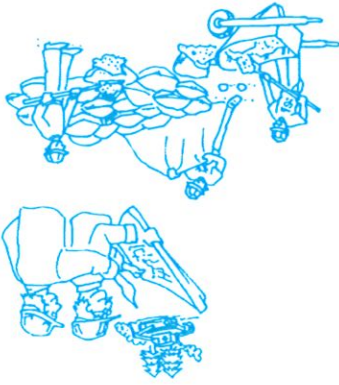
The primary purpose of storm drains is to carry rain water away from developed areas to prevent flooding. Pollutants discharged to storm drains are transported directly into rivers, lakes and streams. Soaps, degreasers, automotive fluids, litter and a host of materials are washed off buildings, sidewalks, plazas and parking areas. Vehicles and equipment must be properly managed to prevent the pollution of local waterways.

Unintentional spills by mobile service operators can flow into storm drains and pollute our waterways. **Avoid mishaps.** Always have a **Spill Response Kit** on hand to clean up unintentional spills. Only emergency **Mechanical** repairs should be done in City streets, using drip pans for spills. **Plumbing** should be done on private property. Always store chemicals in a leak-proof container and keep covered when not in use. **Window/Power Washing** waste water shouldn't be released into the streets, but should be disposed of in a sanitary sewer, landscaped area or in the soil. Soiled **Carpet Cleaning** wash water should be filtered before being discharged into the sanitary sewer. Dispose of all filter debris properly. **Car Washing/Detailing** operators should wash cars on private property and use a regulated hose nozzle for water flow control and runoff prevention. Capture and dispose of waste water and chemicals properly. Remember, storm drains are for receiving rain water runoff only.

**REPORT ILLEGAL STORM DRAIN DISPOSAL**  
**1-800-506-2555**







The two most common sources of stormwater pollution problems associated with construction activities are **erosion and sedimentation**. Failure to maintain adequate erosion and sediment controls at construction sites often results in sediment discharges into the storm drain system, creating multiple problems once it enters local waterways. Construction vehicles and heavy equipment can also track significant amounts of mud and sediment onto adjacent streets. Additionally, wind may transport construction materials and wastes into streets storm drains, or directly into our local waterways.

## STORMWATER POLLUTION FROM CONSTRUCTION ACTIVITIES

## Resources

State Water Resources Control Board  
Division of Water Quality  
1001 I Street  
Sacramento CA 95814  
(916) 341-5455  
[www.swrcb.ca.gov/stormwtr/](http://www.swrcb.ca.gov/stormwtr/)

Colorado River Basin Regional Water Quality Control Board - Region 7  
73-720 Fred Waring Drive, Suite 100  
Palm Desert, CA 92260  
(760) 346-7491  
[www.swrcb.ca.gov/~rwqcb7/](http://www.swrcb.ca.gov/~rwqcb7/)

Santa Ana Regional Water Quality Control Board - Region 8  
3737 Main Street, Suite 500  
Riverside, CA 92501-3348  
(909) 782-4130  
[www.swrcb.ca.gov/~rwqcb8/](http://www.swrcb.ca.gov/~rwqcb8/)

San Diego Regional Water Quality Control Board - Region 9  
9771 Clairemont Mesa Blvd., Suite A  
San Diego, CA 92124  
(858) 467-2952  
[www.swrcb.ca.gov/~rwqcb9/](http://www.swrcb.ca.gov/~rwqcb9/)

In accordance with applicable federal and state law, the Cities and County of Riverside have adopted ordinances for stormwater management and discharge control that **prohibit** the discharge of pollutants into the storm drain system or local surface water. This includes discharges from construction sites containing sediment, concrete, mortar, paint, solvents, lubricants, vehicle fluids, fuel, pesticides, and construction debris.

**PLEASE NOTE:** The Federal, State and local regulations strictly prohibit the discharge of sediment and pollutants into the streets, the storm drain system or waterways. As an owner, operator or supervisor of a construction site, you may be held financially responsible for any environmental damage caused by your subcontractors or employees.

Because preventing pollution is much easier and less costly than cleaning up "after the fact," the Cities and County of Riverside StormWater/CleanWater Protection Program informs residents and businesses on pollution prevention activities. This pamphlet describes various Best Management Practices (BMPs) that construction site operators can use to prevent stormwater pollution.



## The Cities and County of Riverside StormWater/CleanWater Protection Program



Riverside County has two drainage systems - sewers and storm drains. The storm drain system was designed to reduce flooding by carrying excess rainwater away from streets and developed areas. Since the storm drain system does not provide for water treatment, it also serves the *unintended* function of transporting pollutants directly to our local waterways.

Unlike sanitary sewers, storm drains are not connected to a wastewater treatment plant - they flow directly to our local streams, rivers and lakes.

Stormwater runoff is a part of the natural hydrologic process. However, land development and construction activities can significantly alter natural drainage processes and introduce pollutants into stormwater runoff. Polluted stormwater runoff from construction sites has been identified as a major source of water pollution in California. It jeopardizes the quality of our local waterways and can pose a serious threat to the health of our aquatic ecosystems.

## StormWater Pollution... What You Should Know

To report a hazardous materials spill, call:

Riverside County Hazardous Materials  
Emergency Response Team  
(909) 358-5055 8:00 a.m. - 5:00 p.m.  
(909) 358-5245 after 5:00 p.m.

In an emergency call: 911

For recycling and hazardous waste disposal, call:

(909) 358-5055

To report an illegal dumping or a clogged storm drain, call:

1-800-506-2555

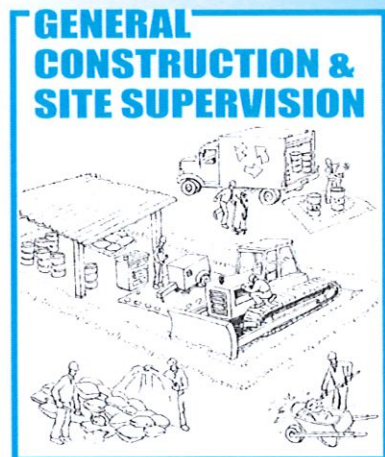
To order additional brochures or to obtain information on other pollution prevention activities, please call (909) 955-1200 or visit the StormWater/CleanWater Protection Program website at:  
[www.co.riverside.ca.us/depts/flood/waterquality/npdes.asp](http://www.co.riverside.ca.us/depts/flood/waterquality/npdes.asp)



The StormWater/CleanWater Protection Program gratefully acknowledges the Santa Clara Valley Nonpoint Pollution Control Program, Alameda Countywide CleanWater Program and the City of Los Angeles Stormwater Management Division for information provided in this brochure.

## StormWater Pollution

What you should know for...



## Best Management Practices (BMPs) for:

- ✓ Developers
- ✓ General Contractors
- ✓ Home Builders
- ✓ Construction Inspectors
- ✓ Anyone in the construction business



## What Should You Do? Advance Planning to Prevent Pollution

- Remove existing vegetation only as needed.
- Schedule excavation, grading, and paving operations for dry weather periods, if possible.
- Designate a specific area of the construction site, well away from storm drain inlets or watercourses, for material storage and equipment maintenance.
- Develop and implement an effective combination of erosion and sediment controls for the construction site.
- Practice source reduction by ordering only the amount of materials that are needed to finish the project.
- Educate your employees and subcontractors about stormwater management requirements and their pollution prevention responsibilities.
- Control the amount of surface runoff at the construction site by impeding internally generated flows and using berms or drainage ditches to direct incoming offsite flows to go around the site. *Note: Consult local drainage policies for more information.*

## BEST MANAGEMENT PRACTICES

The following Best Management Practices (BMPs) can significantly reduce pollutant discharges from your construction site. Compliance with stormwater regulations can be as simple as minimizing stormwater contact with potential pollutants by providing covers and secondary containment for construction materials, designating areas away from storm drain systems for storing equipment and materials and implementing good housekeeping practices at the construction site.

- Protect all storm drain inlets and streams located near the construction site to prevent sediment-laden water from entering the storm drain system.
- Limit access to and from the site. Stabilize construction entrances/exits to minimize the track out of dirt and mud onto adjacent streets. Conduct frequent street sweeping.
- Protect stockpiles and construction materials from winds and rain by storing them under a roof, secured impermeable tarp or plastic sheeting.
- Avoid storing or stockpiling materials near storm drain inlets, gullies or streams.
- Phase grading operations to limit disturbed areas and duration of exposure.
- Perform major maintenance and repairs of vehicles and equipment offsite.
- Wash out concrete mixers only in designated washout areas at the construction site.
- Set-up and operate small concrete mixers on tarps or heavy plastic drop cloths.
- Keep construction sites clean by removing trash, debris, wastes, etc. on a regular basis.
- Clean-up spills immediately using dry clean-up methods (e.g., absorbent materials such as cat litter, sand or rags for liquid spills; sweeping for dry spills such as cement, mortar or fertilizer) and by removing the contaminated soil from spills on dirt areas.
- Prevent erosion by implementing any or a combination of soil stabilization practices such as mulching, surface roughening, permanent or temporary seeding.
- Maintain all vehicles and equipment in good working condition. Inspect frequently for leaks, and repair promptly.
- Practice proper waste disposal. Many construction materials and wastes, including solvents, water-based paint, vehicle fluids, broken asphalt and concrete, wood, and cleared vegetation can be recycled. Materials that cannot be recycled must be taken to an appropriate landfill or disposed of as hazardous waste.
- Cover open dumpsters with secured tarps or plastic sheeting. Never clean out a dumpster by washing it down on the construction site.
- Arrange for an adequate debris disposal schedule to insure that dumpsters do not overflow.

## GENERAL CONSTRUCTION ACTIVITIES STORMWATER PERMIT (Construction Activities General Permit)

The State Water Resources Control Board (SWRCB) adopted a new Construction Activities General Permit (WQ Order No. 99-08DWQ) on August 19, 1999, superseding the now expired SWRCB statewide General Permit (WQ Order No. 92-08DWQ). This permit is administered and enforced by the SWRCB and the local Regional Water Quality Control Boards (RWQCB). The updated Construction Activities General Permit establishes a number of new stormwater management requirements for construction site operator.

**NOTE:** Some construction activities stormwater permits are issued on a regional basis. Consult your local RWQCB to find out if your project requires coverage under any of these permits.

### Frequently Asked Questions:

#### Does my construction site require coverage under the Construction Activities General Permit?

Yes, if construction activity results in the disturbance of five or more acres of total land area or is part of a common plan of development that results in the disturbance of five or more acres.

#### How do I obtain coverage under the Construction Activities General Permit?

Obtain the permit package and submit the completed Notice of Intent (NOI) form to the

SWRCB prior to grading or disturbing soil at the construction site. For ongoing construction activity involving a change of ownership, the new owner must submit a new NOI within 30 days of the date of change of ownership. The completed NOI along with the required fee should be mailed to the SWRCB.

#### What must I do to comply with the requirements of the Construction Activities General Permit?

- Implement BMPs for non-stormwater discharges year-round.
- Prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) prior to commencing construction activities.
- Keep a copy of the SWPPP at the construction site for the entire duration of the project.
- Calculate the anticipated stormwater runoff.
- Implement an effective combination of erosion and sediment control on all soil disturbed areas.
- Conduct site inspections prior to anticipated storm events, every 24-hours during extended storm events, and after actual storm event.
- Perform repair and maintenance of BMPs as soon as possible after storm events depending upon worker safety.

- Update the SWPPP as needed, to manage pollutants or reflect changes in site conditions.
- Include description of post construction BMPs at the construction site, including parties responsible for long-term maintenance.

**NOTE:** Please refer to the Construction Activities General Permit for detailed information. You may contact the SWRCB, your local RWQCB, or visit the SWRCB website at [www.swrcb.ca.gov/stormwtr/](http://www.swrcb.ca.gov/stormwtr/) to obtain a State Construction Activities Stormwater General Permit packet.

#### How long is this Construction Activities General Permit in effect?

The Permit coverage stays in effect until you submit a Notice of Termination (NOT) to the SWRCB. For the purpose of submitting a NOT, all soil disturbing activities have to be completed and one of the three following criteria has to be met:

1. Change of ownership;
2. A uniform vegetative cover with 70 percent coverage has been established; or,
3. Equivalent stabilization measures such as the use of reinforced channel liners, soil cement, fiber matrices, geotextiles, etc., have been employed.



## For Information:

For more information on the General Industrial Storm Water Permit contact:

State Water Resources Control Board (SWRCB)  
(916) 657-1146 or [www.swrcb.ca.gov/](http://www.swrcb.ca.gov/) or, at your  
Regional Water Quality Control Board (RWQCCB).

Santa Ana Region (8)  
California Tower  
3737 Main Street, Ste. 500  
Riverside, CA 92501-3339  
(909) 782-4130

San Diego Region (9)  
3771 Clairemont Mesa Blvd., Ste. A  
San Diego, CA 92124  
(619) 467-2952

Colorado River Basin Region (7)  
73-720 Fred Waring Dr., Ste. 100  
Palm Desert, CA 92260  
(760) 346-7491

**SPILL RESPONSE AGENCY:** (909) 358-5055  
**HAZ-MAT:** (909) 358-5055  
**HAZARDOUS WASTE DISPOSAL:** (909) 358-5055  
**RECYCLING INFORMATION:** 1-800-366-SAVE  
**TO REPORT ILLEGAL DUMPING OR A CLOGGED  
STORM DRAIN:** 1-800-506-2555

To order additional brochures or to obtain information on other pollution prevention activities, call: (909) 955-1111.



Riverside County gratefully acknowledges the State Water Quality Control Board and the American Public Works Association, Storm Water Quality Task Force for the information provided in this brochure.

## DID YOU KNOW . . .

### YOUR FACILITY MAY NEED A STORM WATER PERMIT?



Many industrial facilities  
and manufacturing operations  
must obtain coverage under the  
Industrial Activities Storm Water  
General Permit

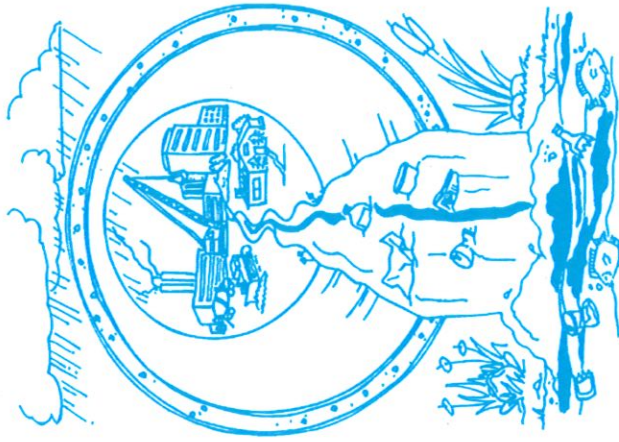
**FIND OUT  
IF YOUR FACILITY  
MUST OBTAIN A PERMIT**

## StormWater Pollution . . . What you should know

Riverside County has two drainage systems - sanitary sewers and storm drains. The storm drain system is designed to help prevent flooding by carrying excess rainwater away from streets. Since the storm drain system does not provide for water treatment, it also serves the unintended function of transporting pollutants directly to our waterways.

*Unlike sanitary sewers, storm drains are not connected to a treatment plant - they flow directly to our local streams, rivers and lakes.*

In recent years, awareness of the need to protect water quality has increased. As a result, federal, state, and local programs have been established to reduce polluted stormwater discharges to our waterways. The emphasis of these programs is to prevent stormwater pollution since it's much easier, and less costly, than cleaning up "after the fact."



## National Pollutant Discharge Elimination System (NPDES)

In 1987, the Federal Clean Water Act was amended to establish a framework for regulating industrial stormwater discharges under the NPDES permit program. In California, NPDES permits are issued by the State Water Resources Control Board (SWRCB) and the nine (9) Regional Water Quality Control Boards (RWQCCB). In general, certain industrial facilities and manufacturing operations must obtain coverage under the Industrial Activities Storm Water General Permit if the type of facilities or operations falls into one of the several categories described in this brochure.



## How Do I Know If I Need A Permit?

Following are **general descriptions** of the industry categories types that are regulated by the Industrial Activities Storm Water General Permit. Contact your local Region Water Quality Control Board to determine if your facility/operation requires coverage under the Permit.

- Facilities such as cement manufacturing; feedlots; fertilizer manufacturing; petroleum refining; phosphate manufacturing; steam electric power generation; coal mining; mineral mining and processing; ore mining and dressing; and asphalt emulsion;
- Facilities classified as lumber and wood products (except wood kitchen cabinets); pulp, paper, and paperboard mills; chemical producers (except some pharmaceutical and biological products); petroleum and coal products; leather production and products; stone, clay and glass products; primary metal industries; fabricated structural metal; ship and boat building and repairing;
- Active or inactive mining operations and oil and gas exploration, production, processing, or treatment operations;
- Hazardous waste treatment, storage, or disposal facilities;

## How do I obtain coverage under the Industrial Activities Storm Water General Permit?

Obtain a permit application package from your local Regional Water Quality Control Board listed on the back of this brochure or the State Water Resources Control Board (SWRCB). Submit a completed Notice of Intent (NOI) form, site map and the appropriate fee (\$250 or \$500) to the SWRCB. Facilities must submit an NOI thirty (30) days prior to beginning operation. Once you submit the NOI, the State Board will send you a letter acknowledging receipt of your NOI and will assign your facility a waste discharge identification number (WDID No.). You will also receive an annual fee billing. These billings should roughly coincide with the date the State Board processed your original NOI submission.

## What are the requirements of the Industrial Activities Storm Water General Permit?

The basic requirements of the Permit are:

1. The facility must eliminate any non-stormwater discharges or obtain a separate permit for such discharges.
2. The facility must develop and implement a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP must identify sources of pollutants that may be exposed to stormwater. Once the sources of pollutants have been identified, the facility operator must develop and implement Best Management Practices (BMPs) to minimize or prevent polluted runoff.  
*Guidance in preparing a SWPPP is available from a document prepared by the California Storm Water Quality Task Force called the California Storm Water Best Management Practice Handbook.*
3. The facility must develop and implement a Monitoring Program that includes conducting visual observations and collecting samples of the facility's storm water discharges associated with industrial activity. The General Permit requires that the analysis be conducted by a laboratory that is certified by the State of California.
4. The facility must submit to the Regional Board, every July 1, an annual report that includes the results of its monitoring program.

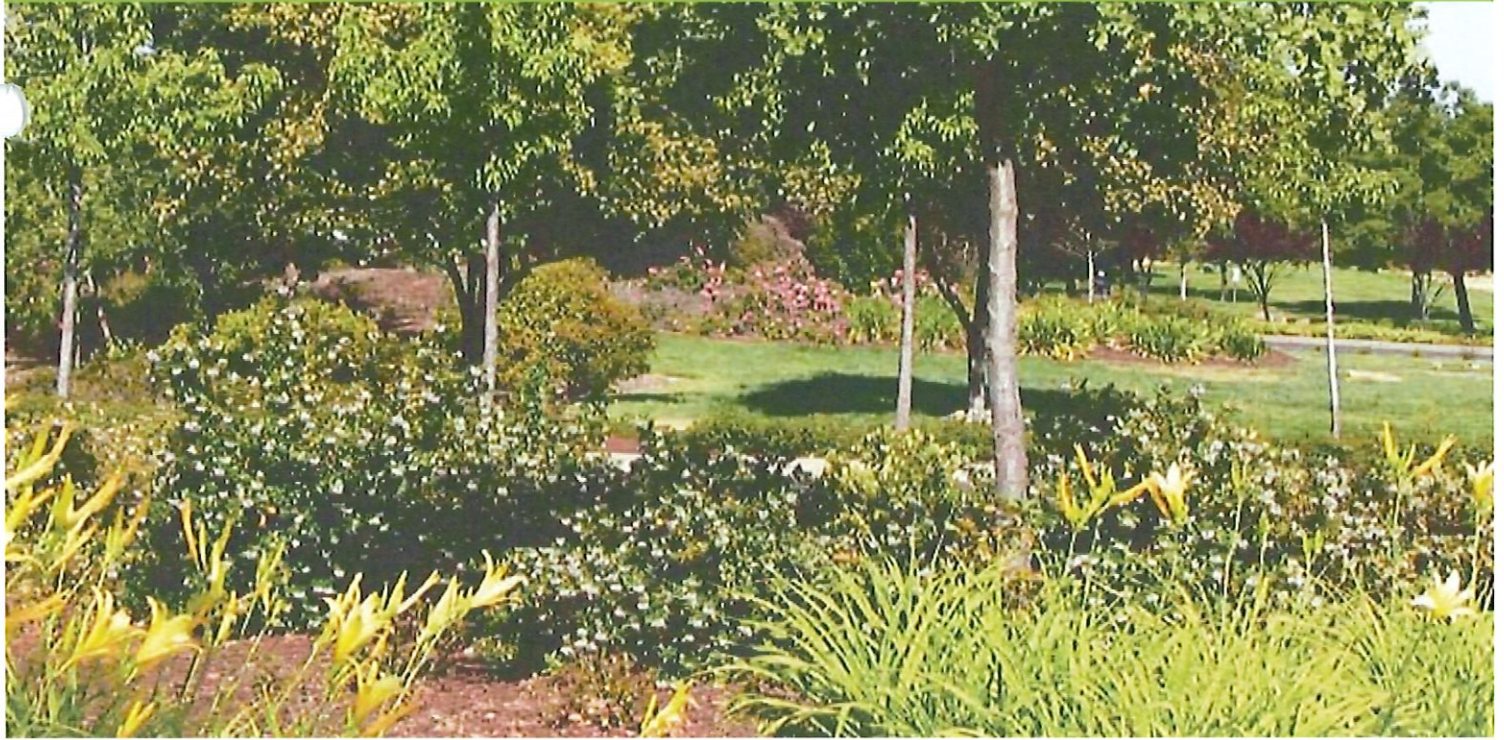
**A Non-Storm Water Discharge is...** any discharge to a storm drain system that is not composed entirely of storm water. The following non-storm water discharges are authorized by the General Permit: fire hydrant flushing; potable water sources, including potable water related to the operation, maintenance, or testing of potable water systems; drinking fountain water; atmospheric condensates including refrigeration, air conditioning, and compressor condensate; irrigation drainage; landscape watering; springs; non-contaminated ground water; foundation or footing drainage; and sea water infiltration where the sea waters are discharged back into the sea water source.

**A BMP is . . .** a technique, process, activity, or structure used to reduce the pollutant content of a storm water discharge. BMPs may include simple, non-structural methods such as good housekeeping, staff training and preventive maintenance. Additionally, BMPs may include structural modifications such as the installation of berms, canopies or treatment control (e.g. setting basins, oil/water separators, etc.)



**WARNING:** There are significant penalties for non-compliance: a minimum fine of \$5,000 for failing to obtain permit coverage, and, up to \$10,000 per day, per violation plus \$10 per gallon of discharge in excess of 1,000 gallons.





# The Updated Model Water Efficient Landscape Ordinance

CALIFORNIA DEPARTMENT OF WATER RESOURCES

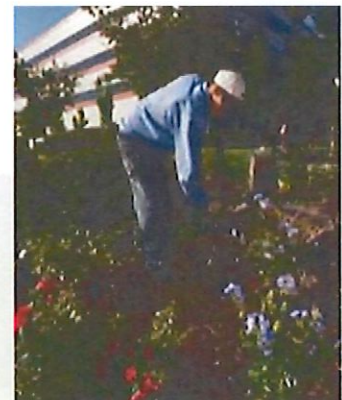
Landscapes are essential to the quality of life in California. They provide areas for recreation, enhance the environment, clean the air and water, prevent erosion, offer fire protection and replace ecosystems lost to development.

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

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

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

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







## Important points to consider...

### **Water purveyors have an important role.**

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

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

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

### **Existing landscapes are also subject to the Model Ordinance.**

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

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

### **All new landscapes will be assigned a water budget.**

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

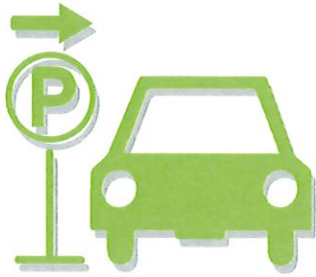
The MAWA, is the water budget used for compliance and is an annual water allowance based on landscape area, local evapotranspiration and ETAF of 0.7. The ETWU is an annual water use estimation for design purposes and is based on the water needs of the plants actually chosen for a given landscape. The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

### **Water efficient landscapes offer multiple benefits.**

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

### **The Department of Water Resources will offer technical assistance.**

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



## R-3 AUTOMOBILE PARKING

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

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

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

### Required Activities

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

### Recommended Activities

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

For additional information contact:  
County of Orange, **OC Watershed**

Main: (714) 955-0600/ 24hr Water Pollution Discharge Hotline 1-877-89-SPILL  
or visit our website at: [www.ocwatersheds.com](http://www.ocwatersheds.com)





## R-8 WATER CONSERVATION

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

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

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

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

### Required Activities

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

### Recommended Activities

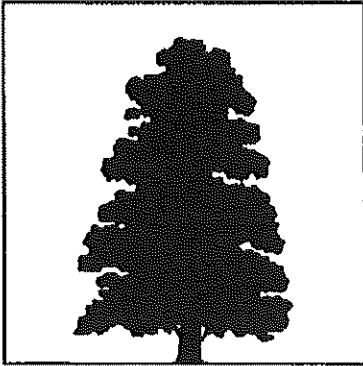
- Fix any leaking faucets and eliminate unnecessary water sources.
- Use xeroscaping and drought tolerant landscaping to reduce the watering needs.
- Do not over watering lawns or gardens. Over watering wastes water and promotes diseases.
- Use a bucket to re-soak sponges/rags while washing automobiles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

For additional information contact:

County of Orange, **OC Watershed**

Main: (714) 955-0600/ 24hr Water Pollution Discharge Hotline 1-877-89-SPILL

or visit our website at: [www.ocwatersheds.com](http://www.ocwatersheds.com)



## LANDSCAPE MAINTENANCE

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

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

### POLLUTION PREVENTION:

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

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

### MODEL PROCEDURES:

#### 1. Mowing, Trimming/Weeding, and Planting

##### **Mowing, Trimming/Weeding**

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

## FP-2

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

### Planting

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

- ✓ When planting or replanting consider using low water use groundcovers.

#### OPTIONAL:

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

## 2. Irrigation

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

## 3. Fertilizer and Pesticide Management

### Usage

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

#### OPTIONAL:

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

### Scheduling

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



## Disposal

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

## 4. Managing Landscape Waste

*Also see Waste Handling and Disposal procedure sheet*

- ✓ Compost leaves, sticks, or other collected vegetation or dispose of at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- ✓ Place temporarily stockpiled material away from watercourses and storm drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- ✓ Reduce the use of high nitrogen fertilizers that produce excess growth requiring more frequent mowing or trimming.
- ✓ Inspection of drainage facilities should be conducted to detect illegal dumping of clippings/cuttings in or near these facilities. Materials found should be picked up and properly disposed of.
- ✓ Landscape wastes in and around storm drain inlets should be avoided by either using bagging equipment or by manually picking up the material.

## 5. Erosion Control

*Also see Waste Handling and Disposal procedure sheet*

- ✓ Maintain vegetative cover on medians and embankments to prevent soil erosion. Apply mulch or leave clippings to serve as additional cover for soil stabilization and to reduce the velocity of storm water runoff.
- ✓ Minimize the use of disking as a means of vegetation management because the practice may result in erodable barren soil.
- ✓ Confine excavated materials to pervious surfaces away from storm drain inlets, sidewalks, pavement, and ditches. Material must be covered if rain is expected.

---

## LIMITATIONS:

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

## REFERENCES:

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

County of Orange. 2000. Public Facilities and Resources Department, Management Guidelines for the Use of Fertilizers and Pesticides. September.

King County Stormwater Pollution Control Manual. Best Management Practices for Businesses. 1995. King County Surface Water Management. July. On-line: <http://dnr.metrokc.gov/wlr/dss/spcm.htm>

Los Angeles County Stormwater Quality Model Programs. Public Agency Activities  
[http://ladpw.org/wmd/npdes/model\\_links.cfm](http://ladpw.org/wmd/npdes/model_links.cfm)

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

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

## IC7. LANDSCAPE MAINTENANCE

### Best Management Practices (BMPs)

A BMP is a technique, measure or structural control that is used for a given set of conditions to improve the quality of the stormwater runoff in a cost effective manner<sup>1</sup>. The minimum required BMPs for this activity are outlined in the box to the right. Implementation of pollution prevention/good housekeeping measures may reduce or eliminate the need to implement other more costly or complicated procedures. Proper employee training is key to the success of BMP implementation.

The BMPs outlined in this fact sheet target the following pollutants:

Targeted Constituents	
Sediment	x
Nutrients	x
Floatable Materials	x
Metals	
Bacteria	x
Oil & Grease	
Organics & Toxicants	
Pesticides	x
Oxygen Demanding	x

#### MINIMUM BEST MANAGEMENT PRACTICES

##### Pollution Prevention/Good Housekeeping

- Properly store and dispose of gardening wastes.
- Use mulch or other erosion control measures on exposed soils.
- Properly manage irrigation and runoff.
- Properly store and dispose of chemicals.
- Properly manage pesticide and herbicide use.
- Properly manage fertilizer use.

##### Stencil storm drains

##### Training

- Train employees on these BMPs, storm water discharge prohibitions, and wastewater discharge requirements.
- Provide on-going employee training in pollution prevention.

Provided below are specific procedures associated with each of the minimum BMPs along with procedures for additional BMPs that should be considered if this activity takes place at a facility located near a sensitive waterbody. In order to meet the requirements for medium and high priority facilities, the owners/operators must select, install and maintain appropriate BMPs on site. Since the selection of the appropriate BMPs is a site-specific process, the types and numbers of additional BMPs will vary for each facility.

1. **Take steps to reduce landscape maintenance requirements.**
  - Where feasible, retain and/or plant native vegetation with features that are determined to be beneficial. Native vegetation usually requires less maintenance than planting new vegetation.
  - When planting or replanting consider using low water use flowers, trees, shrubs, and groundcovers.
  - Consider alternative landscaping techniques such as naturoscaping and xeriscaping.
2. **Properly store and dispose of gardening wastes.**
  - Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage at a permitted landfill or by composting.
  - Do not dispose of gardening wastes in streets, waterways, or storm drainage systems.
  - Place temporarily stockpiled material away from watercourses and storm drain inlets, and berm and/or cover.
3. **Use mulch or other erosion control measures on exposed soils.**

<sup>1</sup> EPA "Preliminary Data Summary of Urban Stormwater Best Management Practices"

**4. Properly manage irrigation and runoff.**

- Irrigate slowly or pulse irrigate so the infiltration rate of the soil is not exceeded.
- Inspect irrigation system regularly for leaks and to ensure that excessive runoff is not occurring.
- If re-claimed water is used for irrigation, ensure that there is no runoff from the landscaped area(s).
- If bailing of muddy water is required (e.g. when repairing a water line leak), do not put it in the storm drain; pour over landscaped areas.
- Use automatic timers to minimize runoff.
- Use popup sprinkler heads in areas with a lot of activity or where pipes may be broken. Consider the use of mechanisms that reduce water flow to broken sprinkler heads.

**5. Properly store and dispose of chemicals.**

- Implement storage requirements for pesticide products with guidance from the local fire department and/or County Agricultural Commissioner.
- Provide secondary containment for chemical storage.
- Dispose of empty containers according to the instructions on the container label.
- Triple rinse containers and use rinse water as product.

**6. Properly manage pesticide and herbicide use.**

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of pesticides and herbicides and training of applicators and pest control advisors.
- Follow manufacturers' recommendations and label directions.
- Use pesticides only if there is an actual pest problem (not on a regular preventative schedule). When applicable use less toxic pesticides that will do the job. Avoid use of copper-based pesticides if possible. Use the minimum amount of chemicals needed for the job.
- Do not apply pesticides if rain is expected or if wind speeds are above 5 mph.
- Do not mix or prepare pesticides for application near storm drains. Prepare the minimum amount of pesticide needed for the job and use the lowest rate that will effectively control the targeted pest.
- Whenever possible, use mechanical methods of vegetation removal rather than applying herbicides. Use hand weeding where practical.
- Do not apply any chemicals directly to surface waters, unless the application is approved and permitted by the state. Do not spray pesticides within 100 feet of open waters.
- Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.
- When conducting mechanical or manual weed control, avoid loosening the soil, which could lead to erosion.
- Purchase only the amount of pesticide that you can reasonably use in a given time period.
- Careful soil mixing and layering techniques using a topsoil mix or composted organic material can be used as an effective measure to reduce herbicide use and watering.

**7. Properly manage fertilizer use.**

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers.
- Follow manufacturers' recommendations and label directions.
- Employ techniques to minimize off-target application (e.g. spray drift) of fertilizer, including consideration of alternative application techniques. Calibrate fertilizer distributors to avoid excessive application.
- Periodically test soils for determining proper fertilizer use.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Sweep pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Use slow release fertilizers whenever possible to minimize leaching
-



- 8. Incorporate the following integrated pest management techniques where appropriate:**
- Mulching can be used to prevent weeds where turf is absent.
  - Remove insects by hand and place in soapy water or vegetable oil. Alternatively, remove insects with water or vacuum them off the plants.
  - Use species-specific traps (e.g. pheromone-based traps or colored sticky cards).
  - Sprinkle the ground surface with abrasive diatomaceous earth to prevent infestations by soft-bodied insects and slugs. Slugs also can be trapped in small cups filled with beer that are set in the ground so the slugs can get in easily.
  - In cases where microscopic parasites, such as bacteria and fungi, are causing damage to plants, the affected plant material can be removed and disposed of (pruning equipment should be disinfected with bleach to prevent spreading the disease organism).
  - Small mammals and birds can be excluded using fences, netting, and tree trunk guards.
  - Promote beneficial organisms, such as bats, birds, green lacewings, ladybugs, praying mantis, ground beetles, parasitic nematodes, trichogramma wasps, seedhead weevils, and spiders that prey on detrimental pest species.

### **Training**

1. Train employees on these BMPs, storm water discharge prohibitions, and wastewater discharge requirements.
2. Educate and train employees on the use of pesticides and pesticide application techniques. Only employees properly trained to use pesticides can apply them.
3. Train and encourage employees to use integrated pest management techniques.
4. Train employees on proper spill containment and cleanup.
  - Establish training that provides employees with the proper tools and knowledge to immediately begin cleaning up a spill.
  - Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.
  - BMP IC17 discusses Spill Prevention and Control in detail.
5. Establish a regular training schedule, train all new employees, and conduct annual refresher training.
6. Use a training log or similar method to document training.

### **Stencil storm drains**

Storm drain system signs act as highly visible source controls that are typically stenciled directly adjacent to storm drain inlets. Stencils should read "No Dumping Drains to Ocean".

### **References**

California Storm Water Best Management Practice Handbook. Industrial and Commercial. 2003. [www.cabmphandbooks.com](http://www.cabmphandbooks.com)

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

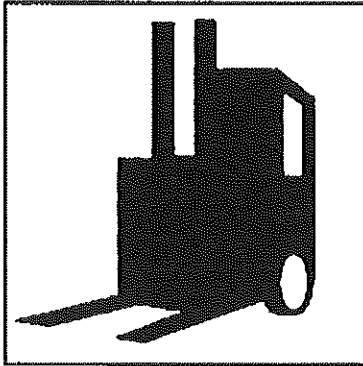
King County Stormwater Pollution Control Manual. Best Management Practices for Businesses. King County Surface Water Management. July 1995. On-line: <http://dnr.metrokc.gov/wlr/dss/spcm.htm>

Stormwater Management Manual for Western Washington. Volume IV Source Control BMPs. Prepared by Washington State Department of Ecology Water Quality Program. Publication No. 99-14. August 2001.

Water Quality Handbook for Nurseries. Oklahoma Cooperative Extension Service. Division of Agricultural Sciences and Natural Resources. Oklahoma State University. E-951. September 1999.

**For additional information contact:**

County of Orange  
Watershed & Coastal Resources  
Stormwater Program  
(714)567-6363  
or visit our website at:  
[www.ocwatersheds.com](http://www.ocwatersheds.com)



## MATERIAL LOADING AND UNLOADING

The loading/unloading of materials usually takes place outside; therefore, materials spilled, leaked, or lost during loading/unloading have the potential to collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned. Additionally, rainfall may wash pollutants from machinery used to unload or move materials. Material loading and unloading involves the following activities:

### POLLUTION PREVENTION:

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

- Check loading and unloading equipment regularly for leaks.
- Cover loading docks.
- Once per year, educate municipal staff on pollution prevention measures.

### MODEL PROCEDURES:

#### General Guidelines

- ✓ Regularly clean work areas to remove materials such as debris, sandblasting material, etc.
- ✓ Design loading/unloading area to prevent stormwater runoff that would include grading or berming the area, and positioning roof downspouts so they direct stormwater away from loading/unloading areas.
- ✓ Use overhangs or door skirts that enclose the trailer.
- ✓ Park tank trucks or delivery vehicles so that spills or leaks can be contained.
- ✓ Avoid loading and exposing materials during rain events unless the loading dock is covered and protected from rain. A seal or door skirt between the trailer and the building may also prevent exposure to rain.
- ✓ Shipboard cooling and process water discharges should be directed to minimize contact with spent abrasives, paint, and other debris.

## Tank truck transfers

- ✓ 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.
- ✓ Transfer area should be designed to prevent runoff of stormwater from adjacent areas. Sloping the pad and using a berm around the uphill side of the transfer area should reduce runoff.
- ✓ 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. A positive control valve should be installed on the drain.

## Spill Control

*Also see Spill Prevention and Control procedures sheet*

- ✓ Contain leaks during transfer.
- ✓ Use drip pans under hoses.
- ✓ Have an emergency spill cleanup plan readily available.
- ✓ Place spill kits and materials next to or near each loading/unloading area.
- ✓ Use drip pans or comparable devices when transferring oils, solvents, and paints.

## Training

- ✓ Make sure forklift operators are properly trained.
- ✓ Train employees regarding spill containment and cleanup.
- ✓ Employees trained in spill containment and cleanup should be present during the loading/unloading.
- ✓ Use a written operations plan that describes procedures for loading and/or unloading.

## Inspection

*Also see Spill Prevention and Control procedures sheet*

- ✓ Check loading and unloading equipment regularly for leaks, including valves, pumps, flanges and connections.
- ✓ Inspect regularly for leaking valves, pipes, hoses, or soil chutes carrying either water or wastewater.
- ✓ Look for dust or fumes during loading or unloading operations.

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## LIMITATIONS:

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.

## REFERENCES:

*California Storm Water Best Management Practice Handbooks. Municipal Best Management Practice Handbook.*



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*Prepared by Camp Dresser & McKee, Larry Walker Associates, Uribe and Associates, Resources Planning Associates for Stormwater Quality Task Force. March 1993.*

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



## **ROADS, STREETS, AND HIGHWAYS OPERATION AND MAINTENANCE**

**Streets, roads, and highways are significant sources of pollutants in storm water discharges, and operation and maintenance (O&M) practices, if not conducted properly, can contribute to the problem. O&M practices may involve one or more of the following activities:**

- 1. Sweeping & Cleaning**
- 2. Street Repair & Maintenance**
- 3. Bridge and Structure Maintenance**

**Streets, roads, and highways are significant sources of pollutants in storm water discharges, and operation and maintenance (O&M) practices, if not conducted properly, can contribute to the problem. O&M practices may involve one or more of the following activities:**

**Pollution prevention measures that should be consider and the minimum required and optional model procedures for each performance standard are provided below.**

### **POLLUTION PREVENTION:**

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

- Use the least toxic materials available (e.g. water based paints, gels or sprays for graffiti removal)
- Recycle paint and other materials whenever possible.
- Once per year, educate municipal staff on pollution prevention measures.

## MODEL PROCEDURES:

### 1. Sweeping & Cleaning

#### Sweeping Frequency and Timing

- ✓ Maintain a consistent sweeping schedule. Provide minimum monthly sweeping of streets.
- ✓ Perform street cleaning during dry weather if possible.
- ✓ Avoid wet cleaning or flushing of streets, and utilize dry methods where possible.
- ✓ If flushing of a street is absolutely necessary, sweep and remove debris before flushing. Do not let wash water enter storm drain inlets. Collect wash water and direct to a dirt or vegetated area, pump into a vacuum truck and dispose of properly.

#### OPTIONAL:

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

#### Equipment Operation and Selection

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

- ✓ Maintain cleaning equipment in good working condition and purchase replacement equipment as needed. Old sweepers should be replaced as needed with new technologically advanced sweepers (preferably regenerative air sweepers) that maximize pollutant removal.
- ✓ Operate sweepers at manufacturer requested optimal speed levels to increase effectiveness.
- ✓ Clean sweepers at a wash rack that drains to the sanitary sewer. The wash rack area should be covered and bermed and wash water should drain to a clarifier prior to entering the sanitary sewer.
- ✓ Regularly inspect vehicles and equipment for leaks, and repair immediately.

#### OPTIONAL:

- If available use vacuum or regenerative air sweepers in the high sediment and trash areas (typically industrial/commercial).

#### Management of Material Removed by Sweeping

- ✓ Dispose of street sweeping debris and dirt at a landfill.
- ✓ Do not store swept material along the side of the street or near a storm drain inlet.
- ✓ If dewatering of saturated materials is necessary it should be conducted in a designated area away from storm drain inlets and the water contained for proper disposal.

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

## Maximize Access for Sweepers

- ✓ If authorized by the local sanitation agency, water may be discharged to the sanitary sewer only after passing through a clarifier. As an alternative, dewatering can be conducted in a containment area in which saturated materials are placed on a tarp and allowed to dry. Dry debris is then disposed of properly.
- ✓ Keep debris storage to a minimum during the wet season or make sure debris piles are contained (e.g. by berming the area) or covered (e.g. with tarps or permanent covers).
- ✓ Keep accurate operation logs to track program.
- ✓ Properly maintain and operate equipment; which will increase efficiency.
- ✓ Sweeping should be conducted as close to the curb line as possible.

### OPTIONAL:

- Institute a parking policy to restrict parking in problematic areas during periods of street sweeping.
- Post permanent street sweeping signs in problematic areas; use temporary signs if installation of permanent signs is not possible.
- Develop and distribute flyers notifying residents of street sweeping schedules.

## 2. Repair and Maintenance

### Pavement Marking

- ✓ Develop paint handling procedures for proper use, storage, and disposal of paints.
- ✓ Transfer and load paint and hot thermoplastic away from storm drain inlets.
- ✓ Street or hand sweep thermoplastic grindings. Yellow thermoplastic grindings may require special handling as they may contain lead.
- ✓ Replace paints containing lead and tributyltin with less toxic alternatives.
- ✓ Use water based paints. Clean application equipment in a sink that is connected to the sanitary sewer.
- ✓ Properly store leftover paints if they are to be kept for the next job, or dispose of properly.
- ✓ See *Spill Control procedure sheet* for guidance on the proper cleanup of paint spills.

### Concrete Installation and Repair

- ✓ Avoid mixing excess amounts of fresh concrete or cement mortar on-site. Only mix what is needed for the job.
- ✓ Wash concrete trucks off site or in designated areas on site, such that there is no discharge of concrete wash water into storm drain inlets, open ditches, streets, or other stormwater conveyance structures.



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- ✓ Store concrete materials under cover, away from drainage areas.
- ✓ Return leftover materials to the transit mixer. Dispose of small amounts of hardened excess concrete, grout, and mortar in the trash.
- ✓ Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile, or dispose in the trash.
- ✓ When washing poured concrete areas to remove fine particles and expose the aggregate, contain the wash water for proper disposal; do not discharge water to the storm drain system.
- ✓ Do not allow excess concrete to be dumped on-site, except in designated areas.
- ✓ Apply concrete, asphalt, and seal coat during dry weather to allow the material to adequately dry prior to a rain event.
- ✓ When making saw cuts in pavement, use as little water as possible and perform during dry weather. Cover each nearby or appropriate storm drain inlet completely with filter fabric or plastic during the sawing operation and contain the slurry by placing straw bales, sandbags, or gravel dams around the inlets. After the liquid drains or evaporates, shovel or vacuum the slurry residue from the pavement or gutter and remove from site. Alternatively, a small on-site vacuum may be used to pick up the slurry as this will prohibit slurry from reaching storm drain inlets.

### **Patching, Resurfacing, and Surface Sealing**

- ✓ Pre-heat, transfer or load hot bituminous material away from storm drain inlets.
- ✓ Apply concrete, asphalt, and seal coat during dry weather to allow the material to adequately dry prior to a rain event.
- ✓ Where applicable, cover and seal each nearby or appropriate storm drain inlet (with waterproof material, plastic or mesh) and maintenance holes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and until all water from emulsified oil sealants has drained or evaporated. Clean any debris from covered man holes and storm drain inlets when the job is complete.
- ✓ 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.
- ✓ Prior to a rain event or at the completion of a project, sweep the project area by hand or with a street sweeper.

### **Equipment Cleaning, Maintenance, and Storage**

*Also see Equipment Repair &  
Maintenance procedure sheet.*

- ✓ Clean equipment including sprayers, sprayer paint supply lines, patch and paving equipment, and mudjacking equipment at the end of each day. If equipment can be cleaned and materials reapplied at the job site, do so in compliance with the laws and regulations. Clean in a sink or other area (e.g. vehicle wash area) that is connected to the sanitary sewer.

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

- ✓ If refueling or repairing vehicles and equipment must be done on-site, conduct the activity away from storm drain inlets and watercourses.
- ✓ Place drip pans or absorbent materials under heavy equipment when not in use.
- ✓ Clean paint brushes and tools covered with water-based paints in sinks connected to sanitary sewers. 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.

**OPTIONAL:**

- Conduct cleaning at a corporation or maintenance yard if possible.
- When practical, perform major equipment repairs at the corporation yard.

→ *In addition to the procedures above, review and apply general procedures outlined for Minor Construction activities when conducting street, road, and highway repair and maintenance activities.*

## 3. Bridge and Structure Maintenance

### Painting and Paint Removal

- ✓ Transport paint and materials to and from job sites in containers with secure lids and tied down to the transport vehicle.
- ✓ Do not transfer or load paint near storm drain inlets or watercourses.
- ✓ Test and inspect spray equipment prior to starting to paint. Tighten all hoses and connections and do not overfill paint container.
- ✓ If sand blasting is used to remove paint, cover nearby storm drain inlets prior to starting work.
- ✓ If the bridge crosses a watercourse, perform work on a maintenance traveler or platform, or use suspended netting or tarps to capture paint, rust, paint removing agents, or other materials, to prevent discharge of materials to surface waters. If sanding, use a sander with a vacuum filter bag.
- ✓ Recycle paint when possible (e.g. paint may be used for graffiti removal activities). Dispose of paint at an appropriate household hazardous waste facility.
- ✓ See Spill Control procedure sheet for guidance on the proper cleanup of paint spills.

### Graffiti Removal

- ✓ Avoid graffiti abatement activities during rain events.
- ✓ Protect nearby storm drain inlets prior to removing graffiti from walls, signs, sidewalks, or other structures needing graffiti abatement. Clean up

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afterwards by sweeping or vacuuming thoroughly, and/or by using absorbent and properly disposing of the absorbent.

- ✓ Note that care should be taken when disposing of waste since it may need to be disposed of as hazardous waste.
- ✓ When graffiti is removed by painting over, implement the procedures under *Painting and Paint Removal* above.
- ✓ Direct runoff from sand blasting and high pressure washing (with no cleaning agents) into a landscaped or dirt area.
- ✓ If a graffiti abatement method generates wash water containing a cleaning compound (such as high pressure washing with a cleaning compound), plug nearby storm drains and collect wash water and dispose of properly.

### OPTIONAL:

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

### Guardrail and Fence Repair

- ✓ When cleaning guardrails or fences follow the appropriate surface cleaning methods (depending on the type of surface) outlined in the *Sidewalk, Plaza, and Fountain Maintenance and Cleaning* procedure sheet.
- ✓ If painting is conducted, follow the *Painting and Paint Removal* procedures above.
- ✓ If graffiti removal is conducted, follow the *Grffiti Removal* procedures above.
- ✓ If construction takes place, see the procedure sheet for *Minor Construction*.
- ✓ Recycle materials whenever possible.

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### LIMITATIONS:

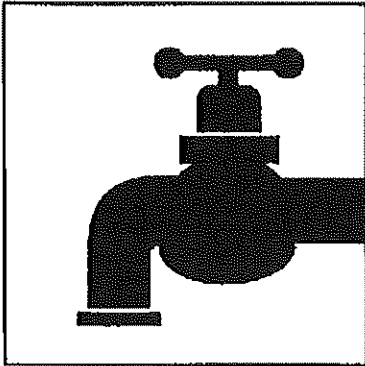
Limitations related to street sweeping may include high equipment costs, the potential inability to restrict parking in urban areas, the need for sweeper operator training, the inability of current sweeper technology to remove oil and grease, and the lack of scientific evidence regarding the expected levels of pollutant removal.

### REFERENCES:

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

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

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



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## **WATER AND SEWER UTILITY OPERATION AND MAINTENANCE**

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

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

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

### **POLLUTION PREVENTION:**

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

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



**MODEL PROCEDURES:**

**1. Water Line Maintenance**

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

**Planned Discharges**

- ✓ For planned discharges use one of the following options:
  - Reuse water for dust suppression, irrigation, or construction compaction
  - Discharge to the sanitary sewer system with approval
  - Discharge to the storm drain system or to a creek using applicable pollution control measures listed below (this option is ONLY applicable to uncontaminated pumped ground water, water line flushing, fire hydrant testing and flushing, discharges from potable water sources other than water main breaks) and may require a permit from the Regional Water Quality Control Board.
- ✓ If water is discharged to a storm drain inlet (catch basin), control measures must be put in place to control potential pollutants (i.e. sediment, chlorine, etc.). Examples of some storm drain inlet protection options include:
  - Silt fence – appropriate where the inlet drains a relatively flat area.
  - Gravel and wire mesh sediment filter – Appropriate where concentrated flows are expected.
  - Wooden weir and fabric – use at curb inlets where a compact installation is desired.
- ✓ Prior to discharge, inspect discharge flow path and clear/cleanup any debris or pollutants found (i.e. remove trash, leaves, sediment, and wipe up liquids, including oil spills).
- ✓ Select appropriate pollution control measure(s) considering the receiving system (i.e. curb inlet, drop inlet, culvert, creek, etc.) and ensure that the control device(s) fit properly.

- ✓ General design considerations for inlet protection devices include the following:
  - The device should be constructed such that cleaning and disposal of trapped sediment is made easy, while minimizing interference with discharge activities.
  - Devices should be constructed so that any standing water resulting from the discharge will not cause excessive inconvenience or flooding/damage to adjacent land or structures.
- ✓ The effectiveness of control devices must be monitored during the discharge period and any necessary repairs or modifications made as needed.

#### OPTIONAL:

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

#### Unplanned Discharges

- ✓ Stop the discharge as quickly as possible by turning off water source.
- ✓ Inspect flow path of the discharged water:
  - Control erosion along the flow path.
  - Identify areas that may produce significant sediment or gullies, use sandbags to redirect the flow.
  - Identify erodible areas which may need to be repaired or protected during subsequent repairs or corrective actions
- ✓ If repairs or corrective action will cause additional discharges of water, select the appropriate procedures for erosion control, chlorine residual, turbidity, and chemical additives. Prevent potential pollutants from entering the flow path and ensure that no additional discharged water enters storm drain inlets.

## 2. Sanitary Sewer Maintenance

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

## Sewer System Cleaning

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

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## Preventative and Corrective Maintenance

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

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

#### Control

*Also see Drainage System procedures sheet*

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

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

## Response and Containment

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

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## LIMITATIONS:

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

## REFERENCES:

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

Los Angeles County Stormwater Quality. Public Agency Activities Model Program. On-line:  
[http://ladpw.org/wmd/npdes/public\\_TC.cfm](http://ladpw.org/wmd/npdes/public_TC.cfm)

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

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



## IC7. LANDSCAPE MAINTENANCE

### Best Management Practices (BMPs)

A BMP is a technique, measure or structural control that is used for a given set of conditions to improve the quality of the stormwater runoff in a cost effective manner<sup>1</sup>. The minimum required BMPs for this activity are outlined in the box to the right. Implementation of pollution prevention/good housekeeping measures may reduce or eliminate the need to implement other more costly or complicated procedures. Proper employee training is key to the success of BMP implementation.

The BMPs outlined in this fact sheet target the following pollutants:

Targeted Constituents	
Sediment	x
Nutrients	x
Floatable Materials	x
Metals	
Bacteria	x
Oil & Grease	
Organics & Toxicants	
Pesticides	x
Oxygen Demanding	x

Provided below are specific procedures associated with each of the minimum BMPs along with procedures for additional BMPs that should be considered if this activity takes place at a facility located near a sensitive waterbody. In order to meet the requirements for medium and high priority facilities, the owners/operators must select, install and maintain appropriate BMPs on site. Since the selection of the appropriate BMPs is a site-specific process, the types and numbers of additional BMPs will vary for each facility.

1. Take steps to reduce landscape maintenance requirements.
  - Where feasible, retain and/or plant native vegetation with features that are determined to be beneficial. Native vegetation usually requires less maintenance than planting new vegetation.
  - When planting or replanting consider using low water use flowers, trees, shrubs, and groundcovers.
  - Consider alternative landscaping techniques such as naturescaping and xeriscaping.
2. Properly store and dispose of gardening wastes.
  - Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage at a permitted landfill or by composting.
  - Do not dispose of gardening wastes in streets, waterways, or storm drainage systems.
  - Place temporarily stockpiled material away from watercourses and storm drain inlets, and berm and/or cover.
3. Use mulch or other erosion control measures on exposed soils.

#### MINIMUM BEST MANAGEMENT PRACTICES

##### Pollution Prevention/Good Housekeeping

- Properly store and dispose of gardening wastes.
- Use mulch or other erosion control measures on exposed soils.
- Properly manage irrigation and runoff.
- Properly store and dispose of chemicals.
- Properly manage pesticide and herbicide use.
- Properly manage fertilizer use.

##### Stencil storm drains

##### Training

- Train employees on these BMPs, storm water discharge prohibitions, and wastewater discharge requirements.
- Provide on-going employee training in pollution prevention.

<sup>1</sup> EPA "Preliminary Data Summary of Urban Stormwater Best Management Practices"

4. **Properly manage irrigation and runoff.**
  - Irrigate slowly or pulse irrigate so the infiltration rate of the soil is not exceeded.
  - Inspect irrigation system regularly for leaks and to ensure that excessive runoff is not occurring.
  - If re-claimed water is used for irrigation, ensure that there is no runoff from the landscaped area(s).
  - If bailing of muddy water is required (e.g. when repairing a water line leak), do not put it in the storm drain; pour over landscaped areas.
  - Use automatic timers to minimize runoff.
  - Use popup sprinkler heads in areas with a lot of activity or where pipes may be broken. Consider the use of mechanisms that reduce water flow to broken sprinkler heads.
5. **Properly store and dispose of chemicals.**
  - Implement storage requirements for pesticide products with guidance from the local fire department and/or County Agricultural Commissioner.
  - Provide secondary containment for chemical storage.
  - Dispose of empty containers according to the instructions on the container label.
  - Triple rinse containers and use rinse water as product.
6. **Properly manage pesticide and herbicide use.**
  - Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of pesticides and herbicides and training of applicators and pest control advisors.
  - Follow manufacturers' recommendations and label directions.
  - Use pesticides only if there is an actual pest problem (not on a regular preventative schedule). When applicable use less toxic pesticides that will do the job. Avoid use of copper-based pesticides if possible. Use the minimum amount of chemicals needed for the job.
  - Do not apply pesticides if rain is expected or if wind speeds are above 5 mph.
  - Do not mix or prepare pesticides for application near storm drains. Prepare the minimum amount of pesticide needed for the job and use the lowest rate that will effectively control the targeted pest.
  - Whenever possible, use mechanical methods of vegetation removal rather than applying herbicides. Use hand weeding where practical.
  - Do not apply any chemicals directly to surface waters, unless the application is approved and permitted by the state. Do not spray pesticides within 100 feet of open waters.
  - Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.
  - When conducting mechanical or manual weed control, avoid loosening the soil, which could lead to erosion.
  - Purchase only the amount of pesticide that you can reasonably use in a given time period.
  - Careful soil mixing and layering techniques using a topsoil mix or composted organic material can be used as an effective measure to reduce herbicide use and watering.
7. **Properly manage fertilizer use.**
  - Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers.
  - Follow manufacturers' recommendations and label directions.
  - Employ techniques to minimize off-target application (e.g. spray drift) of fertilizer, including consideration of alternative application techniques. Calibrate fertilizer distributors to avoid excessive application.
  - Periodically test soils for determining proper fertilizer use.
  - Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
  - Sweep pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
  - Use slow release fertilizers whenever possible to minimize leaching
  -

8. Incorporate the following Integrated pest management techniques where appropriate:
- Mulching can be used to prevent weeds where turf is absent.
  - Remove insects by hand and place in soapy water or vegetable oil. Alternatively, remove insects with water or vacuum them off the plants.
  - Use species-specific traps (e.g. pheromone-based traps or colored sticky cards).
  - Sprinkle the ground surface with abrasive diatomaceous earth to prevent infestations by soft-bodied insects and slugs. Slugs also can be trapped in small cups filled with beer that are set in the ground so the slugs can get in easily.
  - In cases where microscopic parasites, such as bacteria and fungi, are causing damage to plants, the affected plant material can be removed and disposed of (pruning equipment should be disinfected with bleach to prevent spreading the disease organism).
  - Small mammals and birds can be excluded using fences, netting, and tree trunk guards.
  - Promote beneficial organisms, such as bats, birds, green lacewings, ladybugs, praying mantis, ground beetles, parasitic nematodes, trichogramma wasps, seedhead weevils, and spiders that prey on detrimental pest species.

### Training

1. Train employees on these BMPs, storm water discharge prohibitions, and wastewater discharge requirements.
2. Educate and train employees on the use of pesticides and pesticide application techniques. Only employees properly trained to use pesticides can apply them.
3. Train and encourage employees to use integrated pest management techniques.
4. Train employees on proper spill containment and cleanup.
  - Establish training that provides employees with the proper tools and knowledge to immediately begin cleaning up a spill.
  - Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.
  - BMP IC17 discusses Spill Prevention and Control in detail.
5. Establish a regular training schedule, train all new employees, and conduct annual refresher training.
6. Use a training log or similar method to document training.

### Stencil storm drains

Storm drain system signs act as highly visible source controls that are typically stenciled directly adjacent to storm drain inlets. Stencils should read "No Dumping Drains to Ocean".

### References

California Storm Water Best Management Practice Handbook. Industrial and Commercial. 2003.  
[www.cabmphandbooks.com](http://www.cabmphandbooks.com)

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

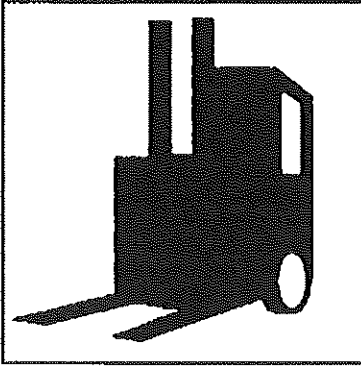
King County Stormwater Pollution Control Manual. Best Management Practices for Businesses. King County Surface Water Management. July 1995. On-line: <http://dnr.metrokc.gov/wlr/dss/spcm.htm>

Stormwater Management Manual for Western Washington. Volume IV Source Control BMPs. Prepared by Washington State Department of Ecology Water Quality Program. Publication No. 99-14. August 2001.

Water Quality Handbook for Nurseries. Oklahoma Cooperative Extension Service. Division of Agricultural Sciences and Natural Resources. Oklahoma State University. E-951. September 1999.

**For additional information contact:**

County of Orange  
Watershed & Coastal Resources  
Stormwater Program  
(714)567-6363  
or visit our website at:  
[www.ocwatersheds.com](http://www.ocwatersheds.com)



## MATERIAL LOADING AND UNLOADING

**The loading/unloading of materials usually takes place outside; therefore, materials spilled, leaked, or lost during loading/unloading have the potential to collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned. Additionally, rainfall may wash pollutants from machinery used to unload or move materials. Material loading and unloading involves the following activities:**

### POLLUTION PREVENTION:

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

- Check loading and unloading equipment regularly for leaks.
- Cover loading docks.
- Once per year, educate municipal staff on pollution prevention measures.

### MODEL PROCEDURES:

#### General Guidelines

- ✓ Regularly clean work areas to remove materials such as debris, sandblasting material, etc.
- ✓ Design loading/unloading area to prevent stormwater runoff that would include grading or berming the area, and positioning roof downspouts so they direct stormwater away from loading/unloading areas.
- ✓ Use overhangs or door skirts that enclose the trailer.
- ✓ Park tank trucks or delivery vehicles so that spills or leaks can be contained.
- ✓ Avoid loading and exposing materials during rain events unless the loading dock is covered and protected from rain. A seal or door skirt between the trailer and the building may also prevent exposure to rain.
- ✓ Shipboard cooling and process water discharges should be directed to minimize contact with spent abrasives, paint, and other debris.



## Tank truck transfers

- ✓ 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.
- ✓ Transfer area should be designed to prevent runoff of stormwater from adjacent areas. Sloping the pad and using a berm around the uphill side of the transfer area should reduce runoff.
- ✓ 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. A positive control valve should be installed on the drain.

## Spill Control

*Also see Spill Prevention and Control procedures sheet*

- ✓ Contain leaks during transfer.
- ✓ Use drip pans under hoses.
- ✓ Have an emergency spill cleanup plan readily available.
- ✓ Place spill kits and materials next to or near each loading/unloading area.
- ✓ Use drip pans or comparable devices when transferring oils, solvents, and paints.

## Training

- ✓ Make sure forklift operators are properly trained.
- ✓ Train employees regarding spill containment and cleanup.
- ✓ Employees trained in spill containment and cleanup should be present during the loading/unloading.
- ✓ Use a written operations plan that describes procedures for loading and/or unloading.

## Inspection

*Also see Spill Prevention and Control procedures sheet*

- ✓ Check loading and unloading equipment regularly for leaks, including valves, pumps, flanges and connections.
- ✓ Inspect regularly for leaking valves, pipes, hoses, or soil chutes carrying either water or wastewater.
- ✓ Look for dust or fumes during loading or unloading operations.

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## LIMITATIONS:

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.

## REFERENCES:

*California Storm Water Best Management Practice Handbooks. Municipal Best Management Practice Handbook.*

*Prepared by Camp Dresser & McKee, Larry Walker Associates, Uribe and Associates, Resources Planning Associates for Stormwater Quality Task Force. March 1993.*

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



## **ROADS, STREETS, AND HIGHWAYS OPERATION AND MAINTENANCE**

**Streets, roads, and highways are significant sources of pollutants in storm water discharges, and operation and maintenance (O&M) practices, if not conducted properly, can contribute to the problem. O&M practices may involve one or more of the following activities:**

- 1. Sweeping & Cleaning**
- 2. Street Repair & Maintenance**
- 3. Bridge and Structure Maintenance**

**Streets, roads, and highways are significant sources of pollutants in storm water discharges, and operation and maintenance (O&M) practices, if not conducted properly, can contribute to the problem. O&M practices may involve one or more of the following activities:**

**Pollution prevention measures that should be consider and the minimum required and optional model procedures for each performance standard are provided below.**

### **POLLUTION PREVENTION:**

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

- Use the least toxic materials available (e.g. water based paints, gels or sprays for graffiti removal)
- Recycle paint and other materials whenever possible.
- Once per year, educate municipal staff on pollution prevention measures.

## MODEL PROCEDURES:

### 1. Sweeping & Cleaning

#### Sweeping Frequency and Timing

- ✓ Maintain a consistent sweeping schedule. Provide minimum monthly sweeping of streets.
- ✓ Perform street cleaning during dry weather if possible.
- ✓ Avoid wet cleaning or flushing of streets, and utilize dry methods where possible.
- ✓ If flushing of a street is absolutely necessary, sweep and remove debris before flushing. Do not let wash water enter storm drain inlets. Collect wash water and direct to a dirt or vegetated area, pump into a vacuum truck and dispose of properly.

#### OPTIONAL:

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

#### Equipment Operation and Selection

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

- ✓ Maintain cleaning equipment in good working condition and purchase replacement equipment as needed. Old sweepers should be replaced as needed with new technologically advanced sweepers (preferably regenerative air sweepers) that maximize pollutant removal.
- ✓ Operate sweepers at manufacturer requested optimal speed levels to increase effectiveness.
- ✓ Clean sweepers at a wash rack that drains to the sanitary sewer. The wash rack area should be covered and bermed and wash water should drain to a clarifier prior to entering the sanitary sewer.
- ✓ Regularly inspect vehicles and equipment for leaks, and repair immediately.

#### OPTIONAL:

- If available use vacuum or regenerative air sweepers in the high sediment and trash areas (typically industrial/commercial).

#### Management of Material Removed by Sweeping

- ✓ Dispose of street sweeping debris and dirt at a landfill.
- ✓ Do not store swept material along the side of the street or near a storm drain inlet.
- ✓ If dewatering of saturated materials is necessary it should be conducted in a designated area away from storm drain inlets and the water contained for proper disposal.

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

## Maximize Access for Sweepers

- ✓ If authorized by the local sanitation agency, water may be discharged to the sanitary sewer only after passing through a clarifier. As an alternative, dewatering can be conducted in a containment area in which saturated materials are placed on a tarp and allowed to dry. Dry debris is then disposed of properly.
- ✓ Keep debris storage to a minimum during the wet season or make sure debris piles are contained (e.g. by berming the area) or covered (e.g. with tarps or permanent covers).
- ✓ Keep accurate operation logs to track program.
- ✓ Properly maintain and operate equipment; which will increase efficiency.
- ✓ Sweeping should be conducted as close to the curb line as possible.

### OPTIONAL:

- Institute a parking policy to restrict parking in problematic areas during periods of street sweeping.
- Post permanent street sweeping signs in problematic areas; use temporary signs if installation of permanent signs is not possible.
- Develop and distribute flyers notifying residents of street sweeping schedules.

## 2. Repair and Maintenance

### Pavement Marking

- ✓ Develop paint handling procedures for proper use, storage, and disposal of paints.
- ✓ Transfer and load paint and hot thermoplastic away from storm drain inlets.
- ✓ Street or hand sweep thermoplastic grindings. Yellow thermoplastic grindings may require special handling as they may contain lead.
- ✓ Replace paints containing lead and tributyltin with less toxic alternatives.
- ✓ Use water based paints. Clean application equipment in a sink that is connected to the sanitary sewer.
- ✓ Properly store leftover paints if they are to be kept for the next job, or dispose of properly.
- ✓ See *Spill Control procedure sheet* for guidance on the proper cleanup of paint spills.

### Concrete Installation and Repair

- ✓ Avoid mixing excess amounts of fresh concrete or cement mortar on-site. Only mix what is needed for the job.
- ✓ Wash concrete trucks off site or in designated areas on site, such that there is no discharge of concrete wash water into storm drain inlets, open ditches, streets, or other stormwater conveyance structures.



- ✓ Store concrete materials under cover, away from drainage areas.
- ✓ Return leftover materials to the transit mixer. Dispose of small amounts of hardened excess concrete, grout, and mortar in the trash.
- ✓ Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile, or dispose in the trash.
- ✓ When washing poured concrete areas to remove fine particles and expose the aggregate, contain the wash water for proper disposal; do not discharge water to the storm drain system.
- ✓ Do not allow excess concrete to be dumped on-site, except in designated areas.
- ✓ Apply concrete, asphalt, and seal coat during dry weather to allow the material to adequately dry prior to a rain event.
- ✓ When making saw cuts in pavement, use as little water as possible and perform during dry weather. Cover each nearby or appropriate storm drain inlet completely with filter fabric or plastic during the sawing operation and contain the slurry by placing straw bales, sandbags, or gravel dams around the inlets. After the liquid drains or evaporates, shovel or vacuum the slurry residue from the pavement or gutter and remove from site. Alternatively, a small on-site vacuum may be used to pick up the slurry as this will prohibit slurry from reaching storm drain inlets.

## **Patching, Resurfacing, and Surface Sealing**

- ✓ Pre-heat, transfer or load hot bituminous material away from storm drain inlets.
- ✓ Apply concrete, asphalt, and seal coat during dry weather to allow the material to adequately dry prior to a rain event.
- ✓ Where applicable, cover and seal each nearby or appropriate storm drain inlet (with waterproof material, plastic or mesh) and maintenance holes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and until all water from emulsified oil sealants has drained or evaporated. Clean any debris from covered man holes and storm drain inlets when the job is complete.
- ✓ 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.
- ✓ Prior to a rain event or at the completion of a project, sweep the project area by hand or with a street sweeper.

## **Equipment Cleaning, Maintenance, and Storage**

*Also see Equipment Repair & Maintenance procedure sheet.*

- ✓ Clean equipment including sprayers, sprayer paint supply lines, patch and paving equipment, and mudjacking equipment at the end of each day. If equipment can be cleaned and materials reapplied at the job site, do so in compliance with the laws and regulations. Clean in a sink or other area (e.g. vehicle wash area) that is connected to the sanitary sewer.

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

- ✓ If refueling or repairing vehicles and equipment must be done on-site, conduct the activity away from storm drain inlets and watercourses.
- ✓ Place drip pans or absorbent materials under heavy equipment when not in use.
- ✓ Clean paint brushes and tools covered with water-based paints in sinks connected to sanitary sewers. 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.

**OPTIONAL:**

- Conduct cleaning at a corporation or maintenance yard if possible.
- When practical, perform major equipment repairs at the corporation yard.

→ *In addition to the procedures above, review and apply general procedures outlined for Minor Construction activities when conducting street, road, and highway repair and maintenance activities.*

## 3. Bridge and Structure Maintenance

### Painting and Paint Removal

- ✓ Transport paint and materials to and from job sites in containers with secure lids and tied down to the transport vehicle.
- ✓ Do not transfer or load paint near storm drain inlets or watercourses.
- ✓ Test and inspect spray equipment prior to starting to paint. Tighten all hoses and connections and do not overfill paint container.
- ✓ If sand blasting is used to remove paint, cover nearby storm drain inlets prior to starting work.
- ✓ If the bridge crosses a watercourse, perform work on a maintenance traveler or platform, or use suspended netting or tarps to capture paint, rust, paint removing agents, or other materials, to prevent discharge of materials to surface waters. If sanding, use a sander with a vacuum filter bag.
- ✓ Recycle paint when possible (e.g. paint may be used for graffiti removal activities). Dispose of paint at an appropriate household hazardous waste facility.
- ✓ See Spill Control procedure sheet for guidance on the proper cleanup of paint spills.

### Graffiti Removal

- ✓ Avoid graffiti abatement activities during rain events.
- ✓ Protect nearby storm drain inlets prior to removing graffiti from walls, signs, sidewalks, or other structures needing graffiti abatement. Clean up

afterwards by sweeping or vacuuming thoroughly, and/or by using absorbent and properly disposing of the absorbent.

- ✓ Note that care should be taken when disposing of waste since it may need to be disposed of as hazardous waste.
- ✓ When graffiti is removed by painting over, implement the procedures under Painting and Paint Removal above.
- ✓ Direct runoff from sand blasting and high pressure washing (with no cleaning agents) into a landscaped or dirt area.
- ✓ If a graffiti abatement method generates wash water containing a cleaning compound (such as high pressure washing with a cleaning compound), plug nearby storm drains and collect wash water and dispose of properly.

#### OPTIONAL:

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

#### **Guardrail and Fence Repair**

- ✓ When cleaning guardrails or fences follow the appropriate surface cleaning methods (depending on the type of surface) outlined in the *Sidewalk, Plaza, and Fountain Maintenance and Cleaning* procedure sheet.
- ✓ If painting is conducted, follow the *Painting and Paint Removal* procedures above.
- ✓ If graffiti removal is conducted, follow the *Graffiti Removal* procedures above.
- ✓ If construction takes place, see the procedure sheet for *Minor Construction*.
- ✓ Recycle materials whenever possible.

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#### **LIMITATIONS:**

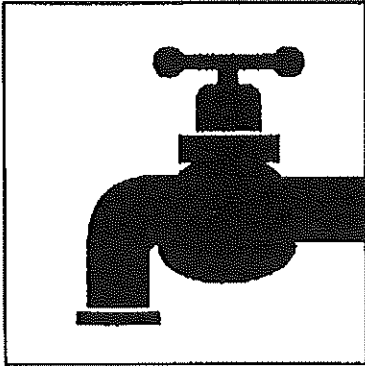
Limitations related to street sweeping may include high equipment costs, the potential inability to restrict parking in urban areas, the need for sweeper operator training, the inability of current sweeper technology to remove oil and grease, and the lack of scientific evidence regarding the expected levels of pollutant removal.

#### **REFERENCES:**

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

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

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



## **WATER AND SEWER UTILITY OPERATION AND MAINTENANCE**

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

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

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

### **POLLUTION PREVENTION:**

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

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

**MODEL PROCEDURES:**

**1. Water Line Maintenance**

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

**Planned Discharges**

- ✓ For planned discharges use one of the following options:
  - Reuse water for dust suppression, irrigation, or construction compaction
  - Discharge to the sanitary sewer system with approval
  - Discharge to the storm drain system or to a creek using applicable pollution control measures listed below (this option is ONLY applicable to uncontaminated pumped ground water, water line flushing, fire hydrant testing and flushing, discharges from potable water sources other than water main breaks) and may require a permit from the Regional Water Quality Control Board.
- ✓ If water is discharged to a storm drain inlet (catch basin), control measures must be put in place to control potential pollutants (i.e. sediment, chlorine, etc.). Examples of some storm drain inlet protection options include:
  - Silt fence – appropriate where the inlet drains a relatively flat area.
  - Gravel and wire mesh sediment filter – Appropriate where concentrated flows are expected.
  - Wooden weir and fabric – use at curb inlets where a compact installation is desired.
- ✓ Prior to discharge, inspect discharge flow path and clear/cleanup any debris or pollutants found (i.e. remove trash, leaves, sediment, and wipe up liquids, including oil spills).
- ✓ Select appropriate pollution control measure(s) considering the receiving system (i.e. curb inlet, drop inlet, culvert, creek, etc.) and ensure that the control device(s) fit properly.



- ✓ General design considerations for inlet protection devices include the following:
  - The device should be constructed such that cleaning and disposal of trapped sediment is made easy, while minimizing interference with discharge activities.
  - Devices should be constructed so that any standing water resulting from the discharge will not cause excessive inconvenience or flooding/damage to adjacent land or structures.
- ✓ The effectiveness of control devices must be monitored during the discharge period and any necessary repairs or modifications made as needed.

#### OPTIONAL:

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

### **Unplanned Discharges**

- ✓ Stop the discharge as quickly as possible by turning off water source.
- ✓ Inspect flow path of the discharged water:
  - Control erosion along the flow path.
  - Identify areas that may produce significant sediment or gullies, use sandbags to redirect the flow.
  - Identify erodible areas which may need to be repaired or protected during subsequent repairs or corrective actions
- ✓ If repairs or corrective action will cause additional discharges of water, select the appropriate procedures for erosion control, chlorine residual, turbidity, and chemical additives. Prevent potential pollutants from entering the flow path and ensure that no additional discharged water enters storm drain inlets.

## 2. Sanitary Sewer Maintenance

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

**Sewer System Cleaning**

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

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**Preventative and Corrective Maintenance**

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

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

**Control**

*Also see Drainage System procedures sheet*

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

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

## Response and Containment

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

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## LIMITATIONS:

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

## REFERENCES:

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

Los Angeles County Stormwater Quality. Public Agency Activities Model Program. On-line:  
[http://ladpw.org/wmd/npdes/public\\_TC.cfm](http://ladpw.org/wmd/npdes/public_TC.cfm)

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

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

## Description

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

## California Experience

There are currently about 100 installations in California.

## Advantages

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

## Limitations

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

## Design Considerations

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

## Targeted Constituents

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

### Legend (Removal Effectiveness)

- Low
- High
- ▲ Medium



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

### **Design and Sizing Guidelines**

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

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

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

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

### **Construction/Inspection Considerations**

No special considerations.

### **Performance**

Manufacturer's differ with respect to performance claims, but a general statement is that the manufacturer's design and rated capacity (cfs) for each model is based on and believed to achieve an aggregate reduction of 90% of all particles with a specific gravity of 2.65 (glacial sand) down to 150 microns, and to capture the floatables, and oil and grease. Laboratory tests of two products support this claim. The stated performance expectation therefore implies that a



lesser removal efficiency is obtained with particles less than 150 microns, and the lighter, organic settleables. Laboratory tests of one of the products found about 60% removal of 50 micron sand at the expected average operating flow rate

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

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

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

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

Sullivan et al. (1982) found that performance is related to the ratios of chamber to inlet diameters,  $D_2/D_1$ , and height between the inlet and outlet and the inlet diameter,  $H_1/D_1$ , shown in Figure 3. The relationships are: as  $D_2/D_1$  approaches one, the efficiency decreases; and, as the  $H_1/D_1$  ratio decreases, the efficiency decreases. These relationships may allow qualitative comparisons of the alternative designs of manufacturers. Engineers who wish to apply these concepts should review relevant publications presented in the References.

## Siting Criteria

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

**Additional Design Guidelines**

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

**Maintenance**

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

***Maintenance Requirements***

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

**Cost**

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

***Cost Considerations***

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

**References and Sources of Additional Information**

Field, R., 1972, The swirl concentrator as a combined sewer overflow regulator facility, EPA/R2-72-008, U.S. Environmental Protection Agency, Washington, D.C.

Field, R., D. Averill, T.P. O'Connor, and P. Steel, 1997, Vortex separation technology, Water Qual. Res. J. Canada, 32, 1, 185

Manufacturers technical materials

Sullivan, R.H., et al., 1982, Design manual – swirl and helical bend pollution control devices, EPA-600/8-82/013, U.S. Environmental Protection Agency, Washington, D.C.

Sullivan, R.H., M.M. Cohn, J.E. Ure, F.F. Parkinson, and G. Caliana, 1974, Relationship between diameter and height for the design of a swirl concentrator as a combined sewer overflow regulator, EPA 670/2-74-039, U.S. Environmental Protection Agency, Washington, D.C.

Sullivan, R.H., M.M. Cohn, J.E. Ure, F.F. Parkinson, and G. Caliana, 1974, The swirl concentrator as a grit separator device, EPA670/2-74-026, U.S. Environmental Protection Agency, Washington, D.C.

Sullivan, R.H., M.M. Cohn, J.E. Ure, F.F. Parkinson, and G. Caliana, 1978, Swirl primary separator device and pilot demonstration, EPA600/2-78-126, U.S. Environmental Protection Agency, Washington, D.C.

## Description

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

## California Experience

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

## Advantages

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

## Limitations

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

## Design and Sizing Guidelines

Refer to manufacturer's guidelines. Drain inserts come in many configurations but can be placed into three general groups: socks, boxes, and trays. The sock consists of a fabric, usually constructed of polypropylene. The fabric may be attached to a frame or the grate of the inlet holds the sock. Socks are meant for vertical (drop) inlets. Boxes are constructed of plastic or wire mesh. Typically a polypropylene "bag" is placed in the wire mesh box. The bag takes the form of the box. Most box products are

## Design Considerations

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

## Targeted Constituents

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

### Removal Effectiveness

See New Development and Redevelopment Handbook-Section 5.



one box; that is, the settling area and filtration through media occurs in the same box. One manufacturer has a double-box. Stormwater enters the first box where settling occurs. The stormwater flows into the second box where the filter media is located. Some products consist of one or more trays or mesh grates. The trays can hold different types of media. Filtration media vary with the manufacturer: types include polypropylene, porous polymer, treated cellulose, and activated carbon.

**Construction/Inspection Considerations**

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

**Performance**

Few products have performance data collected under field conditions.

**Siting Criteria**

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

**Additional Design Guidelines**

Follow guidelines provided by individual manufacturers.

**Maintenance**

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

**Cost**

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

**References and Sources of Additional Information**

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

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

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

Manufacturers literature

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



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



## 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.

## 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.

## Targeted Constituents

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



***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.sevurppp.org>

The Storm Water Managers Resource Center <http://www.stormwatercenter.net/>





## Objectives

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

## 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.

## Targeted Constituents

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



# SC-41 Building & Grounds Maintenance

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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.

# Building & Grounds Maintenance **SC-41**

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- 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.

# SC-41 Building & Grounds Maintenance

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- 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>

King County Storm Water Pollution Control Manual <http://dnr.metrokc.gov/wlr/dss/spcm.htm>

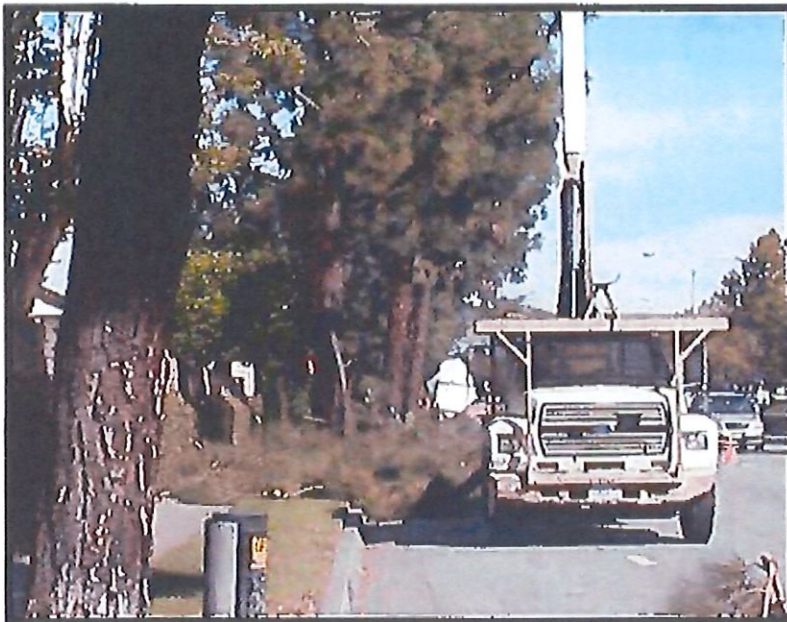
Mobile Cleaners Pilot Program: Final Report. 1997. Bay Area Stormwater Management Agencies Association (BASMAA). <http://www.basmaa.org/>

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

Santa Clara Valley Urban Runoff Pollution Prevention Program <http://www.scvurppp.org>

The Storm Water Managers Resource Center <http://www.stormwatercenter.net/>





## Description

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

## Approach

### Pollution Prevention

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

## Objectives

- Contain
- Educate
- Reduce/Minimize
- Product Substitution

## Targeted Constituents

Sediment	<input checked="" type="checkbox"/>
Nutrients	<input checked="" type="checkbox"/>
Trash	<input checked="" type="checkbox"/>
Metals	
Bacteria	
Oil and Grease	
Organics	
Oxygen Demanding	<input checked="" type="checkbox"/>



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

***Suggested Protocols******Mowing, Trimming, and Weeding***

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

***Planting***

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

***Waste Management***

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

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

## ***Irrigation***

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

## ***Fertilizer and Pesticide Management***

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

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

#### *Inspection*

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

#### *Training*

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

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

### ***Spill Response and Prevention***

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

### ***Other Considerations***

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

### **Requirements**

#### ***Costs***

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

#### ***Maintenance***

Not applicable



**Supplemental Information*****Further Detail of the BMP******Waste Management***

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

***Contractors and Other Pesticide Users***

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

**References and Resources**

King County Stormwater Pollution Control Manual. Best Management Practices for Businesses. 1995. King County Surface Water Management. July. On-line: <http://dnr.metrokc.gov/wlr/dss/spcm.htm>

Los Angeles County Stormwater Quality Model Programs. Public Agency Activities [http://ladpw.org/wmd/npdes/model\\_links.cfm](http://ladpw.org/wmd/npdes/model_links.cfm)

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

Orange County Stormwater Program [http://www.ocwatersheds.com/StormWater/swp\\_introduction.asp](http://www.ocwatersheds.com/StormWater/swp_introduction.asp)

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

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Landscaping and Lawn Care. Office of Water. Office of Wastewater Management. On-line: [http://www.epa.gov/npdes/menuofbmps/poll\\_8.htm](http://www.epa.gov/npdes/menuofbmps/poll_8.htm)

# Site Design & Landscape Planning SD-10



## Design Objectives

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

## Description

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

## Approach

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

## Suitable Applications

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

## Design Considerations

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



# **SD-10 Site Design & Landscape Planning**

## ***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

# **Site Design & Landscape Planning SD-10**

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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.

# **SD-10 Site Design & Landscape Planning**

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.





Rain Garden

## Design Objectives

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

## Description

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

## Approach

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

## Suitable Applications

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

## Design Considerations

### *Designing New Installations*

#### *Cisterns or Rain Barrels*

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



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

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

A cistern system with a permanently open outlet can also provide for metering stormwater runoff. If the cistern outlet is significantly smaller than the size of the downspout inlet (say 1/4 to 1/2 inch diameter), runoff will build up inside the cistern during storms, and will empty out slowly after peak intensities subside. This is a feasible way to mitigate the peak flow increases caused by rooftop impervious land coverage, especially for the frequent, small storms.

#### *Dry wells and Infiltration Trenches*

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

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

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

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

#### *Pop-up Drainage Emitter*

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



## *Foundation Planting*

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

## ***Redeveloping Existing Installations***

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

## **Supplemental Information**

### ***Examples***

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

### **Other Resources**

Hager, Marty Catherine, Stormwater, “Low-Impact Development”, January/February 2003.  
[www.stormh2o.com](http://www.stormh2o.com)

Low Impact Urban Design Tools, Low Impact Development Design Center, Beltsville, MD.  
[www.lid-stormwater.net](http://www.lid-stormwater.net)

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



## Design Objectives

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

## Description

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

## Approach

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

## Suitable Applications

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

## Design Considerations

### *Designing New Installations*

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

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



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

***Redeveloping Existing Installations***

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

**Other Resources**

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

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

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

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





## Design Objectives

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## Description

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

## Approach

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

## Suitable Applications

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

## Design Considerations

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

## Designing New Installations

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

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



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

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

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

### ***Redeveloping Existing Installations***

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define “redevelopment” in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. If the project meets the definition of “redevelopment”, then the requirements stated under “designing new installations” above should be included in all project design plans.

### **Additional Information**

#### ***Maintenance Considerations***

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

#### ***Placement***

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

### **Supplemental Information**

#### ***Examples***

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

### **Other Resources**

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

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

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

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## Description

Several measures can be taken to prevent operations at maintenance bays and loading docks from contributing a variety of toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to the stormwater conveyance system.

## Approach

In designs for maintenance bays and loading docks, containment is encouraged. Preventative measures include overflow containment structures and dead-end sumps. However, in the case of loading docks from grocery stores and warehouse/distribution centers, engineered infiltration systems may be considered.

## Suitable Applications

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

## Design Considerations

Design requirements for vehicle maintenance and repair 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 requirements.

## Designing New Installations

Designs of maintenance bays should consider the following:

- Repair/maintenance bays and vehicle parts with fluids should be indoors; or designed to preclude urban run-on and runoff.
- Repair/maintenance floor areas should be paved with Portland cement concrete (or equivalent smooth impervious surface).



- Repair/maintenance bays should be designed to capture all wash water leaks and spills. Provide impermeable berms, drop inlets, trench catch basins, or overflow containment structures around repair bays to prevent spilled materials and wash-down waters from entering the storm drain system. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.
- Other features may be comparable and equally effective.

The following designs of loading/unloading dock areas should be considered:

- Loading dock areas should be covered, or drainage should be designed to preclude urban run-on and runoff.
- Direct connections into storm drains from depressed loading docks (truck wells) are prohibited.
- Below-grade loading docks from grocery stores and warehouse/distribution centers of fresh food items should drain through water quality inlets, or to an engineered infiltration system, or an equally effective alternative. Pre-treatment may also be required.
- Other features may be 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.

### **Additional Information**

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

### **Other Resources**

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

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

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

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



## 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.

## Design Objectives

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





- 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.

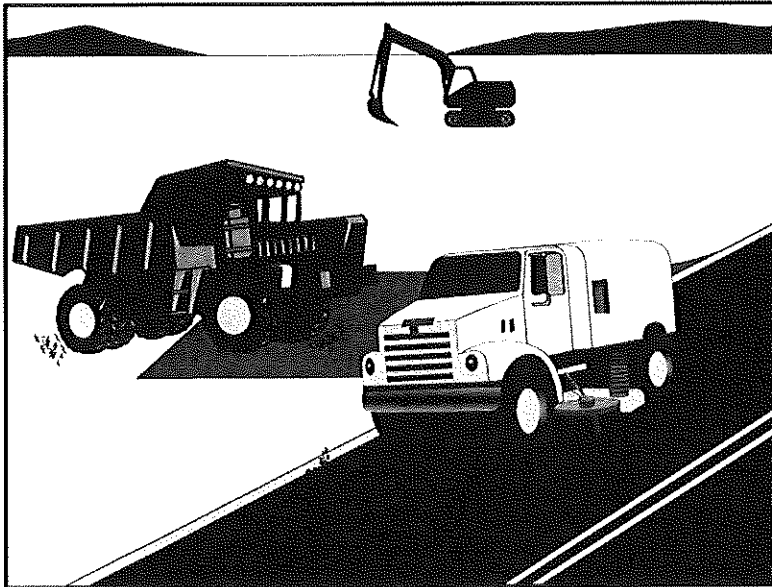
**Other Resources**

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.



## Description and Purpose

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

## Suitable Applications

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

## Limitations

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

## Implementation

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

## Categories

EC	Erosion Control	
SE	Sediment Control	<input checked="" type="checkbox"/>
TC	Tracking Control	<input checked="" type="checkbox"/>
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

## Legend:

- Primary Objective
- Secondary Objective

## Targeted Constituents

Sediment	<input checked="" type="checkbox"/>
Nutrients	
Trash	<input checked="" type="checkbox"/>
Metals	
Bacteria	
Oil and Grease	<input checked="" type="checkbox"/>
Organics	

## Potential Alternatives

None



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

## Costs

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

## Inspection and Maintenance

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

## References

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

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



# **Attachment D**

## **Infiltration Report**



**Geotechnical Engineering Investigation**

Proposed Industrial Warehouse Development  
NEC Philadelphia Street and East End Avenue  
Chino, California

PAMA Management  
4900 Santa Anita Avenue, Suite 2C  
El Monte, California 92731

Attn: Mr. Ryan Liu

Project Number 21432-19  
October 14, 2019

**NorCal Engineering**

**NorCal Engineering**  
Soils and Geotechnical Consultants  
10641 Humbolt Street Los Alamitos, CA 90720  
(562) 799-9469 Fax (562) 799-9459

October 14, 2019

Project Number 21432-19

PAMA Management  
4900 Santa Anita Avenue, Suite 2C  
El Monte, California 92731

Attn: Mr. Ryan Liu

RE: **Geotechnical Engineering Investigation** - Proposed Industrial Warehouse  
Development - Located at the Northwest Corner of Philadelphia Street and East  
End Avenue, in the City of Chino, California

Dear Mr. Liu:

Pursuant to your request, this firm has performed a Geotechnical Engineering Investigation for the above referenced project in accordance with your approval of our proposal dated September 7, 2019. The purpose of this investigation is to evaluate the geotechnical conditions of the subject site and to provide recommendations for the proposed industrial warehouse development.

The scope of work included the following: 1) site reconnaissance; 2) subsurface geotechnical exploration and sampling; 3) laboratory testing; 4) soil infiltration testing; 5) engineering analysis of field and laboratory data; 5) preparation of a geotechnical engineering report. It is the opinion of this firm that the proposed development is feasible from a geotechnical standpoint provided that the recommendations presented in this report are followed in the design and construction of the project.

## **1.0 Project Description**

It is proposed to construct an industrial warehouse development consisting of three (3) buildings totaling 60,000 square feet building as shown on the attached Site Plan by Architects Orange. The proposed concrete tilt-up buildings will be supported by a conventional slab-on-grade foundation system with perimeter-spread footings and isolated interior footings. Other improvements will include asphalt and concrete pavement areas, hardscape and landscaping. It is assumed that the proposed grading for the development will include cut and fill procedures on the order of a few feet to achieve finished grade elevations. Final building plans shall be reviewed by this firm prior to submittal for city approval to determine the need for any additional study and revised recommendations pertinent to the proposed development, if necessary.

## **2.0 Site Description**

The 3.58-acre subject property is located at the northwest corner of East End Avenue and Philadelphia Street, in the City of Chino. The generally rectangular-shaped parcel is elongated in a north to south direction with topography of the relatively level property descending slightly from a north to south direction. The site is undeveloped parcel covered with sparse vegetation growth of natural grasses and weeds.

## **3.0 Site Exploration**

The investigation consisted of the placement of eight (8) subsurface exploratory trenches by a backhoe to depths ranging between 5 and 15 feet below current ground elevations. The trenches were placed at accessible locations throughout the property. The explorations were visually classified and logged by a field engineer with locations of the subsurface explorations shown on the attached plan. The exploratory trenches revealed the existing earth materials to consist of fill and natural soil. Detailed descriptions of the subsurface conditions are listed on the trench logs in Appendix A. It should be noted that the transition from one soil type to another as shown on the trench logs is approximate and may in fact be a gradual transition. The soils encountered are described as follows:

**Fill:** A fill soil classifying as a brown, fine to medium grained, silty SAND was encountered across the site to depths of one foot below ground surface. These soils were noted to be loose and moist.

**Natural:** A natural undisturbed soil classifying as a brown, fine to medium grained, silty SAND to sandy SILT was encountered beneath the upper fill soils. The native soils as encountered were observed to be medium dense to firm and damp to moist.

The overall engineering characteristics of the earth material were relatively uniform with each excavation. Groundwater was not encountered to the depth of our trenches and no caving occurred.

#### 4.0 Laboratory Tests

Relatively undisturbed samples of the subsurface soils were obtained to perform laboratory testing and analysis for direct shear, consolidation tests, and to determine in-place moisture/densities. These relatively undisturbed ring samples were obtained by driving a thin-walled steel sampler lined with one-inch long brass rings with an inside diameter of 2.42 inches into the undisturbed soils. Bulk bag samples were obtained in the upper soils for expansion index tests and maximum density tests. All test results are included in Appendix B, unless otherwise noted.

- 4.1 **Field Moisture Content** (ASTM: D 2216) and the dry density of the ring samples were determined in the laboratory. This data is listed on the logs of explorations.
- 4.2 **Maximum Density tests** (ASTM: D 1557) were performed on typical samples of the upper soils. Results of these tests are shown on Table I.
- 4.3 **Expansion Index tests** (ASTM: D 4829) were performed on remolded samples of the upper soils to determine expansive characteristics. Results of these tests are provided on Table II.

- 4.4 **Corrosion tests** consisting of sulfate, pH, resistivity and chloride analysis to determine potential corrosive effects of soils on concrete and underground utilities. Test results are provided on Table III.
- 4.5 **R-Value test** per California Test Method 301 was performed on a representative sample, which may be anticipated to be near subgrade to determine pavement design. Results are provided within the pavement design section of the report.
- 4.6 **Direct Shear tests** (ASTM: D 3080) were performed on undisturbed and/or remolded samples of the subsurface soils. The test is performed under saturated conditions at loads of 1,000 lbs./sq.ft., 2,000 lbs./sq.ft., and 3,000 lbs./sq.ft. with results shown on Plate A.
- 4.7 **Consolidation tests** (ASTM: D 2435) were performed on undisturbed samples to determine the differential and total settlement which may be anticipated based upon the proposed loads. Water was added to the samples at a surcharge of one KSF and the settlement curves are plotted on Plates B and C.

## 5.0 Seismicity Evaluation

The proposed development lies outside of any Alquist Priolo Special Studies Zone and the potential for damage due to direct fault rupture is considered unlikely. The nearest fault is located less than 2 kilometers from the site and is capable of producing a Magnitude 7.0 earthquake. Ground shaking originating from earthquakes along other active faults in the region is expected to induce lower horizontal accelerations due to smaller anticipated earthquakes and/or greater distances to other faults.

The seismic design acceleration parameters are provided on the following page and are based upon the 2016 California Building Code (CBC). The data was obtained from the American Society of Civil Engineers (ASCE) website, <https://asce7hazardtool.online/>.



**Seismic Design Acceleration Parameters**

Latitude	34.034
Longitude	-117.725
Site Class	D
Risk Category	I/II/III
Mapped Spectral Response Acceleration	$S_S = 2.181$ $S_I = 0.799$
Adjusted Maximum Acceleration	$S_{MS} = 2.181$ $S_{M1} = 1.198$
Design Spectral Response Acceleration Parameters	$S_{DS} = 1.454$ $S_{D1} = 0.799$

**6.0 Liquefaction Evaluation**

The site is expected to experience ground shaking and earthquake activity that is typical of the Southern California area. It is during severe shaking that loose, granular soils below the groundwater table can liquefy. Based on review of the *County of San Bernardino County Land Use Plan – General Plan – Geologic Hazard Overlays (2009)*, the site lies outside a zone of "Suspected Liquefaction Susceptibility". Based on review of local groundwater maps, the depth of groundwater is in excess of 300 feet (Carson & Matti 1982). Thus, the design of the proposed construction in conformance with the latest Building Code provisions for earthquake design is expected to provide mitigation of ground shaking hazards that are typical to Southern California.

**7.0 Infiltration Characteristics**

Infiltration tests within the site were performed to provide preliminary infiltration rates for the purpose of planning and design of an on-site water disposal system. The infiltration tests consisted of the double ring infiltration test per ASTM Method D 3385. The field infiltration rate was computed using a reduction factor –  $R_f$  based on the field measurements with our calculations given in Appendix D. Based upon the results of our testing, the soils encountered in the planned on-site drainage disposal system area exhibit the following infiltration rates.

Test No.	Depth (ft)	Infiltration Rate
T-1	5'	1.6 in/hr
T-2	9.5'	3.6 in/hr
T-3	11'	3.0 in/hr

The correction factors  $CF_t$ ,  $CF_v$  and  $CF_s$  are given below based on soils between 5 and 11 feet from our field tests.

- a)  $CF_t = R_f = 1.0$  for our double ring infiltration test holes.
- b)  $CF_v = 1.0$  based on uniform soils encountered in three trenches for infiltration tests.
- c)  $CF_s = 2.0$  for long-term siltation, plugging and maintenance. The subsurface soils are likely to have some plugging and regular maintenance of storm water discharge devices is required.

Based on the results of our field testing, the subsurface soils encountered in the proposed on-site drainage disposal system from 5 and 11 feet below ground surface shall utilize a design infiltration rate of 2.5 in/hr. for the silty soils. All systems must meet the latest city and/or county specifications and the California Regional Water Quality Control Board (CRWQCB) requirements. A review of the groundwater maps of the Upper Santa Ana River Basin (Carson and Matti, 1982) reveals a groundwater depth in excess of 350 feet.

It is recommended that foundations shall be setback a minimum distance of 10 feet from the drainage disposal system and the bottom of footing shall be a minimum of 10 feet from the expected zone of saturation. The boundary of the zone of saturation may be assumed to project downward from the top of the permeable portion of the disposal system at an inclination of 1 to 1 or flatter, as determined by the geotechnical engineer.

## 8.0 Conclusions and Recommendations

Based upon our evaluations, the proposed development is acceptable from a geotechnical engineering standpoint. By following the recommendations and guidelines set forth in our report, the structures will be safe from excessive settlements under the anticipated design loadings and conditions. The proposed development shall meet all requirements of the City Building Ordinance and will not impose any adverse effect on existing adjacent structures.

The following recommendations are based upon soil conditions encountered in our field investigation; these near-surface soil conditions could vary across the site. Variations in the soil conditions may not become evident until the commencement of grading operations for the proposed development and revised recommendations from the soils engineer may be necessary based upon the conditions encountered.

It is recommended that site inspections be performed by a representative of this firm during all grading and construction of the development to verify the findings and recommendations documented in this report. Any unusual conditions which may be encountered in the course of the project development may require the need for additional study and revised recommendations.

### 8.1 Site Grading Recommendations

Any vegetation and/or demolition debris shall be removed and hauled from proposed grading areas prior to the start of grading operations. Existing vegetation shall not be mixed or disced into the soils. Any removed soils may be reutilized as compacted fill once any deleterious material or oversized materials (in excess of eight inches) is removed. Grading operations shall be performed in accordance with the attached *Specifications for Placement of Compacted Fill*.

### 8.1.1 Removal and Recompaction Recommendations

All disturbed soils and/or fill (about one foot below ground surface) shall be removed to competent native material, the exposed surface scarified to a depth of 12 inches, brought to within 2% of optimum moisture content and compacted to a minimum of 90% of the laboratory standard (ASTM: D 1557) prior to placement of any additional compacted fill soils, foundations, slabs-on-grade and pavement. Grading shall extend a minimum of five horizontal feet outside the edges of foundations or equidistant to the depth of fill placed, whichever is greater.

It is possible that isolated areas of undiscovered fill not described in this report are present on site; if found, these areas should be treated as discussed earlier. A diligent search shall also be conducted during grading operations in an effort to uncover any underground structures, irrigation or utility lines. If encountered, these structures and lines shall be either removed or properly abandoned prior to the proposed construction.

Any imported fill material should be preferably soil similar to the upper soils encountered at the subject site. All soils shall be approved by this firm prior to importing at the site and will be subjected to additional laboratory testing to assure concurrence with the recommendations stated in this report.

If placement of slabs-on-grade and pavement is not completed immediately upon completion of grading operations, additional testing and grading of the areas may be necessary prior to continuation of construction operations. Likewise, if adverse weather conditions occur which may damage the subgrade soils, additional assessment by the soils engineer as to the suitability of the supporting soils may be needed.

Care should be taken to provide or maintain adequate lateral support for all adjacent improvements and structures at all times during the grading operations and construction phase. Adequate drainage away from the structures, pavement and slopes should be provided at all times.

### 8.1.2 Fill Blanket Recommendations

Due to the potential for differential settlement of foundations placed on compacted fill and native materials, it is recommended that all foundations including floor slab areas be underlain by a uniform compacted fill blanket at least two feet in thickness. This fill blanket shall extend a minimum of five horizontal feet outside the edges of foundations or equidistant to the depth of fill placed, whichever is greater.

### 8.2 Shrinkage and Subsidence

Results of our in-place density tests reveal that the soil shrinkage will be on the order of 10 to 20% due to excavation and recompaction, based upon the assumption that the fill is compacted to 92% of the maximum dry density per ASTM standards. Subsidence should be 0.2 feet due to earthwork operations. The volume change does not include any allowance for vegetation or organic stripping, removal of subsurface improvements, or topographic approximations. Although these values are only approximate, they represent our best estimate of lost yardage, which will likely occur during grading. If more accurate shrinkage and subsidence factors are needed, it is recommended that field testing the actual equipment and grading techniques should be conducted.

### 8.3 Temporary Excavations

Temporary unshored excavations in the existing site materials may be made at vertical inclinations up to 4 feet in height unless cohesionless soils are encountered. In areas where soils with little or no binder are encountered, where adverse geological conditions are exposed, or where excavations are adjacent to existing structures, shoring or flatter excavations may be required. The temporary cut slope gradients given above do not preclude local raveling and sloughing. All excavations shall be made in accordance with the requirements of the soils engineer, CAL-OSHA and other public agencies having jurisdiction. Care should be taken to provide or maintain adequate lateral support for all adjacent improvements and structures at all times during the grading operations and construction phase.



#### 8.4 Foundation Design

All foundations may be designed utilizing the following allowable bearing capacities for an embedded depth of 18 inches into approved engineered fill with the corresponding widths:

Allowable Bearing Capacity (psf)		
Width (feet)	Continuous Foundation	Isolated Foundation
1.5	2000	2500
2.0	2075	2575
4.0	2375	2875
6.0	2500	3000

The bearing value may be increased by 500 psf for each additional foot of depth in excess of the 18-inch minimum depth, up to a maximum of 4,000 psf. A one-third increase may be used when considering short-term loading and seismic forces. Any foundations located along property line may utilize an allowable bearing capacity of 1,500 psf. A representative of this firm shall inspect all foundation excavations prior to pouring concrete.

#### 8.5 Settlement Analysis

Resultant pressure curves for the consolidation tests are shown on Plates B and C. Computations utilizing these curves and the recommended allowable soil bearing capacities reveal that the foundations will experience settlements on the order of  $\frac{3}{4}$  inch and differential settlements of less than  $\frac{1}{4}$  inch.

#### 8.6 Lateral Resistance

The following values may be utilized in resisting lateral loads imposed on the structure. Requirements of the California Building Code should be adhered to when the coefficient of friction and passive pressures are combined.

Coefficient of Friction - 0.40

Equivalent Passive Fluid Pressure = 250 lbs./cu.ft.

Maximum Passive Pressure = 2,500 lbs./cu.ft.

The passive pressure recommendations are valid only for approved compacted fill soils or competent native materials.

### 8.7 Retaining Wall Design Parameters

Active earth pressures against retaining walls will be equal to the pressures developed by the following fluid densities. These values are for approved granular backfill material placed behind the walls at various ground slopes above the walls.

<u>Surface Slope of Retained Materials (Horizontal to Vertical)</u>	<u>Equivalent Fluid Density (lb./cu.ft.)</u>
Level	30
5 to 1	35
4 to 1	38
3 to 1	40
2 to 1	45

Any applicable short-term construction surcharges and seismic forces should be added to the above lateral pressure values. An equivalent fluid pressure of 45 pcf may be utilized for the restrained wall condition with a level grade behind the wall.

The seismic-induced lateral soil pressure for walls greater than 6 feet may be computed using a triangular pressure distribution with the maximum value at the top of the wall. The maximum lateral pressure of (20 pcf) H where H is the height of the retained soils above the wall footing should be used in final design of retaining walls. Sliding resistance values and passive fluid pressure values may be increased by 1/3 during short-term wind and seismic loading conditions.

All walls shall be waterproofed as needed and protected from hydrostatic pressure by a reliable permanent subdrain system. The granular backfill to be utilized immediately adjacent to retaining walls shall consist of an approved select granular soil with a sand equivalency greater than 30. This backfill zone of free draining material shall consist of a wedge beginning a minimum of one horizontal foot from the base of the wall extending upward at an inclination of no less than ¾ to 1 (horizontal to vertical).

### 8.8 Slab Design

All concrete slabs shall be a minimum of six inches in thickness in the proposed warehouse areas and four inches in office and hardscape and placed on approved subgrade soils. Additional reinforcement requirements and an increase in thickness of the slabs-on-grade may be necessary based upon soils expansion potential and proposed loading conditions in the structures and should be evaluated further by the project engineers and/or architect.

A vapor retarder (10-mil minimum thickness) should be utilized in areas which would be sensitive to the infiltration of moisture. This retarder shall meet requirements of ASTM E 96, *Water Vapor Transmission of Materials* and ASTM E 1745, *Standard Specification for Water Vapor Retarders used in Contact with Soil or Granular Fill Under Concrete Slabs*. The vapor retarder shall be installed in accordance with procedures stated in ASTM E 1643, *Standard practice for Installation of Water Vapor Retarders used in Contact with Earth or Granular Fill Under Concrete Slabs*.

The moisture retarder may be placed directly upon compacted subgrade soils conditioned to near optimum moisture levels, although one to two inches of sand beneath the membrane is desirable. The subgrade upon which the retarder is placed shall be smooth and free of rocks, gravel or other protrusions which may damage the retarder. Use of sand above the retarder is under the purview of the structural engineer; if sand is used over the retarder, it should be placed in a dry condition.

### 8.9 Pavement Section Design

The table below provides a preliminary pavement design based upon an R-Value of 44 for the subgrade soils for the proposed pavement areas. Final pavement design may need to be based on R-Value testing of the subgrade soils near the conclusion of site grading to assure that these soils are consistent with those assumed in this preliminary design. The recommendations are based upon estimated traffic loads. Client should submit any other anticipated traffic loadings to the geotechnical engineer, if necessary, so that pavement sections may be reviewed to determine adequacy to support the proposed loadings.

Type of Traffic	Traffic Index	Asphalt (in.)	Base Material (in.)
Automobile Parking Stalls	4.0	3.0	3.0
Light Vehicle Circulation Areas	5.5	3.5	4.5
Heavy Truck Access Areas	7.0	4.0	8.0

Any concrete slab-on-grade in pavement areas including truck aprons shall be a minimum of six inches in thickness and may be placed on approved subgrade soils. All pavement areas shall have positive drainage toward an approved outlet from the site. Drain lines behind curbs and/or adjacent to landscape areas should be considered by client and the appropriate design engineers to prevent water from infiltrating beneath pavement. If such infiltration occurs, damage to pavement, curbs and flow lines, especially on sites with expansive soils, may occur during the life of the project.

Any approved base material shall consist of a Class II aggregate or equivalent and should be compacted to a minimum of 95% relative compaction. All pavement materials shall conform to the requirements set forth by the City of Chino. The base material; and asphaltic concrete should be tested prior to delivery to the site and during placement to determine conformance with the project specifications. A pavement engineer shall designate the specific asphalt mix design to meet the required project specifications.

#### 8.10 Utility Trench and Excavation Backfill

Trenches from installation of utility lines and other excavations may be backfilled with on-site soils or approved imported soils compacted to a minimum of 90% relative compaction. All utility lines shall be properly bedded with clean sand having a sand equivalency rating of 30 or more. This bedding material shall be thoroughly water jetted around the pipe structure prior to placement of compacted backfill soils.

### 8.11 Corrosion Design Criteria

Representative samples of the surficial soils, typical of the subgrade soils expected to be encountered within foundation excavations and underground utilities were tested for corrosion potential. The minimum resistivity value obtained for the samples tested is representative of an environment that may be severely corrosive to metals. The soil pH value was considered mildly alkaline and may not have a significant effect on soil corrosivity. Consideration should be given to corrosion protection systems for buried metal such as protective coatings, wrappings or the use of PVC where permitted by local building codes.

According to Table 4.3.1 of ACI 318 Building Code and Commentary, these contents revealed negligible sulfate concentrations. Therefore, a Type II cement according to latest CBC specifications may be utilized for building foundations at this time. It is recommended that additional sulfate tests be performed at the completion of site grading to assure that the as graded conditions are consistent with the recommendations stated in this design. Corrosion test results may be found on the attached Table IV.

### 8.12 Expansive Soil

If expansive soils are encountered, special attention should be given to the project design and maintenance. The attached *Expansive Soil Guidelines* should be reviewed by the engineers, architects, owner, maintenance personnel and other interested parties and considered during the design of the project and future property maintenance.

### 9.0 Closure

The recommendations and conclusions contained in this report are based upon the soil conditions uncovered in our test excavations. No warranty of the soil condition between our excavations is implied. NorCal Engineering should be notified for possible further recommendations if unexpected to unfavorable conditions are encountered during construction phase. It is the responsibility of the owner to ensure that all information within this report is submitted to the Architect and appropriate Engineers for the project.



A preconstruction conference should be held between the developer, general contractor, grading contractor, city inspector, architect, and soil engineer to clarify any questions relating to the grading operations and subsequent construction. Our representative should be present during the grading operations and construction phase to certify that such recommendations are complied within the field.

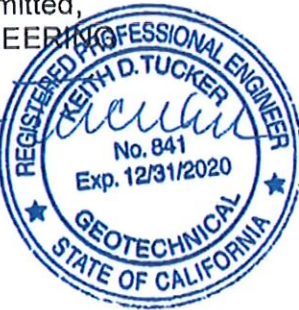
This geotechnical investigation has been conducted in a manner consistent with the level of care and skill exercised by members of our profession currently practicing under similar conditions in the Southern California area. No other warranty, expressed or implied is made.

We appreciate this opportunity to be of service to you. If you have any further questions, please do not hesitate to contact the undersigned.

Respectfully submitted,  
NORCAL ENGINEERING



Keith D. Tucker  
Project Engineer  
R.G.E. 841



Scott D. Spensiero  
Project Manager

### SPECIFICATIONS FOR PLACEMENT OF COMPACTED FILL

#### **Excavation**

Any existing low-density soils and/or saturated soils shall be removed to competent natural soil under the inspection of the Geotechnical Engineering Firm. After the exposed surface has been cleansed of debris and/or vegetation, it shall be scarified until it is uniform in consistency, brought to the proper moisture content and compacted to a minimum of 90% relative compaction (in accordance with ASTM: D 1557).

In any area where a transition between fill and native soil or between bedrock and soil are encountered, additional excavation beneath foundations and slabs will be necessary in order to provide uniform support and avoid differential settlement of the structure.

#### **Material for Fill**

The on-site soils or approved import soils may be utilized for the compacted fill provided they are free of any deleterious materials and shall not contain any rocks, brick, asphaltic concrete, concrete or other hard materials greater than eight inches in maximum dimensions. Any import soil must be approved by the Geotechnical Engineering firm a minimum of 72 hours prior to importation of site.

#### **Placement of Compacted Fill Soils**

The approved fill soils shall be placed in layers not excess of six inches in thickness. Each lift shall be uniform in thickness and thoroughly blended. The fill soils shall be brought to within 2% of the optimum moisture content, unless otherwise specified by the Soils Engineering firm. Each lift shall be compacted to a minimum of 90% relative compaction (in accordance with ASTM: D 1557) and approved prior to the placement of the next layer of soil. Compaction tests shall be obtained at the discretion of the Geotechnical Engineering firm but to a minimum of one test for every 500 cubic yards placed and/or for every 2 feet of compacted fill placed.

The minimum relative compaction shall be obtained in accordance with accepted methods in the construction industry. The final grade of the structural areas shall be in a dense and smooth condition prior to placement of slabs-on-grade or pavement areas. No fill soils shall be placed, spread or compacted during unfavorable weather conditions. When the grading is interrupted by heavy rains, compaction operations shall not be resumed until approved by the Geotechnical Engineering firm.

#### **Grading Observations**

The controlling governmental agencies should be notified prior to commencement of any grading operations. This firm recommends that the grading operations be conducted under the observation of a Soils Engineering firm as deemed necessary. A 24-hour notice must be provided to this firm prior to the time of our initial inspection.

Observation shall include the clearing and grubbing operations to assure that all unsuitable materials have been properly removed; approve the exposed subgrade in areas to receive fill and in areas where excavation has resulted in the desired finished grade and designate areas of overexcavation; and perform field compaction tests to determine relative compaction achieved during fill placement. In addition, all foundation excavations shall be observed by the Geotechnical Engineering firm to confirm that appropriate bearing materials are present at the design grades and recommend any modifications to construct footings.

### EXPANSIVE SOIL GUIDELINES

The following expansive soil guidelines are provided for your project. The intent of these guidelines is to inform you, the client, of the importance of proper design and maintenance of projects supported on expansive soils. *You, as the owner or other interested party, should be warned that you have a duty to provide the information contained in the soil report including these guidelines to your design engineers, architects, landscapers and other design parties in order to enable them to provide a design that takes into consideration expansive soils.*

*In addition, you should provide the soil report with these guidelines to any property manager, lessee, property purchaser or other interested party that will have or assume the responsibility of maintaining the development in the future.*

Expansive soils are fine-grained silts and clays which are subject to swelling and contracting. The amount of this swelling and contracting is subject to the amount of fine-grained clay materials present in the soils and the amount of moisture either introduced or extracted from the soils. Expansive soils are divided into five categories ranging from "very low" to "very high". Expansion indices are assigned to each classification and are included in the laboratory testing section of this report. *If the expansion index of the soils on your site, as stated in this report, is 21 or higher, you have expansive soils.* The classifications of expansive soils are as follows:

Classification of Expansive Soil\*

Expansion Index	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
Above 130	Very High

\*From Table 18A-I-B of California Building Code (1988)

When expansive soils are compacted during site grading operations, care is taken to place the materials at or slightly above optimum moisture levels and perform proper compaction operations. Any subsequent excessive wetting and/or drying of expansive soils will cause the soil materials to expand and/or contract. These actions are likely to cause distress of foundations, structures, slabs-on-grade, sidewalks and pavement over the life of the structure. *It is therefore imperative that even after construction of improvements, the moisture contents are maintained at relatively constant levels, allowing neither excessive wetting or drying of soils.*

Evidence of excessive wetting of expansive soils may be seen in concrete slabs, both interior and exterior. Slabs may lift at construction joints producing a trip hazard or may crack from the pressure of soil expansion. Wet clays in foundation areas may result in lifting of the structure causing difficulty in the opening and closing of doors and windows, as well as cracking in exterior and interior wall surfaces. In extreme wetting of soils to depth, settlement of the structure may eventually result. Excessive wetting of soils in landscape areas adjacent to concrete or asphaltic pavement areas may also result in expansion of soils beneath pavement and resultant distress to the pavement surface.

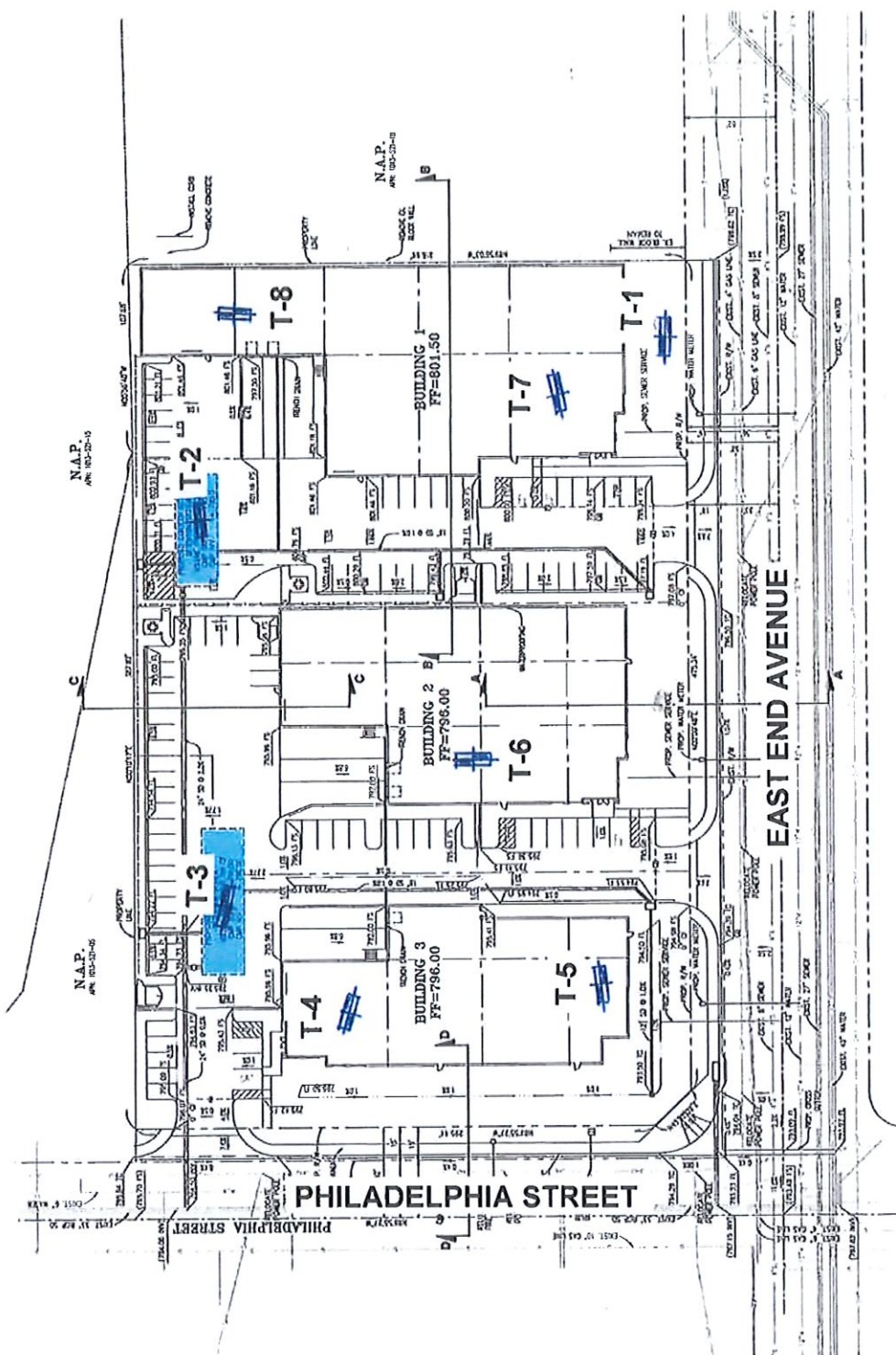
Excessive drying of expansive soils is initially evidenced by cracking in the surface of the soils due to contraction. Settlement of structures and on-grade slabs may also eventually result along with problems in the operation of doors and windows.

*Projects located in areas of expansive clay soils will be subject to more movement and "hairline" cracking of walls and slabs than similar projects situated on non-expansive sandy soils.* There are, however, measures that developers and property owners may take to reduce the amount of movement over the life the development. The following guidelines are provided to assist you in both design and maintenance of projects on expansive soils:



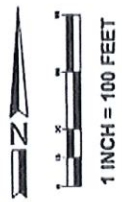
- Drainage away from structures and pavement is essential to prevent excessive wetting of expansive soils. Grades should be designed to the latest building code and maintained to allow flow of irrigation and rain water to approved drainage devices or to the street. Any "ponding" of water adjacent to buildings, slabs and pavement after rains is evidence of poor drainage; the installation of drainage devices or regrading of the area may be required to assure proper drainage. Installation of rain gutters is also recommended to control the introduction of moisture next to buildings. Gutters should discharge into a drainage device or onto pavement which drains to roadways.
- Irrigation should be strictly controlled around building foundations, slabs and pavement and may need to be adjusted depending upon season. This control is essential to maintain a relatively uniform moisture content in the expansive soils and to prevent swelling and contracting. Over-watering adjacent to improvements may result in damage to those improvements. NorCal Engineering makes no specific recommendations regarding landscape irrigation schedules.
- Planting schemes for landscaping around structures and pavement should be analyzed carefully. Plants (including sod) requiring high amounts of water may result in excessive wetting of soils. Trees and large shrubs may actually extract moisture from the expansive soils, thus causing contraction of the fine-grained soils.
- Thickened edges on exterior slabs will assist in keeping excessive moisture from entering directly beneath the concrete. A six-inch thick or greater deepened edge on slabs may be considered. Underlying interior and exterior slabs with 6 to 12 inches or more of non-expansive soils and providing presaturation of the underlying clayey soils as recommended in the soil report will improve the overall performance of on-grade slabs.

- Increase the amount of steel reinforcing in concrete slabs, foundations and other structures to resist the forces of expansive soils. The precise amount of reinforcing should be determined by the appropriate design engineers and/or architects.
- Recommendations of the soil report should always be followed in the development of the project. Any recommendations regarding presaturation of the upper subgrade soils in slab areas should be performed in the field and verified by the Soil Engineer.



**NorCal Engineering**  
 SOILS AND GEOTECHNICAL CONSULTANTS

**SITE PLAN**



PROJECT 21432-19 DATE OCTOBER 2019

## List of Appendices (in order of appearance)

### Appendix A – Log of Excavations

Log of Trenches T-1 to T-8

### Appendix B – Laboratory Tests

Table I – Maximum Dry Density

Table II – Expansion

Table III – Corrosion

Plate A – Direct Shear

Plates B and C - Consolidation

### Appendix C – ASCE Seismic Hazards Report

### Appendix D – Soil Infiltration Data

# Appendix A












MAJOR DIVISION			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINE (APPRECIABLE AMOUNT OF FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE		SM	SILTY SANDS, SAND-SILT MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

### UNIFIED SOIL CLASSIFICATION SYSTEM

## KEY:

-  Indicates 2.5-inch Inside Diameter. Ring Sample.
-  Indicates 2-inch OD Split Spoon Sample (SPT).
-  Indicates Shelby Tube Sample.
-  Indicates No Recovery.
-  Indicates SPT with 140# Hammer 30 in. Drop.
-  Indicates Bulk Sample.
-  Indicates Small Bag Sample.
-  Indicates Non-Standard
-  Indicates Core Run.

## COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 ( 4.6mm )
Sand	No. 4 ( 4.5mm ) to No. 200 ( 0.074mm )
Coarse sand	No. 4 ( 4.5 mm ) to No. 10 ( 2.0 mm )
Medium sand	No. 10 ( 2.0 mm ) to No. 40 ( 0.42 mm )
Fine sand	No. 40 ( 0.42 mm ) to No. 200 ( 0.074 mm )
Silt and Clay	Smaller than No. 200 ( 0.074 mm )

## COMPONENT PROPORTIONS

DESCRIPTIVE TERMS	RANGE OF PROPORTION
Trace	1 - 5%
Few	5 - 10%
Little	10 - 20%
Some	20 - 35%
And	35 - 50%


## MOISTURE CONTENT

DRY	Absance of moisture, dusty, dry to the touch.
DAMP	Some perceptible moisture; below optimum
MOIST	No visible water; near optimum moisture content
WET	Visible free water, usually soil is below water table.

## RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N -VALUE


COHESIONLESS SOILS		COHESIVE SOILS		
Density	N ( blows/ft )	Consistency	N (blows/ft )	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	Very Soft	0 to 2	< 250
Loose	4 to 10	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	Very Stiff	15 to 30	2000 - 4000
		Hard	over 30	> 4000

Boring Location: Philadelphia & East End, Chino  
 Date of Drilling: 10/2/19 Groundwater Depth: None Encountered  
 Drilling Method: Backhoe  
 Hammer Weight: Drop:  
 Surface Elevation: Not Measured

Depth (feet)	Lithology	Material Description	Samples		Laboratory	
			Type	Blow Counts	Moisture	Dry Density
0	 SPT not encountered	FILL Silty (fine to medium grained) SAND Brown, loose, damp				
5		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, moist Boring completed at depth of 5'				
10						
15						
20						
25						
30						
35						

SuperLog CivilTech Software, USA www.civiltech.com File: C:\SuperLog4\PROJEC 12-15-19 Date: 10/10/2019

Boring Location: Philadelphia & East End, China  
 Date of Drilling: 10/2/19 Groundwater Depth: None Encountered  
 Drilling Method: Backhoe  
 Hammer Weight: Drop:  
 Surface Elevation: Not Measured

Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	 GWL not encountered	FILL Silty (fine to medium grained) SAND Brown, loose, damp					
5		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, moist					
10		Boring completed at depth of 9'					
15							
20							
25							
30							
35							

Date: 10/10/2018

File: C:\SuperLeg\PROJ\JET

SuperLeg CivilTech Software, USA www.civiltch.com

Boring Location: Philadelphia & East End, Chicago

Date of Drilling: 10/2/19

Groundwater Depth: None Encountered

Drilling Method: Backhoe

Hammer Weight:

Drop:

Surface Elevation: Not Measured


Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	GWT not encountered	FILL Silty (fine to medium grained) SAND Brown, loose, damp					
5		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, moist					
10		Boring completed at depth of 11'					
15							
20							
25							
30							
35							

Date: 10/10/2019

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\PROJE



Boring Location: Philadelphia & East End, China	
Date of Drilling: 10/2/19	Groundwater Depth: None Encountered
Drilling Method: Backhoe	
Hammer Weight:	Drop:
Surface Elevation: Not Measured	

Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	 GWT not encountered	FILL Silty (fine to medium grained) SAND Brown, loose, damp	■		4.3	109.1	
5		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, moist	■		7.5	103.2	
10		Sandy SILT Brown, firm, moist Boring completed at depth of 10'	■		17.4	101.1	
15							
20							
25							
30							
35							

Boring Location: Philadelphia & East End, Chicago

Date of Drilling: 10/2/19

Groundwater Depth: None Encountered

Drilling Method: Backhoe






Hammer Weight:

Drop:

Surface Elevation: Not Measured

Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	GWT not encountered	FILL Silty (fine to medium grained) SAND Brown, loose, damp					
5		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, damp to moist	■		3.4	110.7	
10		Sandy SILT Brown, firm, moist	■		14.2	98.9	
10		Boring completed at depth of 10'					
15							
20							
25							
30							
35							

Boring Location: Philadelphia & East End, Chino  
 Date of Drilling: 10/2/19 Groundwater Depth: None Encountered  
 Drilling Method: Backhoe  
 Hammer Weight: Drop:  
 Surface Elevation: Not Measured

Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	 GWT not encountered	FILL Silty (fine to medium grained) SAND Brown, loose, damp			3.0	103.6	
5		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, damp to moist			2.9	105.8	
10					3.8	99.9	
15		Boring completed at depth of 15'			7.2	100.4	
20							
25							
30							
35							

SuperLog CivilTech Software, USA www.cvttech.com File: C:\Superlog4\PROJEC 12-15-19 Date: 10/10/2019

Boring Location: Philadelphia & East End, Chicago  
 Date of Drilling: 10/2/19 Groundwater Depth: None Encountered  
 Drilling Method: Backhoe  
 Hammer Weight: Drop:  
 Surface Elevation: Not Measured

Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	GW not encountered	FILL Silty (fine to medium grained) SAND Brown, loose, damp					
5		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, damp	■		3.8	107.1	
10		Boring completed at depth of 10'	■		2.4	109.5	
15							
20							
25							
30							
35							

SuperClog CivilTech Software, USA www.civiltech.com File: C:\SuperClog\PROJECT 2-15168 Date: 10/10/2019

Boring Location: Philadelphia & East End, Chinc	
Date of Drilling: 10/2/19	Groundwater Depth: None Encountered
Drilling Method: Backhoe	
Hammer Weight:	Drop:
Surface Elevation: Not Measured	

Depth (feet)	Lithology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	GWT not encountered	FILL Silty (fine to medium grained) SAND Brown, loose, damp					
5		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, moist	■		6.5	103.5	
10		Boring completed at depth of 10'	■		8.0	100.9	
15							
20							
25							
30							
35							

Date: 10/10/2019  
 12-19.log  
 File: C:\Superlog4\PROJEC  
 SuperLog CivilTech Software, USA www.civiltech.com



## Appendix B

TABLE I  
MAXIMUM DENSITY TESTS

<u>Sample</u>	<u>Classification</u>	<u>Optimum Moisture</u>	<u>Maximum Dry Density (lbs./cu.ft.)</u>
T-6 @ 2'	Silty SAND	10.0	122.0

TABLE II  
EXPANSION TESTS

<u>Sample</u>	<u>Classification</u>	<u>Expansion Index</u>
T-6 @ 2'	Silty SAND	3

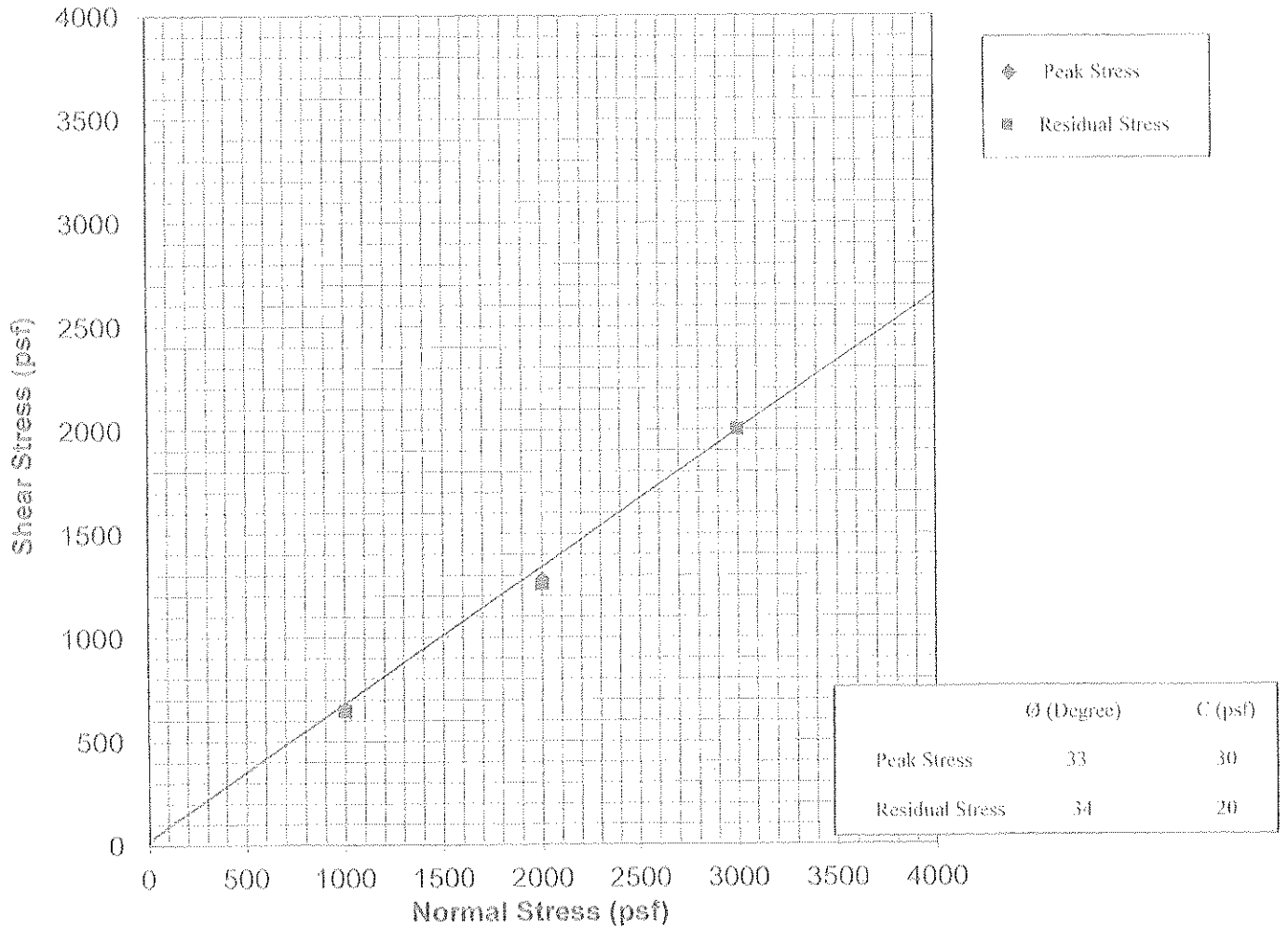
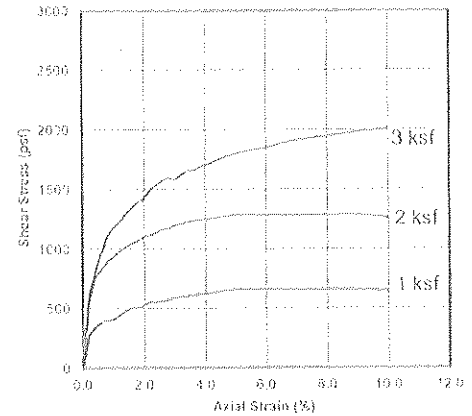
TABLE III  
CORROSION TESTS

<u>Sample</u>	<u>pH</u>	<u>Electrical Resistivity</u>	<u>Sulfate (%)</u>	<u>Chloride (ppm)</u>
T-6 @ 2'	7.1	2,980	0.003	240

% by weight  
ppm – mg/kg

Sample No. T8@4  
 Sample Type: Undisturbed/Saturated  
 Soil Description: Silty Fine-Medium Grained Sand w/ Some Small Gravel

		1	2	3
Normal Stress	(psf)	1000	2000	3000
Peak Stress	(psf)	660	1284	2004
Displacement	(in)	0.125	0.125	0.250
Residual Stress	(psf)	648	1260	2004
Displacement	(in)	0.250	0.250	0.250
In Situ Dry Density	(pcf)	103.5	103.5	103.5
In Situ Water Content	(%)	6.5	6.5	6.5
Saturated Water Content	(%)	23.1	23.1	23.1
Strain Rate	(in/min)	0.020	0.020	0.020



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PAMA Management

PROJECT NUMBER: 21432-19

DATE: 10/16/2019

DIRECT SHEAR TEST

ASTM D3080

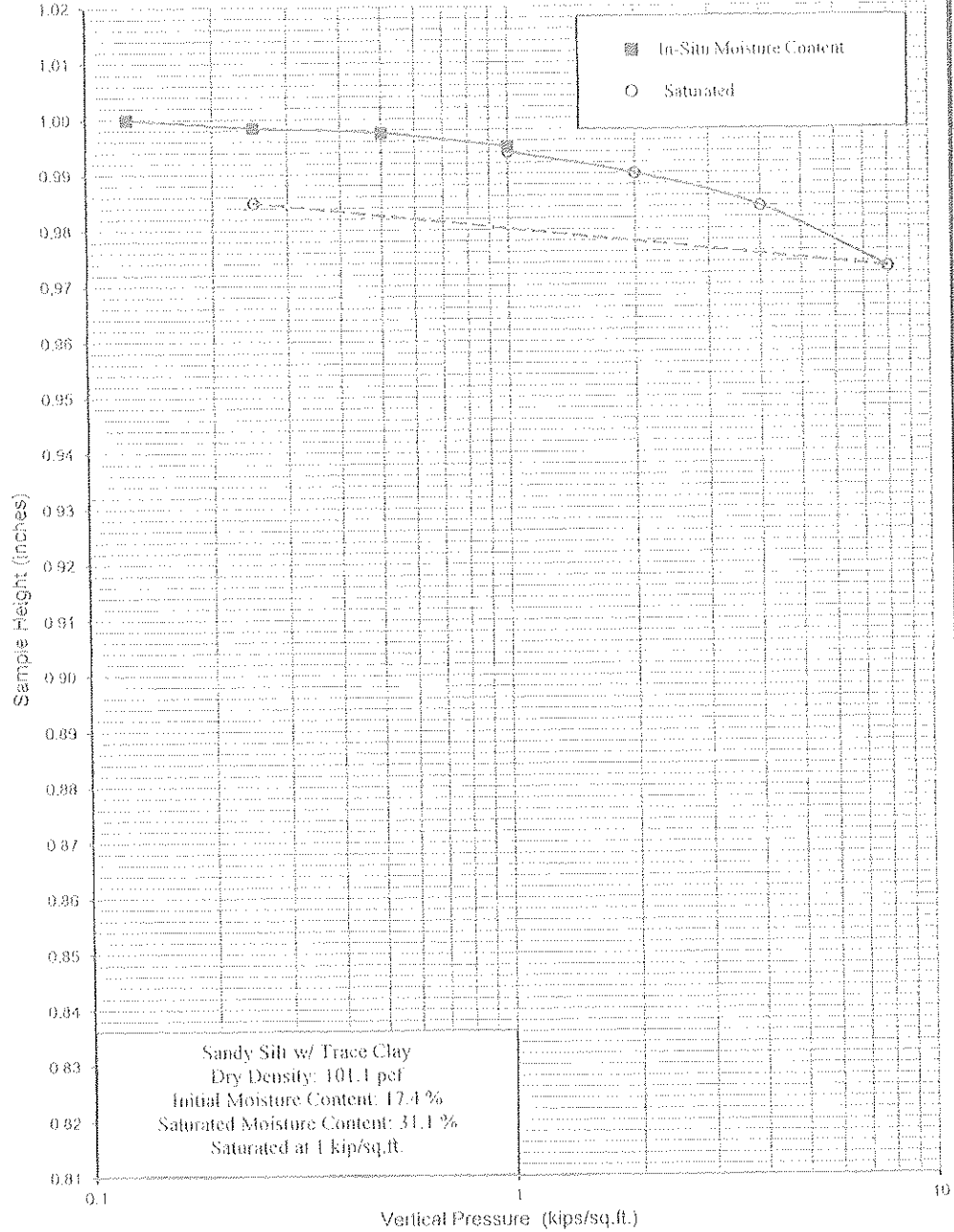
Plate A

Vertical Pressure (kips/sq.ft.)	Sample Height (inches)	Consolidation (percent)	Sample No.	T4	Depth	10'	Date
---------------------------------	------------------------	-------------------------	------------	----	-------	-----	------

0.125	1.0000	0.0
0.25	0.9985	0.2
0.5	0.9975	0.2
1	0.9950	0.5
1	0.9940	0.6
2	0.9900	1.0
4	0.9840	1.6
8	0.9730	2.7
0.25	0.9850	1.5

Saturated

Date Tested: 10/15/2019  
 Sample: T4  
 Depth: 10'



Sandy Silt w/ Trace Clay  
 Dry Density: 101.1 pcf  
 Initial Moisture Content: 17.4 %  
 Saturated Moisture Content: 31.1 %  
 Saturated at 1 kip/sq.ft.

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SOILS AND GEOTECHNICAL CONSULTANTS

PAMA Management

PROJECT NUMBER: 21432-19

DATE: 10/16/2019

### CONSOLIDATION TEST

ASTM D2435

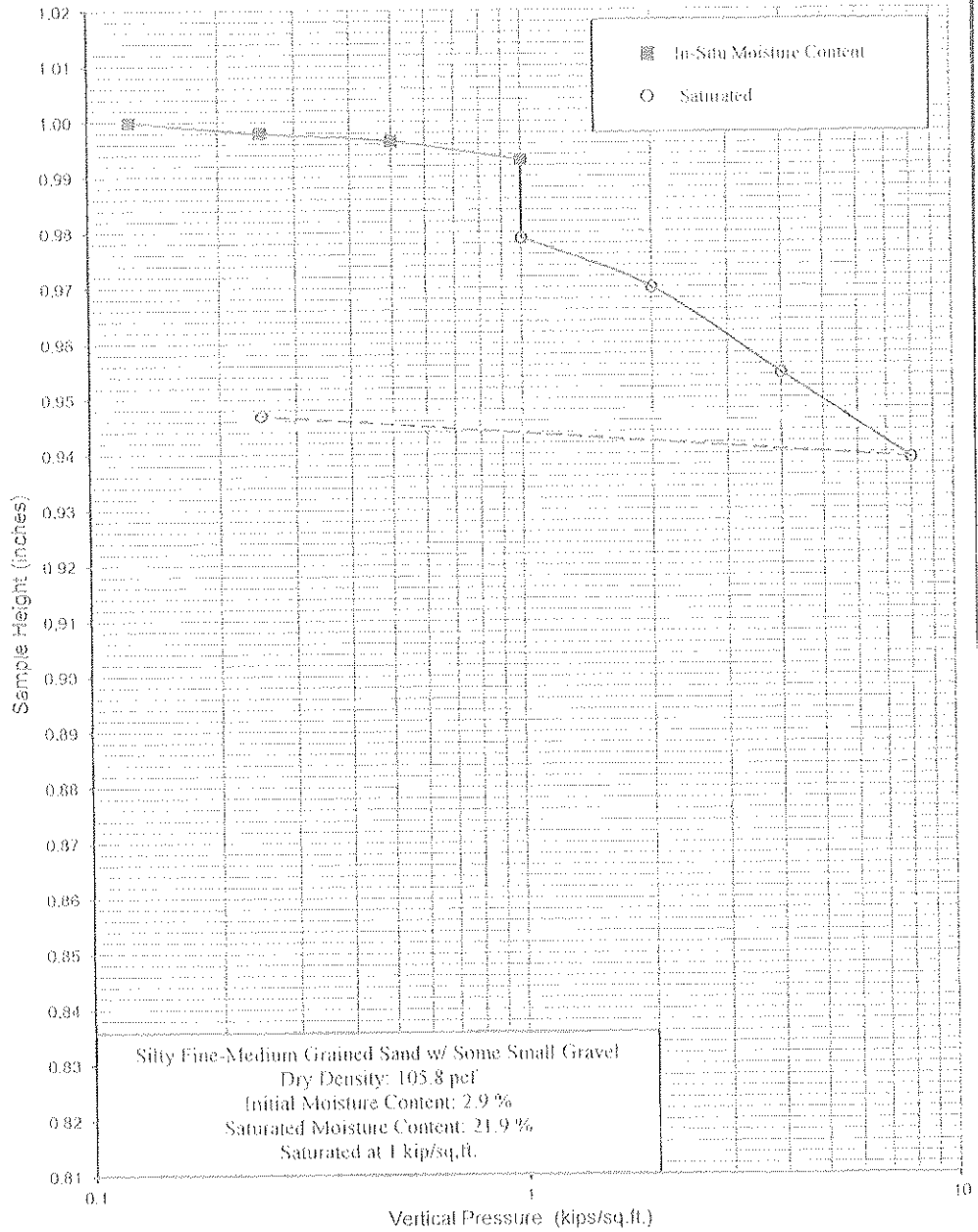
Plate B

Vertical Pressure (kips/sq.ft.)	Sample Height (inches)	Consolidation (percent)	Sample No.	T6	Depth	5'	Date	10/16/2019
---------------------------------	------------------------	-------------------------	------------	----	-------	----	------	------------

0.125	1.0000	0.0
0.25	0.9980	0.2
0.5	0.9965	0.4
1	0.9930	0.7
1	0.9790	2.1
2	0.9700	3.0
4	0.9545	4.6
8	0.9390	6.1
0.25	0.9470	5.3

Saturated

Date Tested: 10/15/2019  
Sample: T6  
Depth: 5'



**NorCal Engineering**  
SOILS AND GEOTECHNICAL CONSULTANTS

PAMA Management

PROJECT NUMBER: 21432-19

DATE: 10/16/2019

CONSOLIDATION TEST

ASTM D2435

Plate C



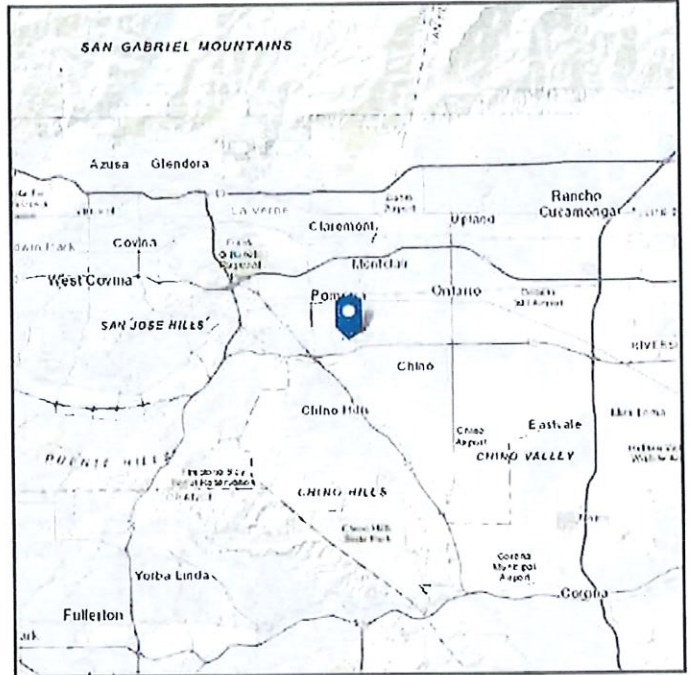
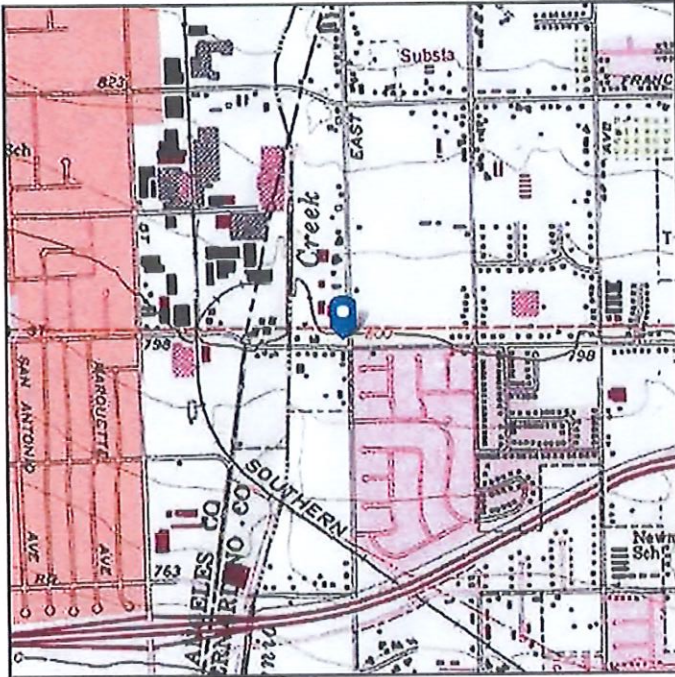
# Appendix C

# ASCE 7 Hazards Report

**Address:**  
No Address at This  
Location

**Standard:** ASCE/SEI 7-10  
**Risk Category:** III  
**Soil Class:** D - Stiff Soil

**Elevation:** 801.51 ft (NAVD 88)  
**Latitude:** 34.033577  
**Longitude:** -117.724587

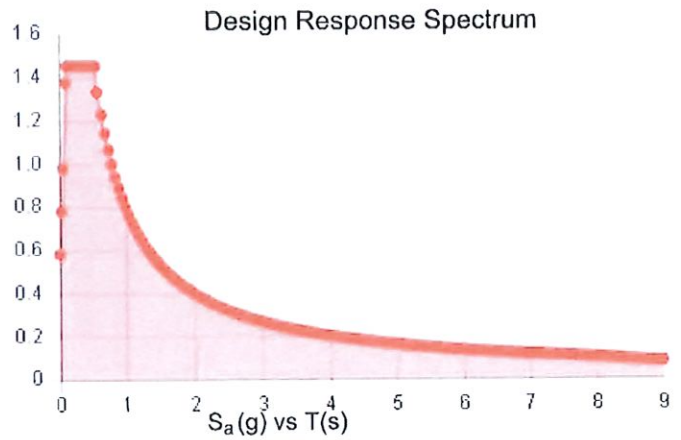
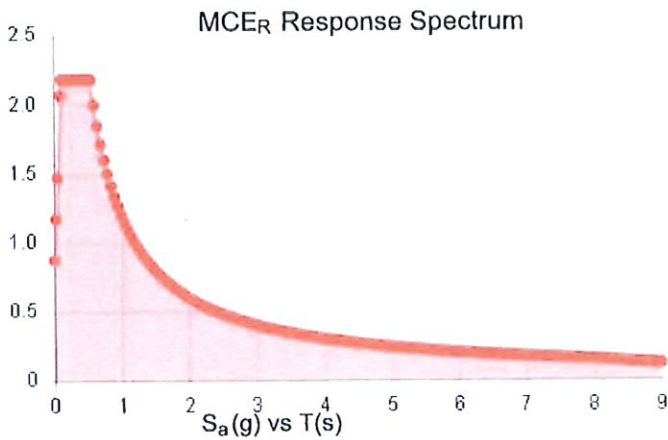


**Site Soil Class:** D - Stiff Soil

**Results:**

$S_s$ :	2.181	$S_{DS}$ :	1.454
$S_1$ :	0.799	$S_{D1}$ :	0.799
$F_a$ :	1	$T_L$ :	8
$F_v$ :	1.5	PGA :	0.774
$S_{MS}$ :	2.181	PGA <sub>M</sub> :	0.774
$S_{M1}$ :	1.198	$F_{PGA}$ :	1
		$I_e$ :	1.25

**Seismic Design Category** E



**Data Accessed:**

Mon Oct 07 2019

**Date Source:**

USGS Seismic Design Maps based on ASCE/SEI 7-10, incorporating Supplement 1 and errata of March 31, 2013, and ASCE/SEI 7-10 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-10 Ch. 21 are available from USGS.

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## Appendix D





SOILS AND GEOTECHNICAL CONSULTANTS

Project: PAMA Management
Project No.: 21432-19
Date: 10/2/19
Test No. 1
Depth: 5'
Tested By: J.S Jr.

TIME (hr/min)	CHANGE TIME (min)	CUMULATIVE TIME (min)	INNER RING READING (cm)	INNER RING CHANGE	INNER RING FLOW (cc)	OUTER RING READING (cm)	OUTER RING CHANGE	OUTER RING FLOW (cc)	INNER RING INF RATE (cm/hr)	OUTER RING INF RATE (cm/hr)	INNER RING INF RATE (ft/hr)
7:01			99.0			39.8					
7:16	15	15	100.4	1.4		42.3	2.5				
7:16			100.4			42.3					
7:31	15	30	101.5	1.1		44.0	1.7				
7:31			101.5			44.0					
7:46	15	45	102.7	1.2		46.0	2.0				
7:46			102.7			46.0					
8:01	15	60	104.0	1.3		47.8	1.8				
8:01			98.3			38.0					
8:16	15	75	99.3	1.0		39.8	1.8				
8:16			99.3			39.8					
8:31	15	90	100.2	0.9		41.0	1.2		3.6	4.8	
8:31			100.2			41.0					
8:46	15	105	101.3	1.1		42.1	1.1		4.4	4.4	
8:46			101.3			42.1					
9:01	15	120	102.3	1.0		43.3	1.2		4.0	4.8	
9:01			102.3			43.3					
9:16	15	135	103.4	1.1		44.5	1.2		4.4	4.8	
9:16			98.3			38.0					
9:31	15	150	99.4	1.1		39.1	1.1		4.4	4.4	
9:31			99.4			39.1					
9:46	15	165	100.4	1.0		40.2	1.1		4.0	4.4	
9:46			100.4			40.2					
10:01	15	180	101.3	0.9		41.4	1.2		3.6	4.8	

Average = 4.1 / 4.6





SOILS AND GEOTECHNICAL CONSULTANTS

Project: PAMA Management
Project No.: 21432-19
Date: 10/2/19
Test No. 2
Depth: 9.5'
Tested By: J.S Jr.

TIME (hr/min)	CHANGE TIME (min)	CUMULATIVE TIME (min)	INNER RING READING (cm)	INNER RING CHANGE	INNER RING FLOW (cc)	OUTER RING READING (cm)	OUTER RING CHANGE	OUTER RING FLOW (cc)	INNER RING INF RATE (cm/hr)	OUTER RING INF RATE (cm/hr)	INNER RING INF RATE (ft/hr)
8:17			68.3			36.1					
8:32	15	15	73.1	4.8		40.3	4.2				
8:32			73.1			40.3					
8:47	15	30	75.8	2.7		43.2	2.9				
8:47			75.8			43.2					
9:02	15	45	77.9	2.1		45.5	2.3				
9:02			71.4			38.6					
9:17	15	60	73.6	2.2		41.9	3.3				
9:17			73.6			41.9					
9:32	15	75	75.8	2.2		44.5	2.6				
9:32			68.9			38.7					
9:47	15	90	71.0	2.1		41.1	2.4		8.4	9.6	
9:47			71.0			41.1					
10:02	15	105	73.3	2.3		43.7	2.6		9.2	10.4	
10:02			73.3			43.7					
10:17	15	120	75.5	2.2		46.0	2.3		8.8	9.2	
10:17			75.5			46.0					
10:32	15	135	77.9	2.4		48.6	2.6		9.6	10.4	
10:32			68.8			38.0					
10:47	15	150	71.1	2.3		40.2	2.2		9.2	8.8	
10:47			71.1			40.2					
11:02	15	165	73.5	2.4		42.6	2.4		9.6	9.6	
11:02			73.5			42.6					
11:17	15	180	75.7	2.2		45.0	2.4		8.8	9.6	

Average = 9.1 / 9.7



SOILS AND GEOTECHNICAL CONSULTANTS

Project: PAMA Management
Project No.: 21432-19
Date: 10/2/19
Test No. 3
Depth: 11'
Tested By: J.S Jr.

TIME (hr/min)	CHANGE TIME (min)	CUMULATIVE TIME (min)	INNER RING READING (cm)	INNER RING CHANGE	INNER RING FLOW (cc)	OUTER RING READING (cm)	OUTER RING CHANGE	OUTER RING FLOW (cc)	INNER RING INF RATE (cm/hr)	OUTER RING INF RATE (cm/hr)	INNER RING INF RATE (ft/hr)
10:10			98.5			40.0					
10:25	15	15	102.0	3.5		44.0	4.0				
10:25			102.0			44.0					
10:40	15	30	104.5	2.5		46.5	2.5				
10:40			104.5			46.5					
10:55	15	45	105.1	2.6		49.0	2.5				
10:55			105.1			49.0					
11:10	15	60	107.7	2.6		51.3	2.3				
11:10			107.7			51.3					
11:25	15	75	110.2	2.5		53.8	2.5				
11:25			98.0			39.0					
11:40	15	90	100.5	2.5		41.8	2.8				
11:40			100.5			41.8					
11:55	15	105	102.5	2.0		44.5	2.7		8.0	10.8	
11:55			102.5			44.5					
12:10	15	120	104.5	2.0		46.7	2.0		8.0	8.0	
12:10			104.5			46.7					
12:25	15	135	106.0	1.5		48.6	1.9		6.0	7.6	
12:25			106.0			48.6					
12:40	15	150	108.0	2.0		49.9	1.3		8.0	5.2	
12:40			108.0			49.9					
12:55	15	165	110.0	2.0		51.2	1.3		8.0	5.2	
12:55			110.0			51.2					
1:10	15	180	111.9	1.9		52.6	1.4		7.6	5.6	

Average = 7.6 / 7.1





**Attachment E**  
**Rainfall Data (NOAA Atlas14) & Factor of Safety**  
**Worksheets**





**NOAA Atlas 14, Volume 6, Version 2**  
**Location name: Chino, California, USA\***  
**Latitude: 34.0345°, Longitude: -117.7252°**  
**Elevation: 803.9 ft\*\***  
\* source: ESRI Maps  
\*\* source: USGS



**POINT PRECIPITATION FREQUENCY ESTIMATES**

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF\\_tabular](#) | [PF\\_graphical](#) | [Maps & aerials](#)

**PF tabular**

<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.121 (0.101-0.147)	0.159 (0.133-0.192)	0.209 (0.174-0.254)	0.252 (0.207-0.308)	0.311 (0.247-0.394)	0.358 (0.279-0.464)	0.407 (0.309-0.542)	0.459 (0.338-0.629)	0.532 (0.375-0.761)	0.590 (0.402-0.876)
10-min	0.174 (0.145-0.211)	0.228 (0.190-0.276)	0.300 (0.250-0.364)	0.361 (0.297-0.442)	0.446 (0.355-0.565)	0.513 (0.399-0.665)	0.583 (0.443-0.776)	0.658 (0.485-0.902)	0.762 (0.538-1.09)	0.846 (0.576-1.26)
15-min	0.211 (0.176-0.255)	0.275 (0.230-0.334)	0.363 (0.302-0.441)	0.436 (0.360-0.534)	0.539 (0.429-0.684)	0.620 (0.483-0.805)	0.705 (0.535-0.939)	0.796 (0.587-1.09)	0.922 (0.651-1.32)	1.02 (0.697-1.52)
30-min	0.308 (0.257-0.373)	0.403 (0.336-0.488)	0.531 (0.442-0.645)	0.638 (0.526-0.782)	0.789 (0.628-1.00)	0.908 (0.707-1.18)	1.03 (0.784-1.37)	1.17 (0.858-1.60)	1.35 (0.952-1.93)	1.50 (1.02-2.22)
60-min	0.457 (0.382-0.553)	0.598 (0.499-0.725)	0.788 (0.655-0.957)	0.947 (0.781-1.16)	1.17 (0.932-1.49)	1.35 (1.05-1.75)	1.53 (1.16-2.04)	1.73 (1.27-2.37)	2.00 (1.41-2.87)	2.22 (1.51-3.30)
2-hr	0.687 (0.574-0.831)	0.895 (0.746-1.08)	1.17 (0.973-1.42)	1.40 (1.15-1.71)	1.71 (1.36-2.17)	1.95 (1.52-2.53)	2.20 (1.67-2.92)	2.46 (1.81-3.37)	2.81 (1.99-4.03)	3.10 (2.11-4.59)
3-hr	0.871 (0.727-1.05)	1.13 (0.943-1.37)	1.47 (1.23-1.79)	1.75 (1.45-2.15)	2.13 (1.70-2.71)	2.43 (1.89-3.15)	2.73 (2.07-3.64)	3.05 (2.25-4.18)	3.48 (2.46-4.98)	3.82 (2.60-5.67)
6-hr	1.23 (1.02-1.48)	1.59 (1.32-1.92)	2.06 (1.71-2.50)	2.44 (2.02-3.00)	2.97 (2.36-3.77)	3.37 (2.63-4.37)	3.79 (2.87-5.04)	4.21 (3.11-5.77)	4.80 (3.39-6.87)	5.26 (3.58-7.80)
12-hr	1.62 (1.35-1.96)	2.10 (1.75-2.55)	2.74 (2.28-3.33)	3.26 (2.69-4.00)	3.98 (3.17-5.05)	4.53 (3.53-5.88)	5.10 (3.87-6.79)	5.69 (4.20-7.80)	6.51 (4.59-9.31)	7.15 (4.87-10.6)
24-hr	2.14 (1.89-2.46)	2.80 (2.47-3.23)	3.69 (3.25-4.26)	4.42 (3.87-5.16)	5.44 (4.61-6.56)	6.24 (5.18-7.68)	7.07 (5.73-8.91)	7.94 (6.26-10.3)	9.15 (6.92-12.3)	10.1 (7.40-14.1)
2-day	2.63 (2.32-3.03)	3.50 (3.09-4.04)	4.68 (4.13-5.42)	5.68 (4.97-6.63)	7.08 (6.00-8.54)	8.20 (6.80-10.1)	9.38 (7.59-11.8)	10.6 (8.37-13.8)	12.4 (9.36-16.7)	13.8 (10.1-19.2)
3-day	2.86 (2.53-3.30)	3.86 (3.41-4.45)	5.22 (4.60-6.04)	6.37 (5.57-7.44)	8.01 (6.78-9.65)	9.32 (7.73-11.5)	10.7 (8.67-13.5)	12.2 (9.60-15.8)	14.3 (10.8-19.3)	16.0 (11.7-22.3)
4-day	3.10 (2.74-3.57)	4.21 (3.72-4.86)	5.72 (5.04-6.62)	7.00 (6.13-8.17)	8.82 (7.47-10.6)	10.3 (8.53-12.6)	11.8 (9.57-14.9)	13.5 (10.6-17.4)	15.8 (11.9-21.3)	17.7 (12.9-24.6)
7-day	3.53 (3.13-4.07)	4.83 (4.26-5.57)	6.58 (5.80-7.62)	8.06 (7.05-9.40)	10.1 (8.57-12.2)	11.8 (9.77-14.5)	13.5 (10.9-17.0)	15.3 (12.1-19.9)	17.9 (13.5-24.1)	20.0 (14.6-27.9)
10-day	3.84 (3.40-4.43)	5.27 (4.66-6.09)	7.21 (6.35-8.34)	8.82 (7.72-10.3)	11.1 (9.39-13.4)	12.9 (10.7-15.8)	14.8 (11.9-18.6)	16.7 (13.2-21.7)	19.5 (14.7-26.3)	21.7 (15.9-30.3)
20-day	4.61 (4.08-5.31)	6.39 (5.65-7.37)	8.80 (7.76-10.2)	10.8 (9.47-12.6)	13.7 (11.6-16.5)	15.9 (13.2-19.6)	18.3 (14.8-23.0)	20.8 (16.4-26.9)	24.3 (18.4-32.7)	27.1 (19.8-37.8)
30-day	5.47 (4.84-6.31)	7.60 (6.72-8.78)	10.5 (9.27-12.2)	13.0 (11.3-15.1)	16.5 (13.9-19.8)	19.3 (16.0-23.7)	22.2 (18.0-28.0)	25.3 (19.9-32.8)	29.7 (22.5-40.1)	33.3 (24.3-46.4)
45-day	6.51 (5.76-7.50)	8.99 (7.95-10.4)	12.4 (11.0-14.4)	15.4 (13.5-18.0)	19.6 (16.6-23.7)	23.1 (19.1-28.4)	26.7 (21.6-33.7)	30.7 (24.2-39.7)	36.3 (27.4-48.9)	40.9 (29.9-57.0)
60-day	7.52 (6.66-8.67)	10.3 (9.10-11.9)	14.2 (12.5-16.4)	17.6 (15.4-20.5)	22.5 (19.0-27.1)	26.5 (22.0-32.6)	30.9 (25.0-38.9)	35.6 (28.0-46.1)	42.4 (32.1-57.2)	48.1 (35.1-67.1)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

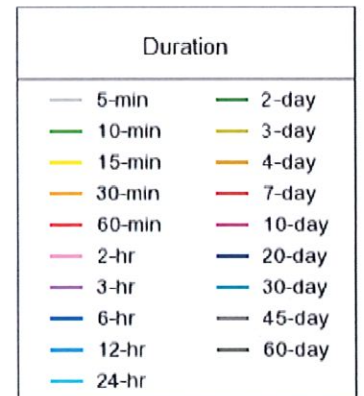
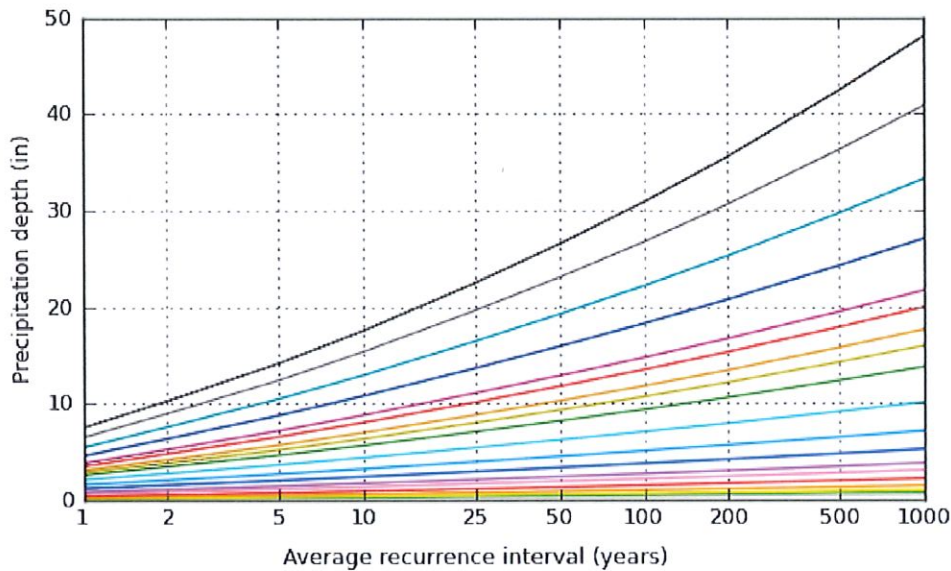
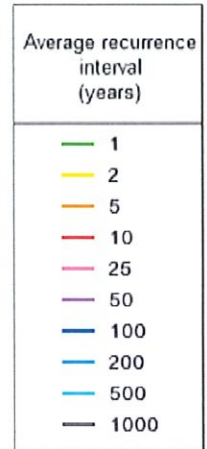
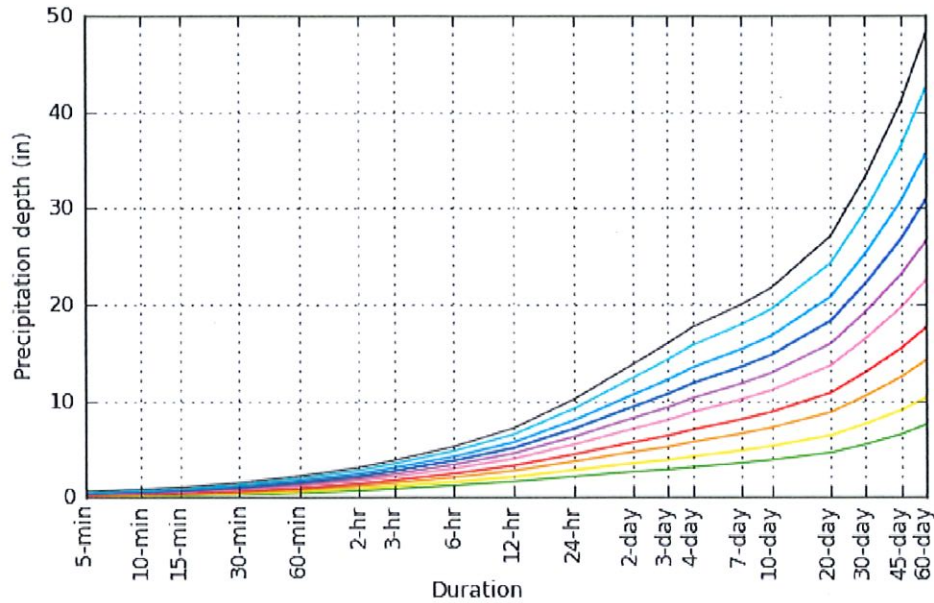
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### PF graphical

PDS-based depth-duration-frequency (DDF) curves

Latitude: 34.0345°, Longitude: -117.7252°



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### Maps & aerials

Small scale terrain





Large scale terrain



Large scale map



Large scale aerial



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VII.4.1. Site Suitability Considerations

Suitability assessment related considerations include (Table VII.3):

- Soil assessment methods – the site assessment extent (e.g., number of borings, test pits, etc.) and the measurement method used to estimate the short-term infiltration rate.
- Predominant soil texture/percent fines – soil texture and the percent of fines can greatly influence the potential for clogging.
- Site soil variability – site with spatially heterogeneous soils (vertically or horizontally) as determined from site investigations are more difficult to estimate average properties for resulting in a higher level of uncertainty associated with initial estimates.
- Depth to seasonal high groundwater/impervious layer – groundwater mounding may become an issue during excessively wet conditions where shallow aquifers or shallow clay lenses are present.

**Table VII.3: Suitability Assessment Related Considerations for Infiltration Facility Safety Factors**

Consideration	High Concern	Medium Concern	Low Concern	
Assessment methods (see explanation below)	Use of soil survey maps or simple texture analysis to estimate short-term infiltration rates	Direct measurement of $\geq 20$ percent of infiltration area with localized infiltration measurement methods (e.g., infiltrometer)	Direct measurement of $\geq 50$ percent of infiltration area with localized infiltration measurement methods or Use of extensive test pit infiltration measurement methods	Per infiltration report in Attachment
Texture Class	Silty and clayey soils with significant fines	Loamy soils	Granular to slightly loamy soils	Per infiltration report in Attachment
Site soil variability	Highly variable soils indicated from site assessment or limited soil borings collected during site assessment	Soil borings/test pits indicate moderately homogeneous soils	Multiple soil borings/test pits indicate relatively homogeneous soils	Per infiltration report in Attachment I
Depth to groundwater/impervious layer	<5 ft below facility bottom	5-10 ft below facility bottom	>10 below facility bottom	Per infiltration report in Attachment

Localized infiltration testing refers to methods such as the double ring infiltrometer test (ASTM D3385-88) which measure infiltration rates over an area less than 10 sq-ft, may include lateral

flow, and do not attempt to account for heterogeneity of soil. The amount of area each test represents should be estimated depending on the observed heterogeneity of the soil.

Extensive infiltration testing refers to methods that include excavating a significant portion of the proposed infiltration area, filling the excavation with water, and monitoring drawdown. The excavation should be to the depth of the proposed infiltration surface and ideally be at least 50 to 100 square feet.

In all cases, testing should be conducted in the area of the proposed BMP where, based on review of available geotechnical data, soils appear least likely to support infiltration.

#### VII.4.2. Design Related Considerations

Design related considerations include ([Table VII.4](#)):

- Size of area tributary to facility – all things being equal, risk factors related to infiltration facilities increase with an increase in the tributary area served. Therefore facilities serving larger tributary areas should use more restrictive adjustment factors.
- Level of pretreatment/expected influent sediment loads – credit should be given for good pretreatment by allowing less restrictive factors to account for the reduced probability of clogging from high sediment loading. Also, facilities designed to capture runoff from relatively clean surfaces such as rooftops are likely to see low sediment loads and therefore should be allowed to apply less restrictive safety factors.
- Redundancy – facilities that consist of multiple subsystems operating in parallel such that parts of the system remains functional when other parts fail and/or bypass should be rewarded for the built-in redundancy with less restrictive correction and safety factors. For example, if bypass flows would be at least partially treated in another BMP, the risk of discharging untreated runoff in the event of clogging the primary facility is reduced. A bioretention facility that overflows to a landscaped area is another example.
- Compaction during construction – proper construction oversight is needed during construction to ensure that the bottoms of infiltration facility are not overly compacted. Facilities that do not commit to proper construction practices and oversight should have to use more restrictive correction and safety factors.



Table VII.4: Design Related Considerations for Infiltration Facility Safety Factors

Consideration	High Concern	Medium Concern	Low Concern
Tributary area size	Greater than 10 acres.	Greater than 2 acres but less than 10 acres.	2 acres or less.
Level of pretreatment/ expected influent sediment loads	Pretreatment from gross solids removal devices only, such as hydrodynamic separators, racks and screens AND tributary area includes landscaped areas, steep slopes, high traffic areas, or any other areas expected to produce high sediment, trash, or debris loads.	Good pretreatment with BMPs that mitigate coarse sediments such as vegetated swales AND influent sediment loads from the tributary area are expected to be relatively low (e.g., low traffic, mild slopes, disconnected impervious areas, etc.).	Excellent pretreatment with BMPs that mitigate fine sediments such as bioretention or media filtration OR sedimentation or facility only treats runoff from relatively clean surfaces, such as rooftops.
Redundancy of treatment	No redundancy in BMP treatment train.	Medium redundancy, other BMPs available in treatment train to maintain at least 50% of function of facility in event of failure.	High redundancy, multiple components capable of operating independently and in parallel, maintaining at least 90% of facility functionality in event of failure.
Compaction during construction	Construction of facility on a compacted site or elevated probability of unintended/ indirect compaction.	Medium probability of unintended/ indirect compaction.	Heavy equipment actively prohibited from infiltration areas during construction and low probability of unintended/ indirect compaction.

~ 3.6 acres

→ Gravity Separators (Aqua Shield or approved equal) will be provided as a pre-treatment control BMP prior to allowing runoff to be conveyed to the primary treatment BMP. The Aqua Shield Units will help remove large debris, trash, sediment and oil/grease from the runoff before outleting into the the on-site infiltration systems. Aqua Shield Unit specification & calculations will be provided in Appendix B for the Final Submission.

The soil in the proposed infiltration system footprints will be uncompacted in-place native material.

Aqua Shield units will become a pretreatment device before entering to underground infiltration system. Aqua Shield units are capable of capturing and retaining 100 percent of pollutants greater than or equal to 2.4 millimeters (mm) regardless of the pollutant's specific gravity. Aqua Shield units are equipped with conventional oil baffles to capture and retain oil and grease. Laboratory evaluations show that the gravity separators are capable of capturing up to 70% of the free oil and grease from storm water. Gravity separators can also accommodate the addition of oil sorbents within their separation chambers. The addition of the oil sorbents can ensure the permanent removal of 80% to 90% of the free oil and grease from the storm water runoff.



VII.4.3. Determining Factor of Safety

A factor of safety shall be used. To assist in selecting the appropriate design infiltration rate, the measured short term infiltration rate should be adjusted using a weighted average of several safety factors using the worksheet shown in **Worksheet H** below. The design infiltration rate would be determined as follows:

1. For each consideration shown in **Table VII.3** and **Table VII.4** above, determine whether the consideration is a high, medium, or low concern.
2. For all high concerns, assign a factor value of 3, for medium concerns, assign a factor value of 2, and for low concerns assign a factor value of 1.
3. Multiply each of the factors by the corresponding weight to get a product.
4. Sum the products within each factor category to obtain a safety factor for each.
5. Multiply the two safety factors together to get the final combined safety factor. If the combined safety factor is less than 2, then 2 shall be used as the safety factor.
6. Divide the measured short term infiltration rate by the combined safety factor to obtain the adjusted design infiltration rate for use in sizing the infiltration facility.

The design infiltration rate shall be used to size BMPs and to evaluate their expected long term performance. This rate shall not be less than 2, but may be higher at the discretion of the design engineer.

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

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) $p = w \times v$
A	Suitability Assessment	Soil assessment methods	0.25	1	0.25
		Predominant soil texture	0.25	3	0.75
		Site soil variability	0.25	1	0.25
		Depth to groundwater / impervious layer	0.25	1	0.25
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			
B	Design	Tributary area size	0.25	2	0.50
		Level of pretreatment/ expected sediment loads	0.25	2	0.50
		Redundancy	0.25	2	0.50
		Compaction during construction	0.25	1	0.25
		Design Safety Factor, $S_B = \Sigma p$			
Combined Safety Factor, $S_{TOT} = S_A \times S_B$				2.625	
Measured Infiltration Rate, inch/hr, $K_M$ (corrected for test-specific bias)				3 or 3.6	
Design Infiltration Rate, in/hr, $K_{DESIGN} = \frac{K_M \div S_{TOT}}{S_{TOT}} \times K_M$				1.0 or 1.2	
<b>Supporting Data</b>					
Briefly describe infiltration test and provide reference to test forms: <p><b>"3" is the infiltration safety factor that we applied to infiltration LID BMP.</b></p>					

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

## VII.5. References

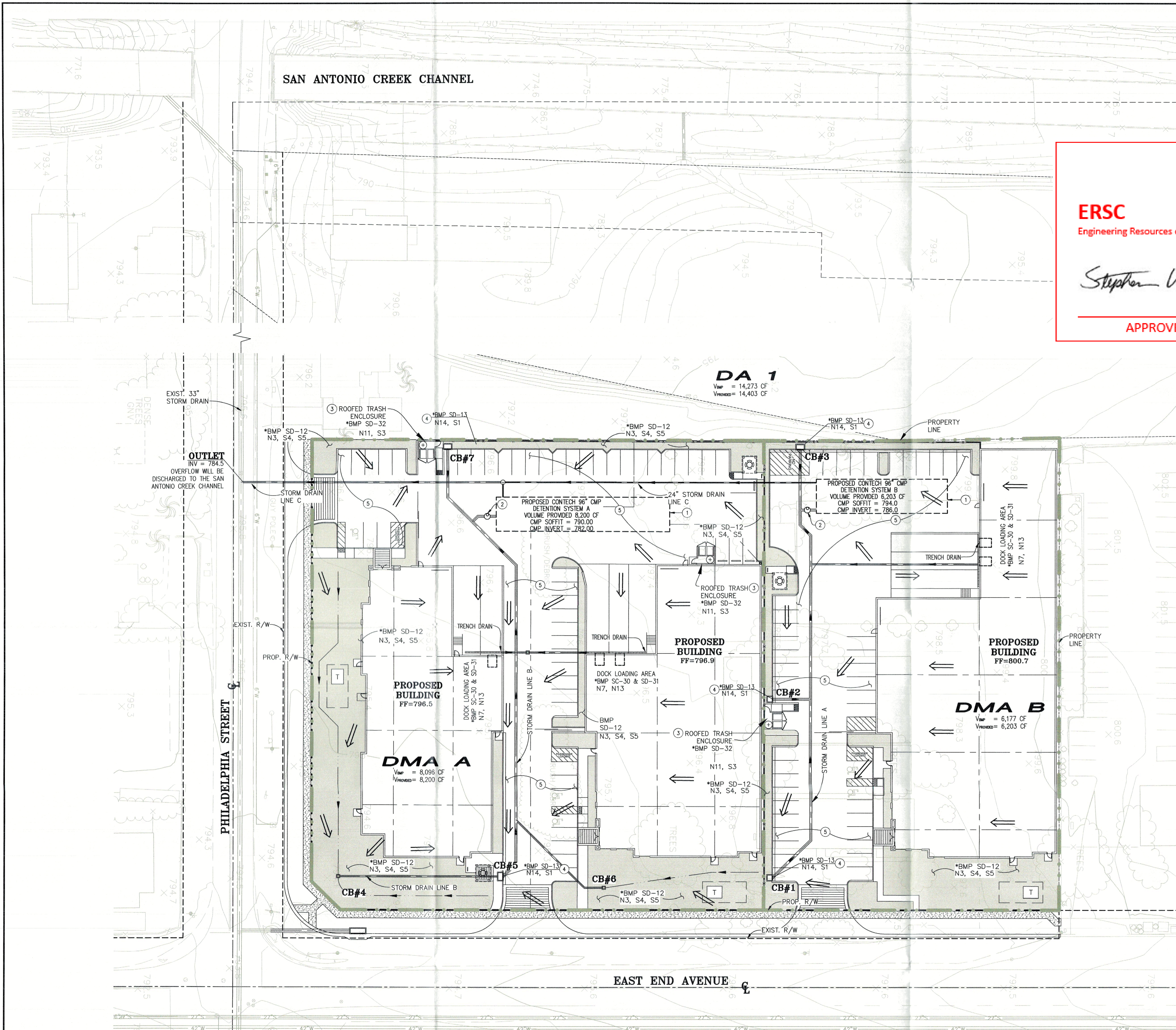
ASTM D 3385-94, 2003. "Standard Test Method for Infiltration Rate of Soils Field Using Double-Ring Infiltrometer." American Society for Testing Materials, Conshohocken, PA. 10 Jun, 2003.

Caltrans, 2003. "Infiltration Basin Site Selection". Study Volume I. California Department of Transportation. Report No. CTSW-RT-03-025.

City of Portland, 2010. *Appendix F.2: Infiltration Testing*. Portland Stormwater Management Manual, Revised February 1, 2010.

United States Department of the Interior, Bureau of Reclamation (USBR), 1990a, "Procedure for Performing Field Permeability Testing by the Well Permeameter Method (USBR 7300-89)," in Earth Manual, Part 2, A Water Resources Technical Publication, 3rd ed., Bureau of Reclamation, Denver, Colo.



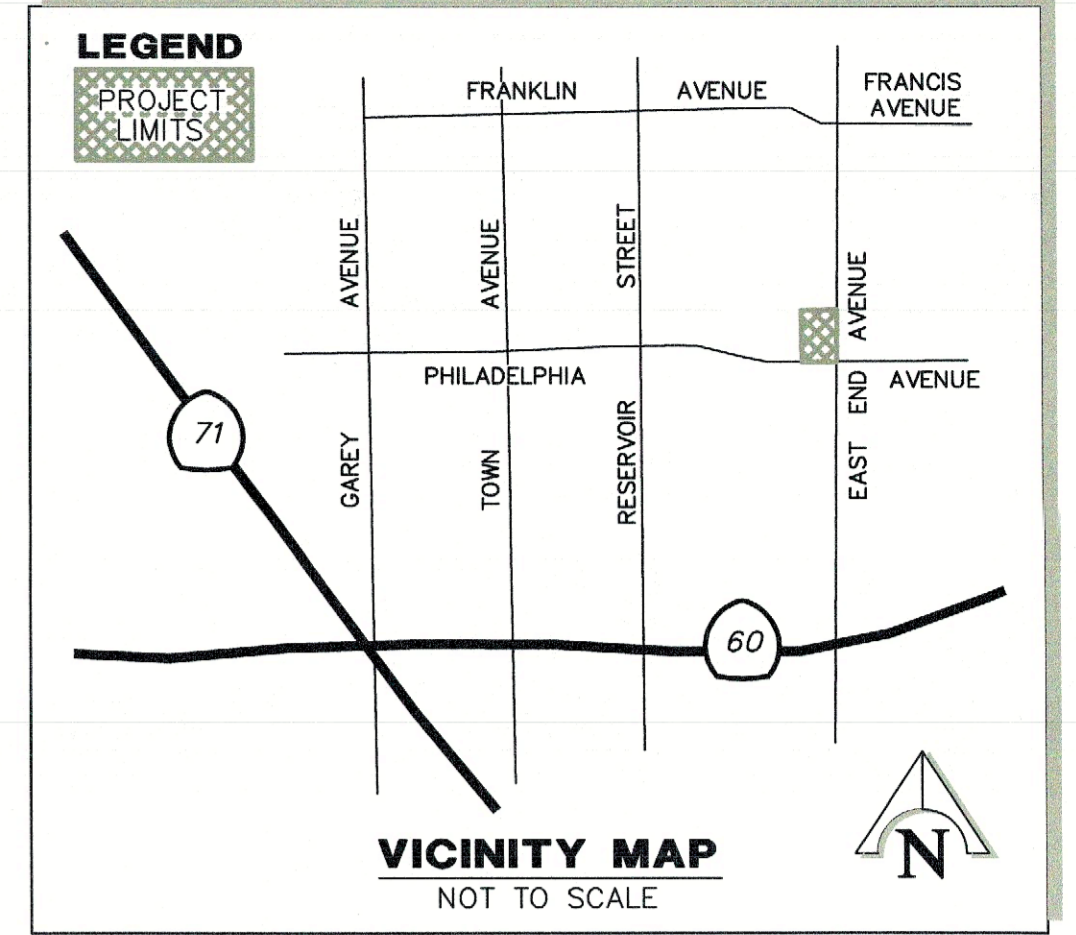


DATE 3/8/2021

**ERSC**  
Engineering Resources of Southern California

*Stephen Wilson*

APPROVED AS SUBMITTED



**LEGEND**

- SD PROPOSED STORM DRAIN
- - - WQMP BOUNDARY
- PROPOSED CURB OPENING INLET W/ FILTER INSERT
- PROPOSED LANDSCAPING AREA - \*BMP SD-10 & SD-12
- CB CATCH BASIN
- ← FLOW DIRECTION

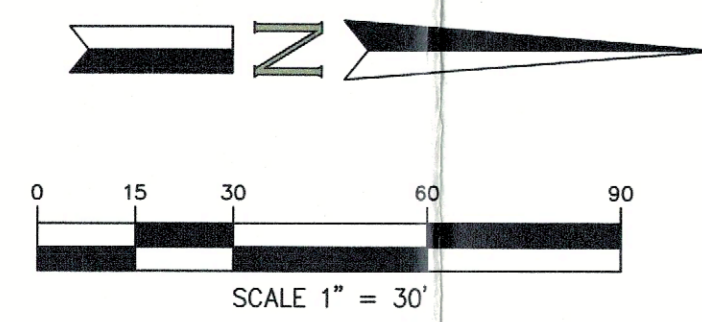
**WQMP MANAGEMENT**

DA Area (SF)	Imperviousness (%)	Runoff Coefficient (P 2yr-1hr)	P6	Drawdown Rate	Design Capture Volume (CF)	BMP	LID BMP Volume Provided (CF)
DA 1	94.524	0.79	0.59	0.598	0.89	Contech 96" CMP Detention System	8,200
DA 2	61,766	0.87	0.69	0.598	0.89	Contech 96" CMP Detention System	6,203

**\*\*NOTE:**  
ON-SITE UNDERGROUND INFILTRATION/ DETENTION SYSTEM WILL PROVIDE STORM WATER DETENTION CAPACITY WHILE REDUCING THE OVERALL DISCHARGE OF STORM WATER DURING ALL STORM EVENTS.

**OWNER/DEVELOPER**  
GOLDEN MANAGEMENT SERVICES  
4900 SANTA ANITA AVENUE, SUITE 2C  
EL MONTE, CA 91731  
PHONE: (626) 258-3374  
CONTACT: MR. RYAN LIU

**ENGINEER**  
HUITT-ZOLLARS  
3990 CONCOURS, SUITE 330  
ONTARIO, CA 91764  
PHONE: (909) 941-7799  
CONTACT: DAVID WHITE



**WQMP BMP NOTES**

1. INSTALL CONTECH 96" CMP INFILTRATION SYSTEM, SEE DETAIL HEREON.
  2. INSTALL AN AQUASHIELD "AQUA SWIRL MODEL AS-3s" GRAVITY SEPARATOR OR EQUIVALENT \* (CASQA MP-51 BMP)
  3. INSTALL ROOFED TRASH ENCLOSURE.
  4. INSTALL STORM DRAIN LABEL MESSAGES STATING "NO DUMPING - DRAINS TO RIVER", (S1)
  5. VACUUM SWEEP PARKING LOT/DRIVE AISLES MONTHLY. (N15)
- \*NOTE:**  
DETAIL WILL BE PROVIDED IN FINAL SUBMITTAL.

IDENTIFIER	DESCRIPTION OF BMP	RESPONSIBLE PARTY
N3	LANDSCAPE MAINTENANCE BMP'S	OWNER
N7	PROVIDE SPILL PLAN	OWNER
N11	LITTER/DEBRIS CONTROL PROGRAM	OWNER
N13	HOUSEKEEPING OF LOADING DOCKS	OWNER
N14	CATCH BASIN INSPECTION PROGRAM	OWNER
N15	VACUUM SWEEPING OF PARKING LOTS	OWNER
S1	STORM DRAIN STENCILING	OWNER
S3	REDUCED WASTE STORAGE POLLUTION	OWNER
S4	EFFICIENT IRRIGATION SYSTEM	OWNER
S5	LANDSCAPING MIN. 1-2" BELOW PAVEMENT	OWNER

\*SEE WQMP REPORT ATTACHMENT C FOR BMP FACT SHEET

**DYODS™**  
Design Your Own Detention System

**CONTECH**  
CMP DETENTION SYSTEMS

For design assistance, drawings, and pricing send completed worksheet to: [dyods@contech-cpi.com](mailto:dyods@contech-cpi.com)

**Project Summary**

Date: 2/24/2021  
Project Name: PAMA CHINO SYSTEM A  
City / County: Chino/San Bernardino County  
State: California  
Designed By: David White  
Company: Huitt-Zollars, Inc.  
Telephone: 909-941-7799

**Storage Volume Required (cf):**

Limiting Width (ft):	30.00
Invert Depth Below Asphalt (ft):	10.00
Solid or Perforated Pipe:	Perforated
Shape Or Diameter (in):	96
Number Of Headers:	2
Spacing between Barrels (ft):	3.00
Stone Width Around Perimeter of System (ft):	2
Depth A: Porous Stone Above Pipe (in):	6
Depth C: Porous Stone Below Pipe (in):	6
Stone Porosity (0 to 40%):	40

**System Sizing**

Pipe Storage:	11,481 cf
Porous Stone Storage:	4,938 cf
Total Storage Provided:	16,389 cf
Number of Barrels:	2 barrels
Length per Barrel:	95.0 ft
Length Per Header:	19.0 ft
Rectangular Footprint (W x L):	23 ft x 115 ft

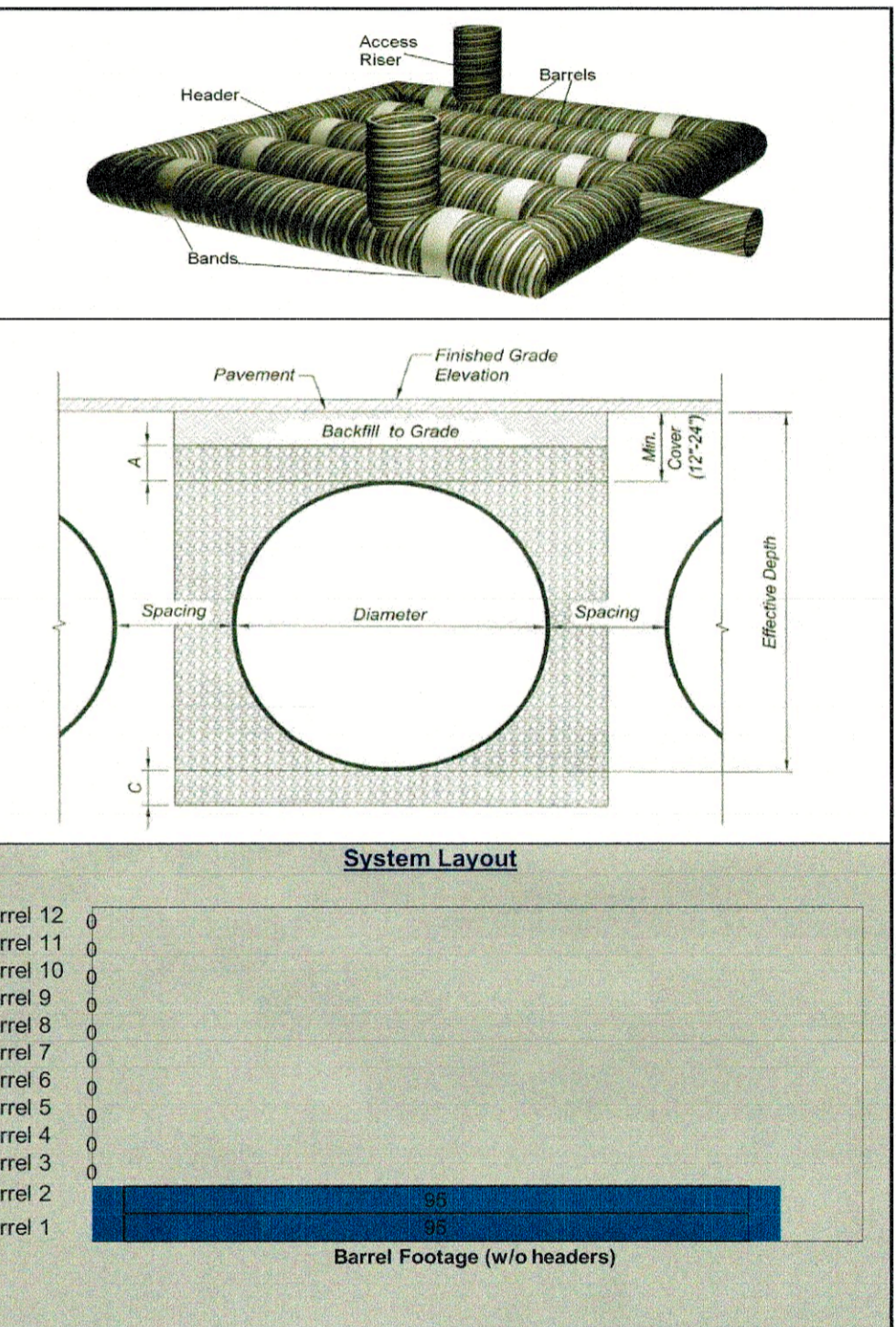
**CONTECH Materials**

Total CMP Footage:	228 ft
Approximate Total Pieces:	10 pcs
Approximate Coupling Bands:	10 bands
Approximate Truckloads:	5 trucks

**Construction Quantities\*\***

Total Excavation:	690 cy
Porous Stone Backfill For Storage:	457 cy stone
Backfill to Grade Excluding Stone:	98 cy fill

\*\*Construction quantities are approximate and should be verified upon final design



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For design assistance, drawings, and pricing send completed worksheet to: [dyods@contech-cpi.com](mailto:dyods@contech-cpi.com)

**Project Summary**

Date: 2/24/2021  
Project Name: PAMA - CHINO SYSTEM B  
City / County: Chino/San Bernardino County  
State: California  
Designed By: David White  
Company: Huitt-Zollars, Inc.  
Telephone: 909-941-7799

**Storage Volume Required (cf):**

Limiting Width (ft):	30.00
Invert Depth Below Asphalt (ft):	12.00
Solid or Perforated Pipe:	Perforated
Shape Or Diameter (in):	96
Number Of Headers:	2
Spacing between Barrels (ft):	3.00
Stone Width Around Perimeter of System (ft):	2
Depth A: Porous Stone Above Pipe (in):	6
Depth C: Porous Stone Below Pipe (in):	6
Stone Porosity (0 to 40%):	40

**System Sizing**

Pipe Storage:	8,646 cf
Porous Stone Storage:	3,745 cf
Total Storage Provided:	12,391 cf
Number of Barrels:	2 barrels
Length per Barrel:	67.0 ft
Length Per Header:	19.0 ft
Rectangular Footprint (W x L):	23 ft x 87 ft

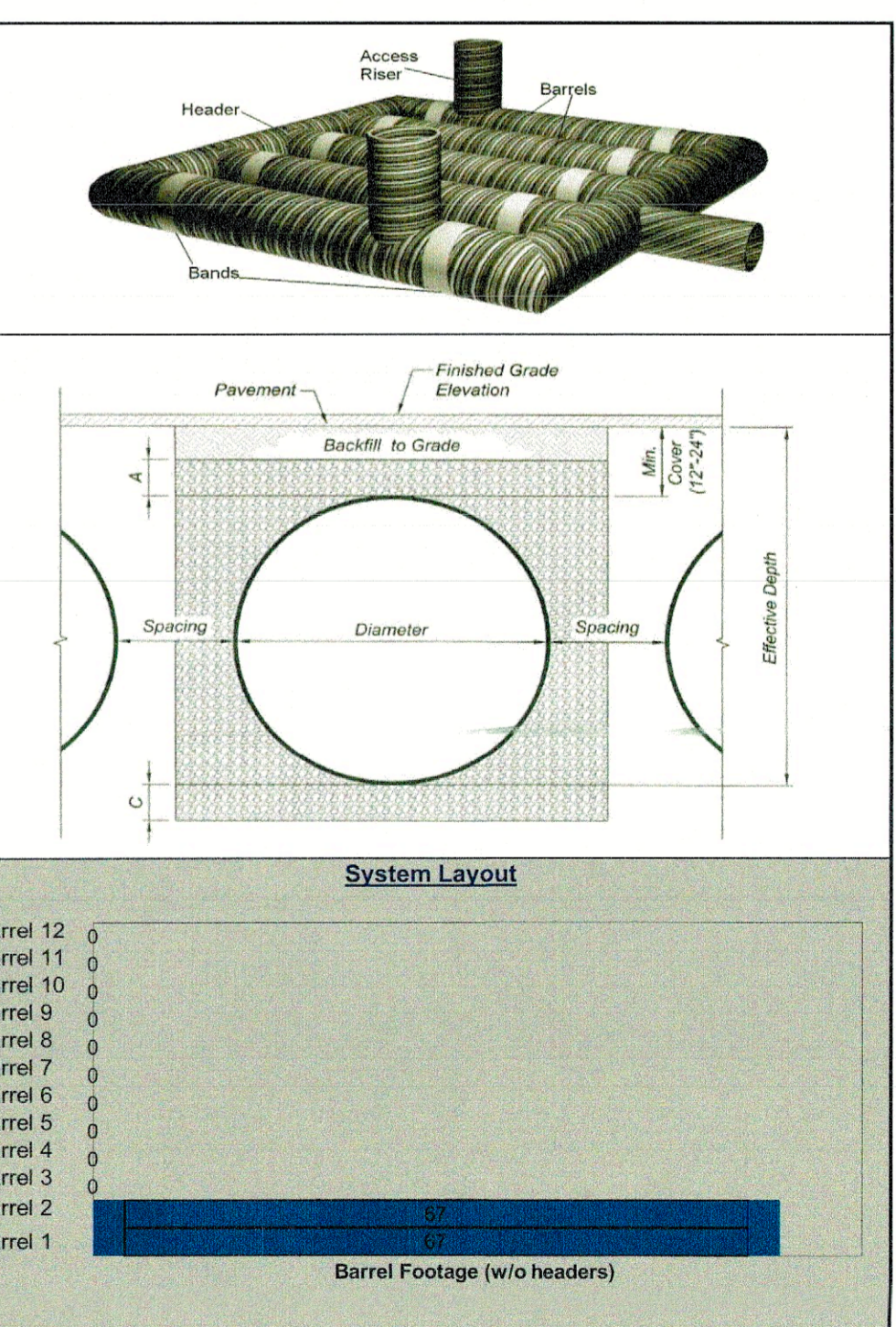
**CONTECH Materials**

Total CMP Footage:	172 ft
Approximate Total Pieces:	8 pcs
Approximate Coupling Bands:	8 bands
Approximate Truckloads:	4 trucks

**Construction Quantities\*\***

Total Excavation:	690 cy
Porous Stone Backfill For Storage:	347 cy stone
Backfill to Grade Excluding Stone:	223 cy fill

\*\*Construction quantities are approximate and should be verified upon final design



**HUITT-ZOLLARS**  
Huitt-Zollars, Inc. Ontario  
3990 CONCOURS, SUITE 330 • ONTARIO, CALIFORNIA 91764 • (909) 941-7799

**COUNTY OF SAN BERNARDINO**  
**PRELIMINARY WQMP SITE PLAN**  
**PHILADELPHIA AND EAST END**  
**COUNTY OF SAN BERNARDINO**

SHEET **1** NO. **1**