

# CITY OF OCEANSIDE

## BMP DESIGN MANUAL

For Permanent Site Design, Storm  
Water Treatment and  
Hydromodification  
Management



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# City of Oceanside BMP Design Manual

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This City of Oceanside BMP Design Manual is considered the local jurisdiction manual based on the Model BMP Design Manual which was adapted for local use by:

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# Summary

In May 2013, the California Regional Water Quality Control Board for the San Diego Region reissued (SDRWQCB) a municipal storm water, National Pollutant Discharge Elimination System permit (Municipal Separate Storm Sewer Systems [MS4] Permit) that covered its region. The San Diego Region is comprised of San Diego, Orange, and Riverside County Copermittees, including the City of Oceanside. The MS4 Permit reissuance to the San Diego County Copermittees went into effect in 2013 (Order No. R9-2013-0001).

The reissued MS4 Permit updates and expands storm water requirements for new developments and redevelopments. In February 2015, the MS4 Permit was amended by Order R9-2015-0001, and again in November 2015 by Order R9-2015-0100. As required by the reissued MS4 Permit, the City of Oceanside (from here in referred to as the “City”) has prepared this Best Management Practices (BMP) Design Manual (from here in referred to as the “**Manual**”) to replace the current Countywide Model Standard Urban Stormwater Mitigation Plan (SUSMP), dated March 25, 2011, which was based on the requirements of the 2007 MS4 Permit. The effective date of this manual is **January 2022**.

## **What this Manual is intended to address:**

This Manual addresses updated onsite post-construction storm water requirements for Standard Projects and Priority Development Projects (PDPs), and provides updated procedures for planning, preliminary design, selection, and design of permanent storm water BMPs based on the performance standards presented in the MS4 Permit.

At the local level, the intended users of the BMP Design Manual include project applicants, for both private and public developments, their representatives responsible for preparation of Storm Water Quality Management Plans (SWQMPs) and Copermittee (City of Oceanside) personnel responsible for review of these plans.

The following are significant updates to storm water requirements of the MS4 Permit compared to the 2007 MS4 Permit and 2011 Countywide Model SUSMP:

- PDP categories have been updated, and the minimum threshold of impervious area to qualify as a PDP has been reduced.
- Many of the low impact development (LID) requirements for site design that were applicable only to PDPs under the 2007 MS4 Permit are applicable to all projects (Standard Projects and PDPs) under the MS4 Permit.
- The standard for storm water pollutant control (formerly treatment control) is retention of the 24-hour 85<sup>th</sup> percentile storm volume, defined as the event that has a precipitation total greater than or equal to 85 percent of all daily storm events larger than 0.01 inches over a given period of record in a specific area or location.
- For situations where onsite retention of the 85<sup>th</sup> percentile storm volume is technically not feasible, biofiltration must be provided to satisfy specific “biofiltration standards”. These standards consist of a set of siting, selection, sizing, design and operation and maintenance (O&M) criteria that must be met for a BMP to be considered a “biofiltration BMP” – see Section 2.2.1 and Appendix F.
- Exemptions from hydromodification management are reduced, and certain categories of exemptions that are not identified in the MS4 Permit must be identified in a Watershed

Management Area Analysis (WMAA).

- The flow control performance standard for hydromodification management is based on controlling flow to pre-development condition (natural) rather than pre-project condition.
- The flow control performance standard is updated. Requirement to compare flow frequency curves is removed. Performance standard for comparing pre-development and post-project flow duration curves is revised.
- Hydromodification management requirements are expanded to include requirements to protect critical coarse sediment yield areas.
- Alternative (offsite) compliance approaches are provided as an option to satisfy pollutant control or hydromodification management performance standards if a Copermittee implements an alternative compliance program. Copermittees are given discretion by the MS4 Permit to allow the project applicants to participate in an alternative compliance program without demonstrating technical infeasibility of retention and/or biofiltration BMPs onsite.

### **What this Manual does not address:**

This Manual provides technical guidance for private and public projects to comply with onsite post-construction storm water provisions in the MS4 Permit. It does not impose additional legal requirements on project applicants.

The MS4 Permit includes provisions for optional participation in an offsite alternative compliance program and implementation of “Green Streets” design concepts. As these elements are jurisdiction-specific and in different stages of development across the San Diego region, this manual which precedes development of local implementation guidance, **does not provide guidance for participation in an alternative compliance program**. This manual only indicates the conditions under which project applicants, public or private, can seek to participate in alternative compliance at the discretion of local jurisdictions. Guidance on green streets design concepts is provided in Appendix K. Additionally, this Manual addresses only post-construction storm water requirements and is not intended to serve as a guidance or criteria document for construction-phase storm water controls.

### **Disclaimer**

Currently, some of the Copermittees are pursuing a subvention of funds from the State to pay for certain activities required by the 2007 Municipal Permit, including activities that require Copermittees to perform activities outside their jurisdictional boundaries and on a regional or watershed basis. Nothing in this manual should be viewed as a waiver of those claims or as a waiver of the rights of Copermittees to pursue a subvention of funds from the State to pay for certain activities required by the MS4 Permit, including the preparation and implementation of the BMP Design Manual. In addition, several Copermittees have filed petitions with the State Board challenging some of the requirements of Provision E of the MS4 Permit. Nothing in this manual should be viewed as a waiver of those claims. Because the State Board has not issued a stay of the 2013 Municipal Permit, Copermittees must comply with the MS4 Permit’s requirements while the State Board process is pending.

### **This Manual is organized in the following manner:**

An introductory section titled “**How to Use this Manual**” provides a practical orientation to intended uses and provides examples of recommended workflows for using the manual.

## City of Oceanside BMP Design Manual

**Chapter 1** provides information to help the manual user determine which of the storm water management requirements are applicable to the project; source controls/site design, pollutant controls, and hydromodification management. This chapter also introduces the procedural requirements for preparation, review, and approval of project submittals. General jurisdiction requirements for processing project submittals are provided in this chapter.

**Chapter 2** defines the performance standards for source control and site design BMPs, storm water pollutant control BMPs, and hydromodification management BMPs based on the MS4 Permit. These are the underlying criteria that must be met by projects, as applicable. This chapter also presents information on the underlying concepts associated with these performance standards to provide the project applicant with technical background; explains why the performance standards are important; and gives a general description of how the performance standards can be met.

**Chapter 3** describes the essential steps in preparing a comprehensive storm water management design and explains the importance of starting the process early during the preliminary design phase. By following the recommended procedures in Chapter 3, project applicants can develop a design that complies with the complex and overlapping storm water requirements. This chapter is intended to be used by both Standard Projects and PDPs; however, certain steps will not apply to Standard Projects (as identified in the chapter).

**Chapter 4** presents the source control and site design requirements to be met by all development projects and is therefore intended to be used by Standard Projects and PDPs.

**Chapter 5** applies to PDPs. It presents the specific process for determining which category of onsite pollutant control BMP, or combination of BMPs, is most appropriate for the PDP site and how to design the BMP to meet the storm water pollutant control performance standard. The prioritization order of onsite pollutant control BMPs begins with retention, then biofiltration, and finally flow-thru treatment control (in combination with offsite alternative compliance). Chapter 5 does not apply to Standard Projects.

**Chapter 6** applies to PDPs that are subject to hydromodification management requirements. This chapter provides guidance for meeting the performance standards for the two components of hydromodification management: protection of critical coarse sediment yield areas and flow control for post-project runoff from the project site. Chapter 6 incorporates applicable requirements of the "Final Hydromodification Management Plan (HMP) Prepared for County of San Diego, California," dated March 2011, with modifications based on updated requirements in the MS4 Permit. Chapter 6 does not apply to Standard Projects or to PDPs with only pollutant control requirements.

**Chapter 7** addresses the long-term O&M requirements of structural BMPs presented in this manual, and mechanisms to ensure O&M in perpetuity. Chapter 7 applies to PDPs only and is not required for Standard Projects; however Standard Projects may use this chapter as a reference.

**Chapter 8** describes the specific requirements for the content of project submittals to facilitate the City's review of project plans for compliance with applicable requirements of the manual and the MS4 Permit. This chapter is applicable to Standard Projects and PDPs. This chapter pertains specifically to the content of project submittals, and not to specific details of the City's requirements for processing of submittals; it is intended to complement the requirements for processing of project submittals that are included in Chapter 1.

**Appendices** to this manual provide detailed guidance for BMP design, calculation procedures, worksheets, maps and other figures to be referenced for BMP design. These Appendices are not intended to be used independently from the overall manual – rather they are intended to be used only

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as referenced in the main body of the manual.

This manual is organized based on project category. Requirements that are applicable to both Standard Projects and PDPs are presented in Chapter 4. Additional requirements applicable only to PDPs are presented in Chapters 5 through 7. While source control and site design BMPs are required for all projects inclusive of Standard Projects and PDPs, structural BMPs are only required for PDPs. Throughout this manual, the term "structural BMP" is a general term that encompasses the pollutant control BMPs and hydromodification management BMPs required for PDPs under the MS4 Permit. A structural BMP may be a pollutant control BMP, a hydromodification management BMP, or an integrated pollutant control and hydromodification management BMP. Hydromodification management BMPs are also referred to as flow control BMPs in this Manual.

## City of Oceanside BMP Design Manual

### Chronology of San Diego Region Storm Water Regulations Model Guidance Documents, and Oceanside Stormwater Standards

Date	Document	Notes
July 16, 1990	MS4 Permit	The SDRWQCB issued general storm water requirements to all jurisdictions within the County of San Diego via the MS4 Permit
February 21, 2001	MS4 Permit	Land Development SUSMP requirements were written into the MS4 Permit during permit reissuance
February 14, 2002	Model SUSMP	Countywide model guidance document was issued for implementation of the 2001 MS4 Permit requirements
January 24, 2007	MS4 Permit	LID and HMP requirements were written into the MS4 Permit during reissuance
July 24, 2008	Model SUSMP	Countywide model guidance document for implementation of the 2007 MS4 Permit requirements, including interim HMP criteria, was prepared
March 25, 2010	Oceanside SUSMP	Completion and approval of City of Oceanside specific guidance based on the “Countywide Model SUSMP”
March 2011	Final HMP	Final HMP addresses HMP requirements of the 2007 MS4 Permit
March 25, 2011	Model SUSMP	Countywide model guidance document for implementation of the 2007 MS4 Permit requirements, including final HMP, was completed
June 30, 2011	Oceanside SUSMP	Updates to March 25, 2010 version to include final HMP requirements
May 8, 2013	MS4 Permit	Storm water retention requirements and requirements for protection of critical coarse sediment yield were written into the MS4 Permit during reissuance
February 11, 2015	MS4 Permit	Amends 2013 MS4 permit and provides clarification on water quality equivalency and provides other technical revisions.

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Date	Document	Notes
June 27, 2015	Model BMP Design Manual	Countywide model guidance document for implementation of the MS4 Permit requirements "Model BMP Design Manual" updates former "Model SUSMP"
February 16, 2016	Model BMP Design Manual	Updates to June 27, 2015 version include updated PDP definitions and definition of redevelopment, updates to storm water requirements applicability timeline, and updates to hydromodification management performance criteria and procedures.
February 16, 2016	City of Oceanside BMP Design Manual	Completion and approval of City of Oceanside specific guidance based on the "Model BMP Design Manual"
May 30, 2018	Model BMP Design Manual	Updates to February 16, 2016 version include updated guidance regarding: geotechnical feasibility, Biofiltration BMP sizing, Hydromodification Sizing Factors, and Operations and Maintenance Requirements. Updates to Appendices include the addition of Source Control Fact
January 2022	City of Oceanside BMP Design Manual	Effective date of City of Oceanside BMP Design Manual incorporating additional local guidance

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## List of Acronyms

303(d)	Refers to Clean Water Act Section 303(d) list of impaired and threatened waters
ASTM	American Society for Testing and Materials
BF	Biofiltration (BMP Category)
BMPs	Best Management Practices
CEQA	California Environmental Quality Act
DCV	Design Capture Volume
DMA	Drainage Management Area
ESA	Environmentally Sensitive Area
FT	Flow-thru Treatment Control BMP (BMP Category)
GLUs	Geomorphic Landscape Units
GR	General Requirements
HMP	Hydromodification Management Plan
HSPF	Hydrologic Simulation Program-FORTRAN
HU	Harvest and Use
INF	Infiltration (BMP Category)
LID	Low Impact Development
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
NRCS	Natural Resource Conservation Service
O&M	Operation and Maintenance
PDPs	Priority Development Projects
POC	Point of Compliance
PR	Partial Retention (BMP Category)
SC	Source Control
SCCWRP	Southern California Coastal Water Research Project
SD	Site Design
SDHM	San Diego Hydrology Model
SDRWQCB	San Diego Regional Water Quality Control Board
SIC	Standard Industrial Classification
SUSMP	Standard Urban Stormwater Mitigation Plan
SWMM	Storm Water Management Model
SWQMP	Storm Water Quality Management Plan
TN	Total Nitrogen
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WMAA	Watershed Management Area Analysis
WQIP	Water Quality Improvement Plan

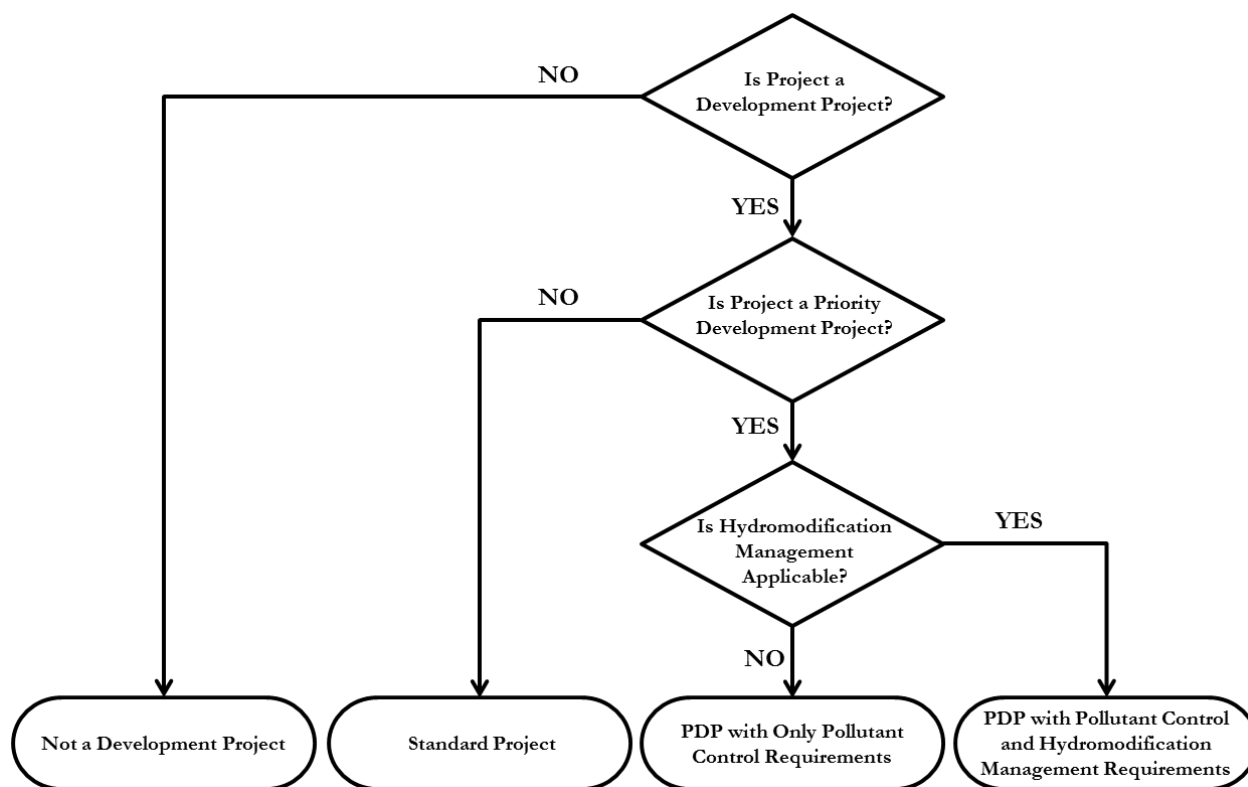
# How to Use this Manual

This Manual is intended to help a project applicant, in coordination with City of Oceanside storm water program staff, develop a SWQMP for a development project (public or private) that complies with local and MS4 Permit requirements. Most applicants will require the assistance of a qualified civil engineer, architect, and/or landscape architect to prepare a SWQMP. The applicant should begin by checking specific requirements with City storm water program staff, because every project is different.

## Beginning Steps for All Projects: What requirements apply?

To use this Manual, start by reviewing **Chapter 1** to determine whether your project is a “Standard Project” or a “PDP” (refer also to local requirements) and which storm water quality requirements apply to your project.

Not all of the requirements and processes described in this Manual apply to all projects. Therefore, it is important to begin with a careful analysis of which requirements apply. Chapter 1 also provides an overview of the process of planning, design, construction, operation, and maintenance, with associated City review and approval steps, leading to compliance. A flow chart that shows how to categorize a project in terms of applicable post-construction storm water requirements is included below. The flow chart is followed by a table that lists the applicable section of this Manual for each project type.



Project Type	Applicable Requirements		
	Source Control and Site Design (Chapter 4)	Storm Water Pollutant Control BMPs (Chapter 5)	Hydromodification Management BMPs (Chapter 6)
Not a Development Project (without impact to storm water quality or quantity – e.g. interior remodels, routine maintenance; Refer to Section 1.3)	Requirements in this Manual do not apply		
Standard Projects	X		
PDPs with only Pollutant Control Requirements	X	X	
PDPs with Pollutant Control and Hydromodification Management Requirements	X	X	X

Once an applicant has determined which requirements apply, **Chapter 2** describes the specific performance standards associated with each requirement. For example, an applicant may learn from Chapter 1 that the project must meet storm water pollutant control requirements. Chapter 2 describes what these requirements entail. This chapter also provides background on key storm water concepts to help understand why these requirements are in place and how they can be met. Refer to the list of acronyms and glossary as guidance to understanding the meaning of key terms within the context of this Manual.

**Next Steps for All Projects: How should an applicant approach a project storm water management design?**

Most projects will then proceed to **Chapter 3** to follow the step-by-step guidance to prepare a storm water project submittal for the site. This chapter does not specify any regulatory criteria beyond those already specified in Chapter 1 and 2 – rather it is intended to serve as a resource for project applicants to help navigate the task of developing a compliant storm water project submittal. Note that the first steps in Chapter 3 apply to both Standard Projects and PDPs; while other steps in Chapter 3 only apply to PDPs.

The use of a step-by-step approach is highly recommended because it helps ensure that the right information is collected, analyzed, and incorporated in to project plans and submittal at the appropriate time in the City’s review process. It also helps facilitate a common framework for discussion between the applicant and the reviewer. However, each project is different and it may be appropriate to use a different approach as long as the applicant demonstrates compliance with the MS4 Permit requirements that apply to the project.

**Final Steps in Using This Manual: How should an applicant design BMPs and prepare documents for compliance?**

Standard Projects	PDPs
<p>Standard Projects will proceed to <b>Chapter 4</b> for guidance on implementing source control and site design requirements.</p> <p>After Chapter 4, Standard Projects will proceed to <b>Chapter 8</b> for project submittal requirements.</p>	<p>PDPs will also proceed to <b>Chapter 4</b> for guidance on implementing source control and site design requirements.</p> <p>PDPs will use <b>Chapters 5 through 7</b> and associated Appendices to implement pollutant control requirements, and hydromodification management requirements for the project site, as applicable. These projects will proceed to <b>Chapter 8</b> for project submittal requirements.</p>

**Plan Ahead to Avoid Common Mistakes**

The following list identifies some common errors made by applicants that delay or compromise development approvals with respect to storm water compliance.

- Not planning for compliance early enough. The strategy for storm water quality compliance should be considered before completing a conceptual site design or sketching a layout of project site or subdivision lots (see Chapter 3). Planning early is crucial under current requirements compared to previous requirements; for example, LID/Site Design is required for all development projects and onsite retention of storm water runoff is required for PDPs. Additionally, collection of necessary information early in the planning process (e.g. geotechnical conditions, groundwater conditions) can help avoid delays resulting from redesign.
- Assuming proprietary storm water treatment facilities will be adequate for compliance and/or relying on strategies acceptable under previous MS4 Permits may not be sufficient to meet compliance. Under the MS4 Permit, the standard for pollutant control for PDPs is **retention of the 85th percentile storm volume** (see Chapter 5). Flow-thru treatment cannot be used to satisfy permit requirements unless the project also participates in an alternative compliance program. Under some conditions, certain proprietary BMPs may be classified as “biofiltration” according to Appendix F of this Manual and can be used for primary compliance with storm water pollutant treatment requirements (i.e. without alternative compliance).
- Not planning for on-going inspections and maintenance of PDP structural BMPs in perpetuity. It is essential to secure a mechanism for funding of long-term O&M of structural BMPs, select structural BMPs that can be effectively operated and maintained by the ultimate property owner, and include design measures to ensure access for maintenance and to control maintenance costs (see Chapter 7).

# Policies and Procedural Requirements

This chapter introduces storm water management policies and is intended to help categorize a project and determine the applicable storm water management requirements as well as options for compliance. This chapter also introduces the procedural requirements for preparation, review, and approval of project submittals.

## 1.1 Introduction to Storm Water Management Policies

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*MS4 Permit Provision E.3.a-c; E.3.d.(1)*

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**Storm water management requirements for development projects are derived from the MS4 Permit and implemented by local jurisdictions.**

On May 8, 2013, the California Regional Water Quality Control Board San Diego Region (referred to as “San Diego Water Board”) reissued a municipal storm water permit titled “National Pollutant Discharge Elimination System Permit and Waste Discharge Requirements for Discharges from the MS4s draining the watersheds within the San Diego Region” (Order No. R9-2013-0001; referred to as MS4 Permit) to the municipal Copermittees, including the City of Oceanside. The MS4 Permit was amended in February 2015 by Order R9-2015-0001, and again in November 2015 by Order R9-2015-0100. The MS4 Permit was issued by the San Diego Water Board pursuant to section 402 of the federal Clean Water Act and implementing regulations (Code of Federal Regulations Title 40, Part 122) adopted by the United States Environmental Protection Agency, and Chapter 5.5, Division 7 of the California Water Code. The MS4 Permit, in part, requires each Copermittee to use its land use and planning authority to implement a development planning program to control and reduce the discharge of pollutants in storm water from new development and significant redevelopment to the maximum extent practicable (MEP). MEP is defined in the MS4 Permit.

**Different requirements apply to different project types.**

The MS4 Permit requires all development projects to implement source control and site design practices that will minimize the generation of pollutants. While all development projects are required to implement source control and site design/LID practices, the MS4 Permit has additional requirements for development projects that exceed size thresholds and/or fit under specific use

categories. These projects, referred to as PDPs, are required to incorporate structural BMPs into the project plan to reduce the discharge of pollutants, and address potential hydromodification impacts from changes in flow and sediment supply.

## 1.2 Purpose and Use of the Manual

**This Manual presents a “unified BMP design approach.”**

To assist the land development community, streamline project reviews, and maximize cost-effective environmental benefits, the regional Copermittees have developed a unified BMP design approach<sup>1</sup> that meets the performance standards specified in the MS4 Permit. By following the process outlined in this Manual, project applicants (for both private and public developments) can develop a single integrated design that complies with the complex and overlapping MS4 Permit source control and site design requirements, storm water pollutant control requirements (i.e. water quality), and hydromodification management (flow-control and sediment supply) requirements. Figure 1-1 presents a flow chart of the decision process that the Manual user should use to:

1. Categorize a project;
2. Determine storm water requirements; and
3. Understand how to submit projects for review and verification.

This figure also indicates where specific procedural steps associated with this process are addressed in Chapter 1.

**Alternative BMP design approaches that meet applicable performance standards may also be acceptable.**

Applicants may choose not to use the unified BMP design approach present in this Manual, in which case they will need to demonstrate to the satisfaction of the City, in their submittal, compliance with applicable performance standards. These performance standards are described in **Chapter 2** and in Section E.3.c of the MS4 Permit.

### 1.2.1 Determining Applicability of Permanent BMP Requirements

The following Table 1-1 reiterates the procedural requirements indicated in Figure 1-1 in a stepwise checklist format. The purpose of Table 1-1 is to guide applicants to appropriate sections in Chapter 1 to identify the post-construction storm water requirements applicable for a project. Table 1-1 is **not** intended to be used as a project intake form. Applicability checklist of permanent, post-construction storm water BMP requirements that may be used as a project intake form is provided in Appendix I-1.

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<sup>1</sup> The term “unified BMP design approach” refers to the standardized process for site and watershed investigation, BMP selection, BMP sizing, and BMP design that is outlined and described in this manual with associated appendices and templates. This approach is considered to be “unified” because it represents a pathway for compliance with the MS4 Permit requirements that is anticipated to be reasonably consistent across the local jurisdictions in San Diego County. In contrast, applicants may choose to take an alternative approach where they demonstrate to the satisfaction of the Copermittee, in their submittal, compliance with applicable performance standards without necessarily following the process identified in this manual.

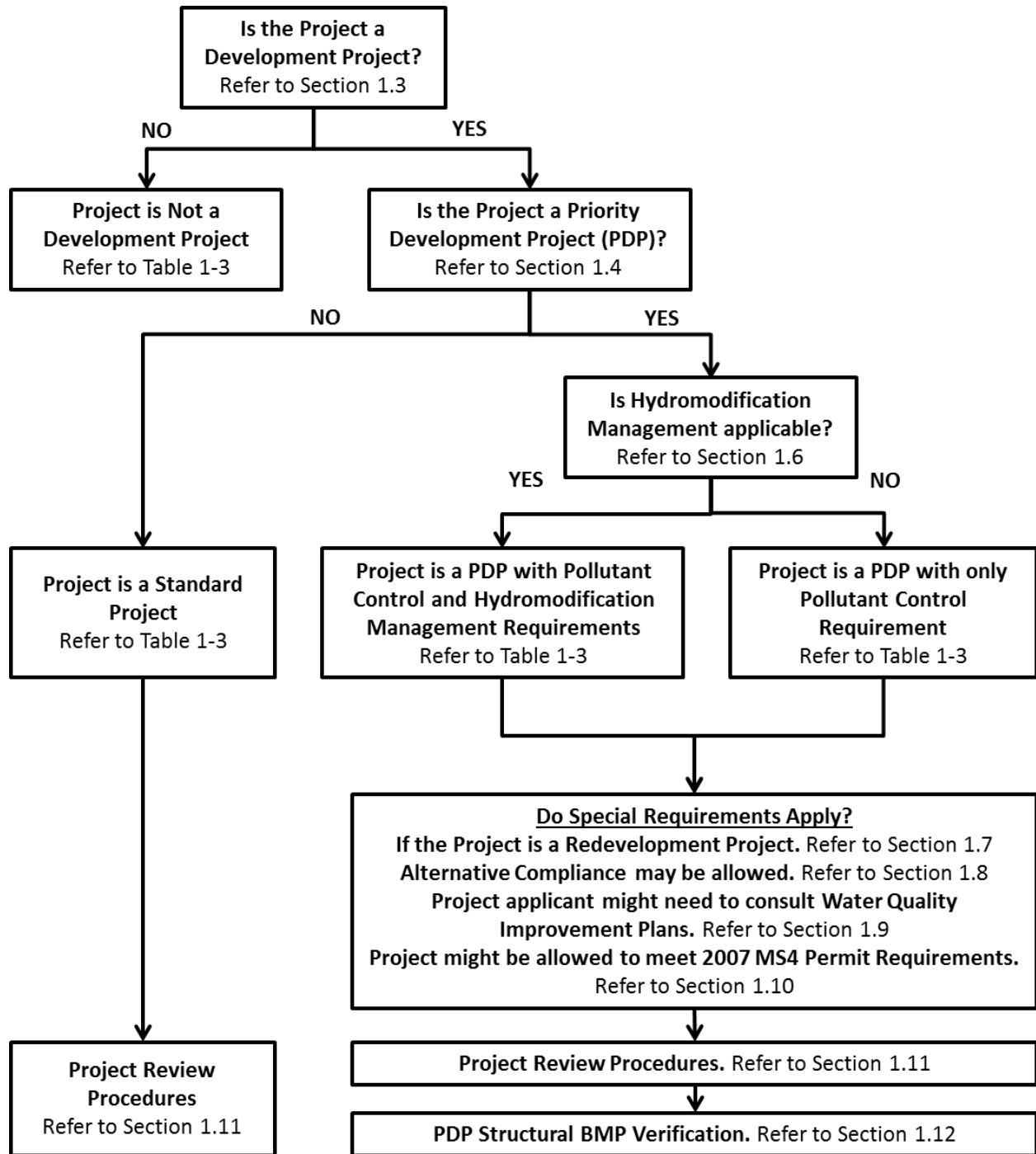


FIGURE 1-1. Procedural Requirements for a Project to Identify Storm Water Requirements

**TABLE 1-1. Checklist for a Project to Identify Applicable Post-Construction Storm Water Requirements**

<p><b>Step 1. Is the project a Development Project?</b></p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>See Section 1.3 for guidance. A phase of a project can also be categorized as a development project. If “Yes” then continue to Step 2. If “No” then stop here; Permanent BMP requirements do not apply i.e. requirements in this Manual are not applicable to the project.</p>		
<p><b>Step 2. Is the project a PDP?</b></p>		
<p><b>Step 2a. Does the project fit one of the PDP definitions a-f?</b></p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>See Section 1.4.1 for guidance. If “Yes” then continue to Step 2b. If “No” then stop here; <u>only</u> Standard Project requirements apply.</p>		
<p><b>Step 2b. Does the project qualify for requiring meeting 2007 MS4 Permit requirements?</b></p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>See Section 1.10 for guidance. If “Yes” then continue to Step 2c. If “No” then go to Step 2d.</p>		
<p><b>Step 2c. Does the project fit one of the PDP definitions in the 2007 MS4 Permit?</b></p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>See SDRWQCB Order No. R9-2007-0001, Provision D.1.d. If “Yes” then continue to Step 2d. If “No” then stop here; Standard Project requirements apply.</p>		
<p><b>Step 2d. Do one of the exceptions to PDP definitions in this Manual apply to the project?</b></p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>See Section 1.4.3 for guidance. If “Yes” then stop here; Standard Project requirements apply, along with additional requirements that qualify the project for the exception. If “No” then continue to Step 3; the project is a PDP.</p>		
<p><b>Step 3. Is the Project Subject to Earlier PDP Requirements Due to a Prior Lawful Approval?</b></p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>See Section 1.10 for guidance. If “Yes” then you may follow the structural BMP requirements, including any hydromodification management exemptions, found in the earlier version of the SUSMP Model manual for the City. If “No” then continue to Step 4.</p>		
<p><b>Step 4. Do Hydromodification Control Requirements Apply?</b></p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>See Section 1.6 for guidance. If “Yes” then continue to Step 4a. If “No” then stop here; PDP with only pollutant control requirements, apply to the project.</p>		
<p><b>Step 4a. Does Protection of Coarse Sediment Supply Areas Apply?</b></p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>See Section 1.6 for guidance. If “Yes” then stop here; requirements to protect coarse sediment supply areas apply to the project. See Appendix H for additional design requirements.</p>		

## **1.2.2 Determine Applicability of Construction BMP Requirements**

All projects are required to ensure that pollutants are not discharged to the MS4 during construction phases. Applicable construction site BMPs are required to be implemented. All projects, or phases of projects, even if exempted from meeting some or all Permanent BMP requirements, are required to implement temporary erosion, sediment, good housekeeping and pollution prevention BMPs to mitigate storm water pollutants during the construction phase. For detailed information on these requirements see the following sources:

- Statewide Construction General Permit (Order No. 2009-0009-DWQ); and
- MS4 permit Section E.4., Construction Management; and

City of Oceanside Stormwater Quality Management Plans (SWQMPs) must address construction BMP requirements even when a SWPPP is not required.

## **1.3 Defining a Project**

**Not all site improvements are considered “development projects” under the MS4 Permit.**

This Manual is intended for new development and redevelopment projects, inclusive of both private- and public funded projects. Development projects are defined by the MS4 Permit as "construction, rehabilitation, redevelopment, or reconstruction of any public or private projects". Development projects are issued local permits to allow construction activities. To further clarify, this Manual applies only to development or redevelopment activities that have the potential to contact storm water and contribute an anthropogenic source of pollutants or reduce the natural absorption and infiltration abilities of the land.

### **1.3.1 Routine Maintenance Determination for Activities within Existing Roadways and Similar Existing Impervious Surfaces**

This section provides a definition of routine maintenance activities for existing roadways and similar existing impervious surfaces. These activities are distinct from “redevelopment,” and as such, require further explanation within the context of this Manual.

“Routine maintenance activities” for existing roadways and similar surfaces can vary in method, but within the context of this Manual, the action must meet specific requirements to satisfy the letter and the intent of the Regional MS4 Permit. Shared general characteristics of “routine maintenance activities” for existing roadways and similar existing impervious surfaces include: (1) a CEQA exemption, (2) the action is conducted wholly within the horizontal and vertical limits of the existing structural cross section of the roadway or surface, (3) no creation of impervious surface(s) beyond the limits of the existing impervious surface footprint, (4) disturbance of the native underlying soil typically does not occur, and (5) reclamation is exclusively comprised of engineered fill, if present and if needed (i.e., backfill, aggregate base/asphalt base and asphalt wearing layer). These maintenance activities are more specifically understood to include Slurry Seal Operations, 1-inch to 2-inch Grind and Overlay Operations, and also includes evolving technologies employed by the City, such as Full Depth Reclamation or Replacement (FDR). The practice of FDR is an in-place recycling method for maintaining or rehabilitating roadways. FDR is an emerging technology that is intended to minimize environmental impacts and construction costs. The FDR process includes milling the asphalt and

## Chapter 1: Policies and Procedural Requirements

mixing it with the underlying soil and base to provide a more stable roadbed that significantly limits any exposure of unpaved areas during the replacement process.

In addition to the minimally invasive methods associated with these actions, the frequency of and need for these actions must also be deemed necessary as part of a routinely scheduled maintenance program (e.g., Capital Improvement Program, HOA/POA Road Maintenance, etc.). The requisite maintenance program must establish that the action is being undertaken solely to ensure or repair the structural integrity of the existing surface. Lastly, regardless of the means, methods, or limits of imperviousness of the proposed action, the action must not be part of, or associated with, development project mitigation requirements, development project construction, a development project construction agreement, conditions of approval, or sidewalk retrofits to comply with Americans with Disabilities Act (ADA) requirements.

Should a proposed action satisfy all the above criteria, then the action may be designated as a “routine maintenance activity” and would therefore not be subject to the post-construction BMP requirements set forth in the Regional MS4 Permit or this Manual. While not subject to post-construction BMP requirements, all routine maintenance activities are subject to the following specific requirements:

1. The responsible party must substantiate that the maintenance will be conducted wholly within the existing roadway structural cross section by obtaining at least one pavement boring per roadway segment.
2. During the implementation of the routine maintenance activity, any exposed soil area shall be covered each day in accordance with the construction BMP requirements specified in the Appendix C of the City’s [Jurisdictional Runoff Management Program \(JRMP\)](#).
3. The responsible party must include supporting documentation (i.e., half-scale 11” x 17” copies of the “as-built” or “record” drawings) in the project file.
4. The City shall maintain a list of projects that fall under this category and keep the supporting documentation in the project file to support the routine maintenance determination.

### **A project must be defined consistent with the California Environmental Quality Act (CEQA) definitions of "project."**

CEQA defines a project as: a discretionary action being undertaken by a public agency that would have a direct or reasonably foreseeable indirect impact on the physical environment. This includes actions by the agency, financing and grants, and permits, licenses, plans, regulations or other entitlements granted by the agency. CEQA requires that the project include “the whole of the action” before the agency. This requirement precludes "piecemealing," which is the improper (and often artificial) separation of a project into smaller parts in order to avoid preparing EIR-level documentation.

In the context of this Manual, the "project" is the "whole of the action" which has the potential for adding or replacing or resulting in the addition or replacement of, roofs, pavement, or other impervious surfaces and thereby resulting in increased flows and storm water pollutants. "Whole of the action" means the project may not be segmented or phased into small parts either onsite or offsite if the effect is to reduce the quantity of impervious area and fall below thresholds for applicability of storm water requirements.

When defining the project, the following questions are considered:

- What are the project activities?
- Do they occur onsite or offsite?
- What are the limits of the project (project boundary)?
- What is the whole of the action associated with the project (i.e. what is the total amount of new or replaced impervious area considering all of the collective project components through all phases of the project)?
- Are any facilities or agreements to build facilities offsite in conjunction with providing service to the project (street widening, utilities)?

**Table 1-2 is used to determine whether storm water management requirements defined in the MS4 Permit and presented in this Manual apply to the project.**

If a project meets one of the exemptions in Table 1-2 then it is not a “development project” within the context of this Manual and Permanent BMP requirements do not apply; however, all project must evaluate construction requirements in Section 1.2.2. If Permanent BMP requirements apply to a project, Sections 1.4 to 1.7 will further define the extent of the applicable requirements based on the MS4 Permit. The MS4 Permit contains standard requirements that are applicable to all projects (Standard Projects and PDPs), and more specific requirements for projects that are classified as PDPs.

### 1.4 Is the Project a PDP?

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*MS4 Permit Provision E.3.b.(1)*

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**PDP categories are defined by the MS4 Permit, but the PDP categories can be expanded by local jurisdictions, and local jurisdictions can offer specific exemptions from PDP categories.**

Section 1.4.1 presents the PDP categories defined in the MS4 Permit. Section 1.4.2 presents additional PDP categories and/or expanded PDP definitions that apply to the specific local jurisdiction. Section 1.4.3 presents specific Oceanside exemptions.

All projects must complete a Storm Water Intake Form to determine whether stormwater requirements are applicable.

**TABLE 1-2. Applicability of Permanent, Post-Construction Storm Water Requirements**

Do permanent storm water requirements apply to your project?
<i>Requirements DO NOT apply to:</i>
<p>Replacement of impervious surfaces that are part of a routine maintenance activity, such as:</p> <ul style="list-style-type: none"> <li>• Replacing roof material on an existing building</li> <li>• Restoring pavement or other surface materials affected by trenches from utility work</li> <li>• Resurfacing existing roads and parking lots, including slurry, overlay and restriping</li> <li>• Routine replacement of damaged pavement, including full depth replacement, if the sole purpose is to repair the damaged pavement</li> <li>• Resurfacing existing roadways, sidewalks, pedestrian ramps or bike lanes on existing roads</li> <li>• Restoring a historic building to its original historic design</li> <li>• Installation of ground mounted solar arrays over existing impermeable surface</li> </ul> <p><b>Note:</b> Work that creates impervious surface outside of the existing impervious footprint is not considered routine maintenance.</p> <p>Repair or improvements to an existing building or structure that do not alter the size:</p> <ul style="list-style-type: none"> <li>• Plumbing, electrical and HVAC work</li> <li>• Interior alterations including major interior remodels and tenant build-out within an existing commercial building</li> <li>• Exterior alterations that do not increase existing impervious surface footprint, and do not expose underlying soil during construction</li> </ul>

All projects must complete a Storm Water Intake Form to determine: (1) if the proposed action is a “development project” within the context of this manual, and (2) if permanent, post-construction storm water BMP requirements apply. The Storm Water Intake Form determines which type of SWQMP Form is required for each project (i.e., either a “Priority Development Project” or a “Standard Project”).

### 1.4.1 PDP Categories

**In the MS4 Permit, PDP categories are defined based on project size, type and design features.**

Projects shall be classified as PDPs if they are in one or more of the PDP categories presented in the MS4 Permit, which are listed below. Review each category, defined in (a) through (f), below. A PDP applicability checklist for these categories is also provided in Appendix I-2. If any of the categories match the project, the entire project is a PDP. For example, if a project feature such as a parking lot falls into a PDP category, then the entire development footprint including project components that otherwise would not have been designated a PDP on their own (such as other impervious components that did not meet PDP size thresholds, and/or landscaped areas), shall be subject to PDP requirements. Note that size thresholds for impervious surface created or replaced vary based on land use, land characteristics, and whether the project is a new development or redevelopment project. Therefore, all definitions must be reviewed carefully. Also, note that categories are defined by the total quantity of “added or replaced” impervious surface, not the net change in impervious surface.

## Chapter 1: Policies and Procedural Requirements

For example, consider a redevelopment project that adds 7,500 square feet of new impervious surface and removes 4,000 square feet of existing impervious surface. The project has a net increase of 3,500 square feet of impervious surface. However, the project is still classified as a PDP because the total added or replaced impervious surface is 7,500 square feet, which is greater than 5,000 square feet.

"**Collectively**" for the purposes of the Manual means that all contiguous and non-contiguous parts of the project that represent the whole of the action must be summed up. For example, consider a residential development project that will include the following impervious components:

- 3,600 square feet of roadway
- 350 square feet of sidewalk
- 4,800 square feet of roofs
- 1,200 square feet of driveways
- 500 square feet of walkways/porches

The collective impervious area is 10,450 square feet.

### *PDP Categories defined by the MS4 Permit:*

- (a) New development projects that create 10,000 square feet or more of impervious surfaces (collectively over the entire project site). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.
- (b) Redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site on an existing site of 10,000 square feet or more of impervious surfaces). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.
- (c) New and redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site), and support one or more of the following uses:
  - (i) Restaurants. This category is defined as a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (Standard Industrial Classification (SIC) code 5812).  
  
Information and an SIC search function are available at <https://www.osha.gov/pls/imis/sicsearch.html>.
  - (ii) Hillside development projects. This category includes development on any natural slope that is twenty-five percent or greater.
  - (iii) Parking lots. This category is defined as a land area or facility for the temporary parking or storage of motor vehicles used personally, for business, or for commerce.
  - (iv) Streets, roads, highways, freeways, and driveways. This category is defined as any paved impervious surface used for the transportation of automobiles, trucks, motorcycles, and other vehicles.
- (d) New or redevelopment projects that create and/or replace 2,500 square feet or more of

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impervious surface (collectively over the entire project site), and discharging directly to an Environmentally Sensitive Area (ESA). “Discharging directly to” includes flow that is conveyed overland a distance of 200 feet or less from the project to the ESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands).

Note: ESAs are areas that include but are not limited to all Clean Water Act Section 303(d) impaired water bodies; areas designated as Areas of Special Biological Significance by the State Water Board and San Diego Water Board; State Water Quality Protected Areas; water bodies designated with the RARE beneficial use by the State Water Board and San Diego Water Board; and any other equivalent environmentally sensitive areas which have been identified by the City (see Section 1.4.2 below to determine if any other local areas have been identified).

For projects adjacent to an ESA, but not discharging to an ESA, the 2,500 sq-ft threshold does not apply as long as the project does not physically disturb the ESA and the ESA is upstream of the project.

- (e) New development projects, or redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface, that support one or more of the following uses:
  - (i) Automotive repair shops. This category is defined as a facility that is categorized in any one of the following SIC codes: 5013, 5014, 5541, 7532-7534, or 7536-7539.  
  
Information and an SIC search function are available at <https://www.osha.gov/pls/imis/sicsearch.html>.
  - (ii) Retail gasoline outlets. This category includes Retail gasoline outlets that meet the following criteria: (a) 5,000 square feet or more or (b) a projected Average Daily Traffic of 100 or more vehicles per day.
- (f) New or redevelopment projects that result in the disturbance of one or more acres of land and are expected to generate pollutants post construction.

Note: Pollutant generating development projects are those projects that generate pollutants at levels greater than background levels. Background pollutant levels means the pollutants generated from an undeveloped site. Projects disturbing one or more acres of land are presumed to generate pollutants post construction unless the applicant presents a design that satisfies the City that pollutants in stormwater discharges will not exceed pre-construction background levels.

Redevelopment projects may have special considerations with regards to the total area required to be treated. Refer to Section 1.7.

### **1.4.2 Local Additional PDP Categories and/or Expanded PDP Definitions**

The City of Oceanside has identified the following areas as environmentally sensitive areas (ESA): Agua Hedionda Creek, Buena Vista Creek, Buena Vista Lagoon, Guajome Lake, Loma Alta Creek, Loma Alta Slough, Oceanside Harbor, the Pacific Ocean shoreline, Pilgrim Creek, and the San Luis Rey River per the current (2018) 303(d) list.

Several other water bodies within the City of Oceanside have a RARE beneficial use and are also considered ESAs. The list can be found in the Section 2 of the San Diego Region Basin Plan. The plan can be accessed through the following link as of the date of this Manual.

[http://www.swrcb.ca.gov/sandiego/water\\_issues/programs/basin\\_plan/docs/update082812/Chpt\\_2\\_2012.pdf](http://www.swrcb.ca.gov/sandiego/water_issues/programs/basin_plan/docs/update082812/Chpt_2_2012.pdf)

### **1.4.3 Local PDP Exemptions or Alternative PDP Requirements**

The MS4 Permit provides the City of Oceanside the discretion to apply exempt certain projects from being defined as PDPs, or to apply alternative PDP requirements.

As allowed by MS4 Permit Section E.3.b.(3), the City may exempt certain projects from being defined as PDPs, or to apply alternative PDP requirements as follows:

- (A) New or retrofit paved sidewalks, bicycle lanes, or trails that meet the following criteria:
  - a. Designed and constructed to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas; OR
  - b. Designed and constructed to be hydraulically disconnected from paved streets or roads; OR
  - c. Designed and constructed with permeable pavements or surfaces in accordance with USEPA Green Streets guidance ["Managing Wet Weather with Green Infrastructure – Municipal Handbook: Green Streets" (USEPA, 2008)].
- (B) Retrofitting or redevelopment of existing paved alleys, streets or roads that are designed and constructed in accordance with the USEPA Green Streets guidance (USEPA, 2008)].

When determining stormwater applicability requirements described in Chapter 1.4.2, total disturbed project footprint must include portions of projects exempted from or allowed alternative PDP requirements.

Portions of projects may be allowed to implement alternative PDP requirements if the impervious surface of that portion consists entirely of one of the project types listed. For example, sidewalks, trails, or frontage roads might exist within a larger PDP footprint—these areas would qualify to utilize Alternative PDP requirements. Retrofitting and redevelopment includes the widening, realignment, and extension of existing paved alleys, streets, or roads.

Portions of projects designed and constructed in accordance with USEPA Green Streets Guidance (USEPA, 2008) must implement Standard Project requirements of Chapter 2.1 Source Control and Site Design Requirements for All Projects.

Appendix K (Green Streets) provides guidance for implementing green street and green infrastructure

## Chapter 1: Policies and Procedural Requirements

project features in accordance with USEPA Green Streets Guidance (USEPA, 2008). Projects or portions of projects implementing USEPA Green Streets Guidance must meet the following minimum design criteria, as specified in the reference document:

Green streets can incorporate a wide variety of design elements including street trees, permeable pavements, bioretention, and swales. Although the design and appearance of green streets will vary, the functional goals are the same: provide source control of stormwater, limit its transport and pollutant conveyance to the collection system, restore predevelopment hydrology to the extent possible, and provide environmentally enhanced roads. Successful application of green techniques will encourage soil and vegetation contact and infiltration and retention of stormwater. (p.2)

As a general practice, applicants are encouraged to utilize Appendix K as a basis for designing and constructing low impact design and sustainable infrastructure features for their projects.

An exemption or alternative to PDP requirements based on the above criteria may, at the City's discretion, modify the requirements for structural BMPs described in Chapters 5 and 6 of this Manual, and annual verification of operation and maintenance described in Chapter 7 of this Manual; however, projects meeting the above criteria for exemption or alternative requirements are still minimally subject to source control and site design requirements presented in Chapter 4. See also Chapter 2, Table 2-1 for a description of requirements and performance standards applicable to different project.

## 1.5 Determining Applicable Storm Water Management Requirements

*MS4 Permit Provision E.3.c.(1)*

Depending on project type and receiving water, different storm water management requirements apply.

New development or redevelopment projects that are subject to this Manual requirement pursuant to Section 1.3, but are not classified as PDPs based on Section 1.4, are called "Standard Projects." Source control and site design requirements apply to all projects including Standard Projects and PDPs. Additional structural BMP requirements (i.e. pollutant control and hydromodification management) apply generally to all PDPs. Storm water management requirements for a project, and the applicable sections of this Manual, are summarized in Table 1-3.

**TABLE 1-3. Applicability of Manual Sections for Different Project Types**

Project Type	Project Development Process (Chapter 3 and 8)	Source Control and Site Design (Section 2.1 and Chapter 4)	Structural Pollutant Control (Section 2.2 and Chapter 5 and 7)	Structural Hydromodification Management (Section 2.3, 2.4 and Chapter 6 and 7)
Not a Development Project	The requirements of this Manual do not apply			
Standard Project	☑	☑	NA	NA
PDP with only Pollutant Control Requirements*	☑	☑	☑	NA
PDPs with Pollutant Control and Hydromodification Management Requirements	☑	☑	☑	☑

\* Some PDPs may be exempt from Structural Hydromodification Management BMPs, refer to Section 1.6 to determine.

## 1.6 Applicability of Hydromodification Management Requirements

*MS4 Permit Provision E.3.c.(2)*

Hydromodification management requirements apply to PDPs only.

If the project is a Standard Project, hydromodification management requirements do not apply. Hydromodification management requirements apply to PDPs (both new and re-development) unless the project meets specific exemptions discussed below.

**PDP exemptions from hydromodification management requirements are based on the receiving water system.**

## Chapter 1: Policies and Procedural Requirements

The City has the discretion to exempt a PDP from hydromodification management requirements where the project discharges storm water runoff to:

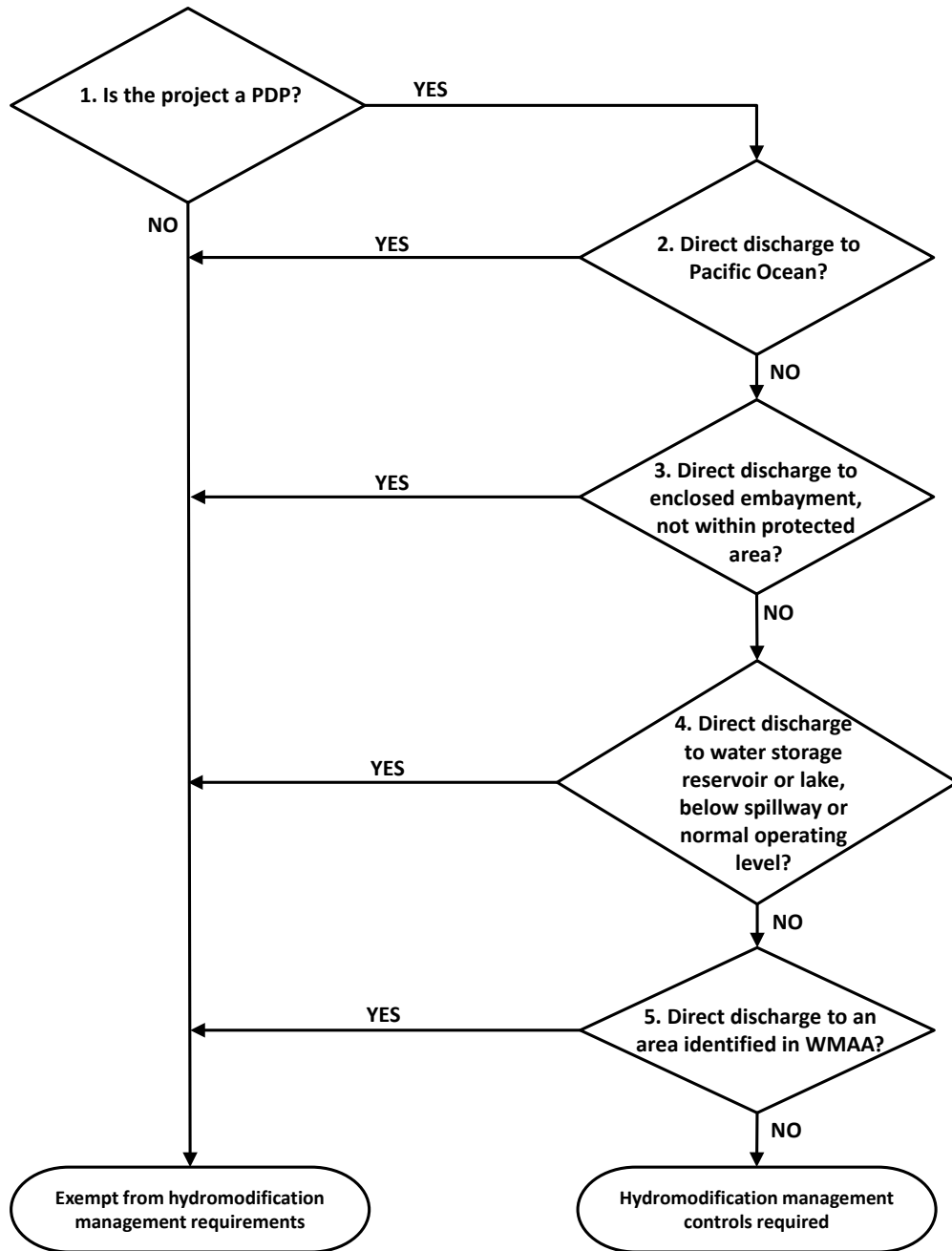
- (i) Existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean;
- (ii) Conveyance channels whose bed and bank are concrete lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean; or
- (iii) An area identified by the Copermittees as appropriate for an exemption by the optional WMAA incorporated into the Water Quality Improvement Plan (WQIP) pursuant to Provision B.3.b.(4) [of the MS4 permit].

Refer to Figure 1-2 and the associated criteria describing nodes in Figure 1-2 to determine applicability of hydromodification management requirements. The criteria reflect the latest list of exemptions that are allowed under the 2013 MS4 Permit, and therefore supersede criteria found in earlier publications.

- Figure 1-2, Node 1 – Hydromodification management control measures are only required if the proposed project is a PDP.
- Figure 1-2, Node 2 – As allowed by the MS4 Permit, projects discharging directly to the Pacific Ocean, by either existing underground storm drain systems or conveyance channels whose bed and bank are concrete-lined all the way from the point of discharge to the Pacific Ocean, are exempt.
  - This exemption is subject to the following additional criteria defined by this Manual:
    - a) The outfall must be located on the beach (not within or on top of a bluff),
    - b) A properly sized energy dissipation system must be provided to mitigate outlet discharge velocity from the direct discharge to the ocean for the ultimate condition peak design flow of the direct discharge,
    - c) The invert elevation of the direct discharge conveyance system (at the point of discharge to the ocean) should be equal to or below the mean high tide water surface elevation at the point of discharge, unless the outfall discharges to quay or other non-erodible shore protection.
- Figure 1-2, Node 3 – As allowed by the MS4 Permit, projects discharging directly to enclosed embayments (e.g., San Diego Bay or Mission Bay), by either existing underground storm drain systems or conveyance channels whose bed and bank are concrete-lined all the way from the point of discharge to the enclosed embayment, are exempt.
  - This exemption is subject to the following additional criteria defined by this Manual:
    - a) The outfall must not be located within a wildlife refuge or reserve area (e.g., Kendall-Frost Mission Bay Marsh Reserve, San Diego Bay National Wildlife Refuge, San Diego National Wildlife Refuge),
    - b) A properly sized energy dissipation system must be provided to mitigate outlet discharge velocity from the direct discharge to the enclosed embayment for the ultimate condition peak design flow of the direct discharge,
    - c) The invert elevation of the direct discharge conveyance system (at the point of discharge to the enclosed embayment) should be equal to or below the mean high tide water surface elevation at the point of discharge, unless the outfall discharges to a quay or other non-erodible shore protection.

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- Figure 1-2, Node 4 – As allowed by the MS4 Permit, projects discharging directly to a water storage reservoir or lake, by either existing underground storm drain systems or conveyance channels whose bed and bank are concrete-lined all the way from the point of discharge to the water storage reservoir or lake, are exempt.
  - This exemption is subject to the following additional criteria defined by this Manual:
    - a) A properly sized energy dissipation system must be provided in accordance with local design standards to mitigate outlet discharge velocity from the direct discharge to the water storage reservoir or lake for the ultimate condition peak design flow of the direct discharge,
    - b) The invert elevation of the direct discharge conveyance system (at the point of discharge to the water storage reservoir or lake) should be equal to or below the lowest normal operating water surface elevation at the point of discharge, unless the outfall discharges to a quay or other non-erodible shore protection. Normal operating water surface elevation may vary by season; contact the reservoir operator to determine the elevation. For cases in which the direct discharge conveyance system outlet invert elevation is above the lowest normal operating water surface elevation but below the reservoir spillway elevation, additional analysis is required to determine if energy dissipation should be extended between the conveyance system outlet and the elevation associated with the lowest normal operating water surface level.
    - c) No exemption may be granted for conveyance system outlet invert elevations located above the reservoir spillway elevation.
- Figure 1-2, Node 5 – As allowed by the MS4 Permit, projects discharging directly to an area identified as appropriate for an exemption in the WMAA for the watershed in which the project resides, by either existing underground storm drain systems or conveyance channels whose bed and bank are concrete-lined all the way from the point of discharge to the designated area, are exempt. Consult the WMAA within the WQIP for the watershed in which the project resides to determine areas identified as appropriate for an exemption. Exemption is subject to any criteria defined within the WMAA, and criteria defined below by this Manual:
  - To qualify as a direct discharge to an exempt river reach:
    - a) A properly sized energy dissipation system must be provided to mitigate outlet discharge velocity from the direct discharge to the exempt river reach for the ultimate condition peak design flow of the direct discharge,
    - b) The invert elevation of the direct discharge conveyance system (at the point of discharge to the exempt river reach) should be equal to or below the 10-year floodplain elevation. Exceptions may be made at the discretion of the [City Engineer], but shall never exceed the 100-year floodplain elevation. The [City Engineer] may require additional analysis of the potential for erosion between the outfall and the 10-year floodplain elevation.
    - c) No exemption may be granted for conveyance system outlet invert elevations located above the 100-year floodplain elevation.



\*Direct discharge refers to an uninterrupted hardened conveyance system; Note to be used in conjunction with Node Descriptions.

**FIGURE 1-2. Applicability of Hydromodification Management BMP Requirements**

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In addition to discharge to the Pacific Ocean, the City of Oceanside shall consider a PDP that discharges directly to the following waterbodies via existing underground storm drains or conveyance channels whose bed and bank are concrete lined as being exempt from hydromodification management requirements.

### **Areas Identified in the WMAA (Exempt Lagoons):**

Buena Vista Lagoon

Direct discharges to Buena Vista Lagoon may be exempt if proper energy dissipation is provided at the outfall. Energy dissipation was confirmed for the systems that are recommended by the WMAA to be exempt. For other systems discharging directly to Buena Vista Lagoon, the project proponent must determine if proper energy dissipation exists. Analysis of the freshwater / saltwater balance and the resultant effects on lagoon-system biology would not be required.

### **Areas Identified in the WMAA (Exempt River Reaches):**

San Luis Rey River from upstream river limit of Basin Plan Sub-watershed 903.1 upstream of Bonsall and near Interstate 15 to the Pacific Ocean.

Direct discharges to the San Luis Rey River may be exempt, provided that the outlet elevation of the project's outfall(s) to the river reach are between the river bottom elevation and the 100-year floodplain elevation, and properly sized energy dissipation is provided at the outfall(s).

## 1.7 Special Considerations for Redevelopment Projects (50% Rule)

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*MS4 Permit Provision E.3.b.(2)*

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Redevelopment PDPs (PDPs on previously developed sites) may need to meet storm water management requirements for **ALL impervious areas (collectively) within the ENTIRE project site.**

If the project is a redevelopment project, the structural BMP performance requirements and hydromodification management requirements apply to redevelopment PDPs as follows:

- (a) Where redevelopment results in the creation or replacement of impervious surface in an amount of less than fifty percent of the surface area of the previously existing development, then the structural BMP performance requirements of Provision E.3.c [of the MS4 Permit] apply only to the creation or replacement of impervious surface, and not the entire development; or
- (b) Where redevelopment results in the creation or replacement of impervious surface in an amount of more than fifty percent of the surface area of the previously existing development, then the structural BMP performance requirements of Provision E.3.c [of the MS4 Permit] apply to the entire development.

These requirements for managing storm water on an entire redevelopment project site are commonly referred to as the "50% rule". For the purpose of calculating the ratio, the surface area of the previously existing development shall be the area of impervious surface within the previously existing development. The following steps shall be followed to estimate the area that requires treatment to satisfy the MS4 Permit requirements:

1. How much total impervious area currently exists on the site?
2. How much existing impervious area will be replaced with new impervious area?
3. How much new impervious area will be created in areas that are pervious in the existing condition?
4. Total created and/or replaced impervious surface = Step 2 + Step 3.
5. **50% rule test:** Is step 4 more than 50% of Step 1? If yes, treat all impervious surface on the site. If no, then treat only Step 4 impervious surface and any area that comingles with created and/or replaced impervious surface area.

Note: Step 2 and Step 3 must not overlap as it is fundamentally not possible for a given area to be both "replaced" and "created" at the same time. Also activities that occur as routine maintenance shall not be included in Step 2 and Step 3 calculation.

For example, a 10,000 sq. ft development proposes replacement of 4,000 sq. ft of impervious area. The treated area is less than 50% of the total development area and only the 4,000 sq. ft area is required to be treated.

## 1.8 Alternative Compliance Program

*MS4 Permit Provision E.3.c.(1).(b); E.3.c.(2).(c); E.3.c.(3)*

### **PDPs may be allowed to participate in an alternative compliance program.**

Copermittees have the discretion to independently develop an alternative compliance program for their jurisdiction.

Participation in an alternative compliance program would allow a PDP to fulfill the requirement of providing retention and/or biofiltration pollutant controls onsite that completely fulfill the performance standards specified in Chapter 5 (pollutant controls) with onsite flow-thru treatment controls and offsite mitigation of the DCV not retained onsite.

PDPs may be allowed to participate in an alternative compliance program by using onsite BMPs to treat offsite runoff. PDPs must consult the City for specific guidelines and requirements for using onsite facilities for alternative compliance.

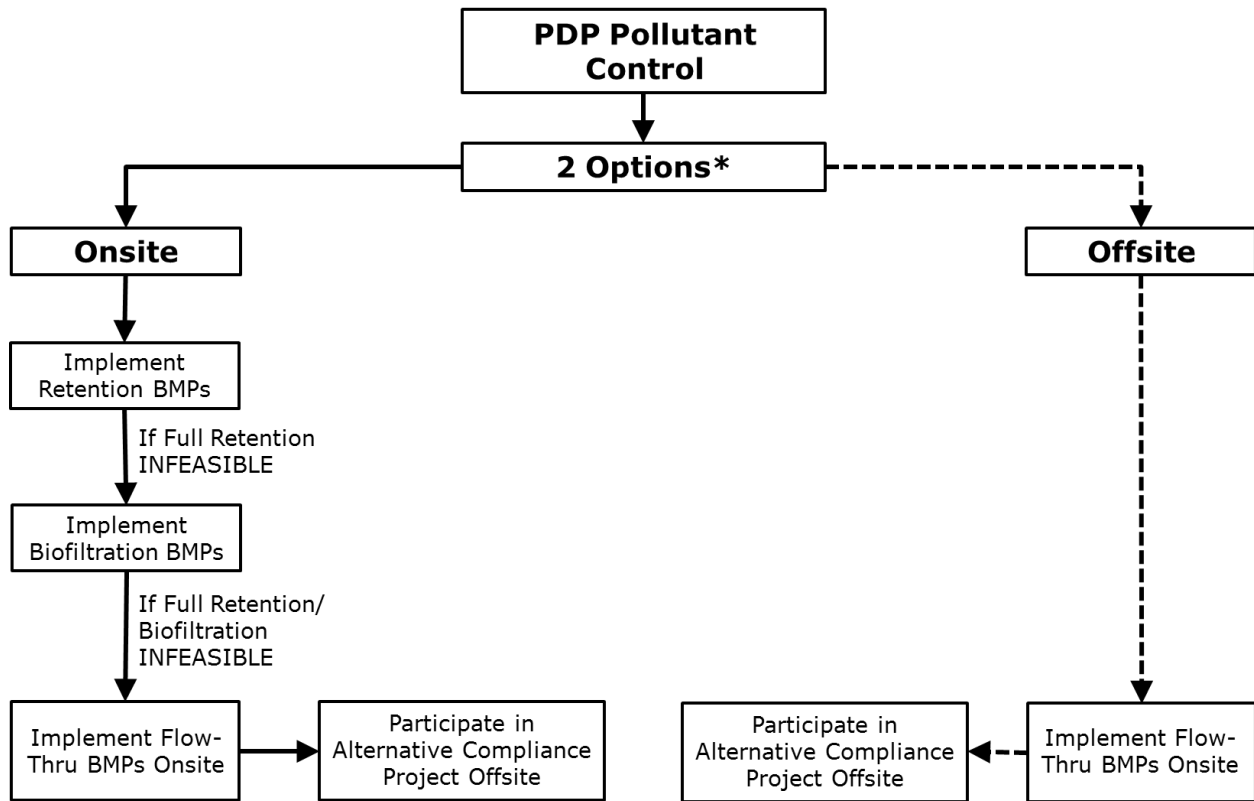
The PDP utilizing the alternative compliance program would (at a minimum) provide flow-thru treatment control BMPs onsite, then fund, contribute to, or implement an offsite alternative compliance project deemed by the jurisdiction-specific alternative compliance program to provide a greater overall water quality benefit for the portion of the pollutants not addressed onsite through retention and/or biofiltration BMPs. Offsite alternative compliance program locations for the purpose of this Manual are defined as location within the same watershed management area as the PDP. Participation in an alternative compliance program would also potentially relieve hydromodification management flow control obligations that are not provided onsite (see Chapter 6 for hydromodification management requirements). PDPs must consult the City for specific guidelines and requirements for participation in potential alternative compliance programs.

Figure 1-3 generally represents two potential pathways for participating in alternative compliance (i.e. offsite projects that supplement the PDPs onsite BMP obligations).

- The first pathway (illustrated using solid line, left side) ultimately ends at alternative compliance if the PDP cannot meet all of the onsite pollutant control obligations via retention and/or biofiltration. This pathway requires performing feasibility analysis for retention and biofiltration BMPs prior to participation in an alternative compliance project.
- The second pathway (illustrated using dashed line, right side) is a discretionary pathway along which jurisdictions may allow for PDPs to proceed directly to an alternative compliance project without demonstrating infeasibility of retention and/or biofiltration BMPs onsite.

### **Participation in an alternative compliance program also requires onsite flow-thru treatment control BMPs.**

Participation in an offsite alternative compliance project **and** the obligation to implement flow-thru treatment controls for the DCV not reliably retained or biofiltered onsite, are linked and cannot be separated. Therefore, if a jurisdiction either does not have an alternative compliance program or does not allow the PDP to participate in the program or propose a project-specific offsite alternative compliance project, then the PDP may not utilize flow-thru treatment control. The PDP should consult with the jurisdiction regarding processing requirements if this is the case.



\*PDP may be allowed to directly participate in an offsite project without demonstrating infeasibility of retention and/or biofiltration BMPs onsite. Consult the City for specific guidelines.

**FIGURE 1-3. Pathways to Participating in Alternative Compliance Program**

**PDPs may be required to provide temporal mitigation when participating in an alternative compliance program.**

Finally, if the PDP is allowed to participate in an offsite alternative compliance project that is constructed after the completion of the development project, the PDP must provide temporal mitigation to address this interim time period. Temporal mitigation must provide equivalent or better pollutant removal and/or hydrologic control (as applicable) as compared to the case where the offsite alternative compliance project is completed at the same time as the PDP.

**Water Quality Equivalency calculations must be accepted by the Regional Board**

The Water Quality Equivalency (WQE) Guidance Document for Region 9 was accepted by the San Diego Water Board’s Executive Officer on March 15, 2019. The WQE provides currency calculations to assess water quality and hydromodification management benefits for a variety of potential offsite project types and provides regional and technical basis for demonstrating a greater water quality benefit for the watershed. The 2018 WQE can be accessed through the following hyperlink

<https://projectcleanwater.org/download/2018-wqe/>

The City of Oceanside does not currently have an alternative compliance program. However, it may allow an applicant to implement an alternative compliance project in lieu of complying on site. In this scenario, the applicant is fully responsible for the alternative compliance project design, construction,

operation and long-term maintenance. Applicant proposed alternative compliance projects shall not be authorized by the City of Oceanside prior to acceptance of the water quality equivalency calculations by the Regional Water Quality Control Board.

### 1.9 Relationship between this Manual and WQIPs

#### **This Manual is connected to other permit-specified planning efforts.**

The MS4 Permit requires each Watershed Management Area within the San Diego Region to develop a **WQIP** that identifies priority and highest priority water quality conditions and strategies that will be implemented with associated goals to demonstrate progress towards addressing the conditions in the watershed. The MS4 Permit also provides an option to perform a **WMAA** as part of the WQIP to develop watershed specific requirements for structural BMP implementation in the watershed management area. PDPs should expect to consult either of these separate planning efforts as appropriate when using this Manual as follows:

1. For PDPs that implement flow-thru treatment BMPs, selection of the type of BMP shall consider the pollutants and conditions of concerns. Among the selection considerations, the PDP must consult the highest priority water quality condition as identified in the WQIP for that particular watershed management area.
2. There may be watershed management area specific BMPs or strategies that are identified in WQIPs, for which PDPs should consult and incorporate as appropriate.
3. As part of the hydromodification management obligations that PDPs must comply with, PDPs shall consult the mapping of potential critical coarse sediment yield areas provided in the WMAA attachment to the WQIPs and design the project according to the procedures outlined in this Manual if these sediments will be impacted by the project.
4. PDPs may be exempt from implementing hydromodification management BMPs (Chapter 6) based on the exemptions indicated in Section 1.6, and potentially from additional exemptions recommended in the WMAA attachment to the WQIPs. PDPs should consult the WMAA for recommended hydromodification management exemptions to determine if the project is eligible.
5. PDPs may have the option of participating in an alternative compliance program. Refer to Section 1.8.

These relationships between this Manual and WQIPs are presented in Figure 1-4.

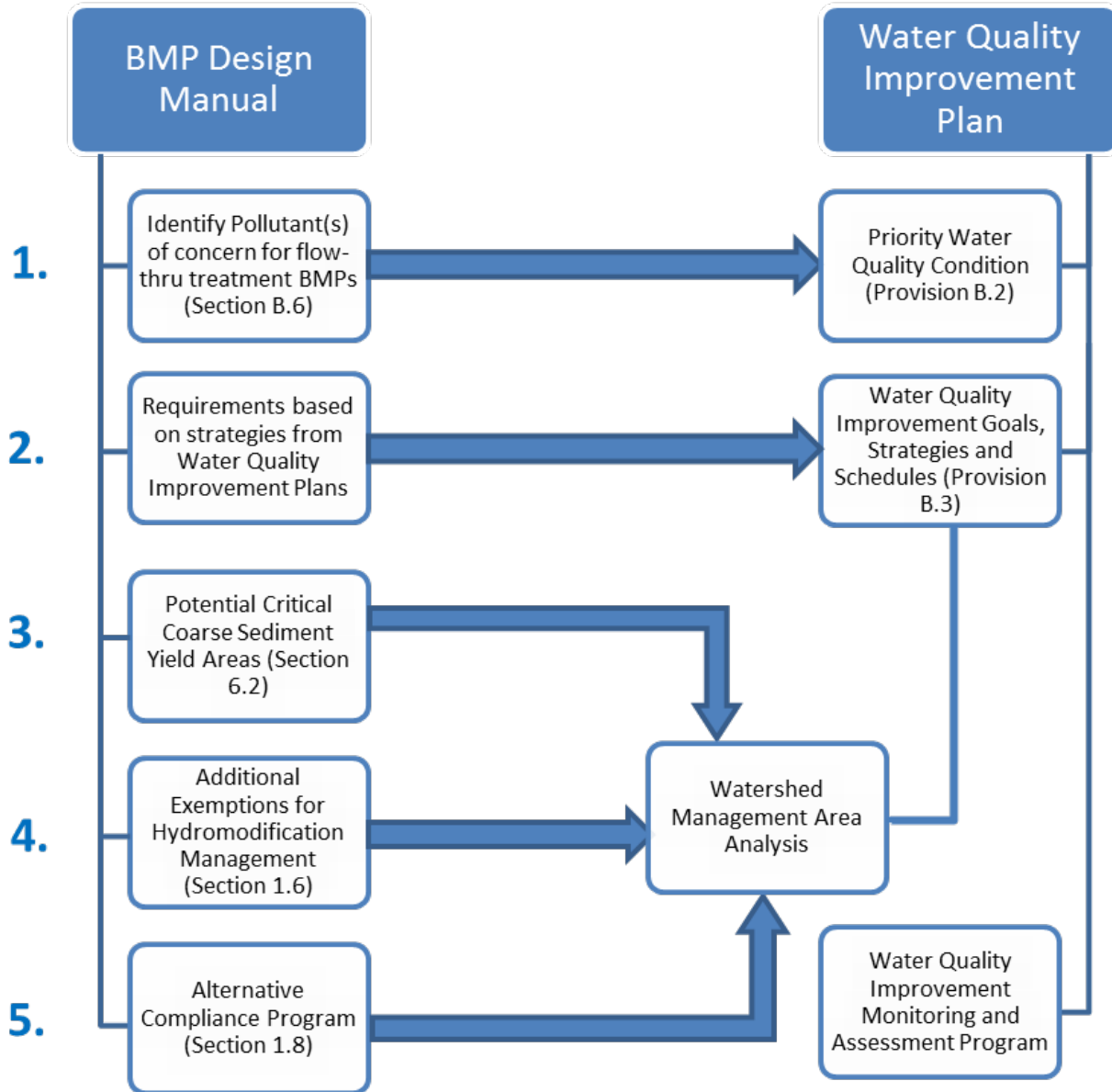


FIGURE 1-4. Relationship between this Manual and WQIP

The City of Oceanside, in collaboration with other responsible agencies, has developed WQIPs for the Carlsbad and San Luis Rey Watershed Management Areas (WMAs). The WQIPs can be accessed through the following links as of the date of this Manual:

**Carlsbad WMA WQIP**

<https://projectcleanwater.org/watersheds/carlsbad-wma/>

**San Luis Rey WMA WQIP**

<https://projectcleanwater.org/watersheds/san-luis-rey-wma/>

The City of Oceanside, in collaboration with other responsible agencies, has developed the Regional WMAA. The Regional WMAA can be accessed through the following links as of the date of this

Manual:

<https://projectcleanwater.org/copermittees/land-development-workgroup/2013-ms4-permit/>

## 1.10 Storm Water Requirement Applicability Timeline

### *MS4 Permit Provision E.3.e.(1)(a)*

A PDP may be allowed to implement the requirements from the 2007 Model SUSMP to meet post construction storm water requirements if the project meets one of the following criteria prior to February 16, 2016:

1. Approved<sup>2</sup> a design that incorporates the storm water drainage system for the PDP in its entirety, including all applicable structural pollutant treatment control and hydromodification management BMPs consistent with the 2007 Model SUSMP; AND
2. Issued a private project permit or approval, or functional equivalent for public projects, that authorizes the PDP applicant to commence construction activities based on a design that incorporates the storm water drainage system approved in conformance with Section 1.10.1.; AND
3. Confirmed that there have been construction activities on the PDP site within the 365 days prior to February 16, 2016 **OR** the applicant confirms that construction activities will commence on the PDP site within 180 days after February 16, 2016, where construction activities are undertaken in reliance on the permit or approval, or functional equivalent for public projects, issued by the City Engineer in conformance with Section 1.10.2.; AND
4. Issued all subsequent private project permits or approvals, or functional equivalent for public projects, that are needed to implement the design initially approved in conformance with Section 1.10.1. within 5 years of February 16, 2016. The storm water drainage system for the PDP in its entirety, including all applicable structural pollutant treatment control and hydromodification management BMPs must remain in substantial conformity with the design initially approved in conformance with Section 1.10.1. OR
5. Project applicant demonstrates that the jurisdiction lacks land use authority or legal authority to require a PDP to implement the post construction storm water requirements listed above.

## 1.11 Project Review Procedures

**The City of Oceanside reviews project plans for compliance with applicable requirements of this Manual and the MS4 Permit.**

The project applicant must provide sufficient documentation to demonstrate that applicable requirements of the BMP Design Manual and the MS4 Permit will be met.

For Standard Projects, this typically means using forms and/or a Standard Project SWQMP or other equivalent documents approved by the City Engineer to document that the following general requirements of the MS4 Permit are met, and showing applicable features onsite grading, building,

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<sup>2</sup> For public projects, a design stamped by the City Engineer, or engineer of record for the project is considered an approved design.

improvement and landscaping plans:

- BMP Requirements for All Development Projects, which includes general requirements, source control BMP requirements, and narrative (i.e. not numerically-sized) site design requirements (MS4 Permit Provision E.3.a).

For PDPs, this typically means preparing a PDP SWQMP to document that the following general requirements of the MS4 Permit are met, and showing applicable features onsite grading and landscaping plans:

- BMP Requirements for All Development Projects, which includes general requirements for siting of permanent, post-construction BMPs, source control BMP requirements, and narrative (i.e. not numerically-sized) site design requirements (MS4 Permit Provision E.3.a);
- Storm Water Pollutant Control BMP Requirements, for numerically sized onsite structural BMPs to control pollutants in storm water (MS4 Permit Provision E.3.c.(1)); and
- Hydromodification Management BMP Requirements, which includes protection of critical sediment yield areas and numerically sized onsite BMPs to manage hydromodification that may be caused by storm water runoff discharged from a project (MS4 Permit Provision E.3.c.(2)).

Detailed submittal requirements are provided in Chapter 8 of this Manual.

Documentation of the permanent, post-construction storm water BMPs at the discretion of the City Engineer must be provided with the first submittal of a project or another preliminary planning stage defined by the City. Storm water requirements will directly affect the layout of the project. Therefore, storm water requirements must be considered from the initial project planning phases, and will be reviewed with each submittal, beginning with the first submittal.

### 1.12 PDP Structural BMP Verification

*MS4 Permit Provision E.3.e.(1)*

**Structural BMPs must be verified by the City prior to project occupancy.**

Pursuant to MS4 Permit Provision E.3.e.(1), each Copermittee must require and confirm the following with respect to PDPs constructed within their jurisdiction:

- (a) Each Copermittee must require and confirm that appropriate easements and ownerships are properly recorded in public records and the information is conveyed to all appropriate parties when there is a change in project or site ownership.
- (b) Each Copermittee must require and confirm that prior to occupancy and/or intended use of any portion of the PDP, each structural BMP is inspected to verify that it has been constructed and is operating in compliance with all of its specifications, plans, permits, ordinances, and the requirements of [the MS4 Permit].

**For PDPs, this means that after structural BMPs have been constructed, the City Engineer may request the project owner provide a certification that the site improvements for the project have been constructed in conformance with the approved storm water management documents and drawings.**

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The City Engineer may require inspection of the structural BMPs at each significant construction stage and at completion. Following construction, the City may require an addendum to the SWQMP and As-Builts to address any changes to the structural BMPs that occurred during construction that were approved by the City Engineer. The City may also require a final update to the O&M Plan, and/or execution of a maintenance agreement that will be recorded for the property. A maintenance agreement that is recorded with the property title can then be transferred to future owners.

Certification of structural BMPs, updates to reports, and recordation of a maintenance agreement may occur concurrently with project closeout, but could be required sooner per City practices. In all cases, it is required prior to occupancy and/or intended use of the project. Specific procedures are provided in Chapter 8 of this Manual.

# Performance Standards and Concepts

**Projects must meet three separate performance standards, as applicable.**

The MS4 Permit establishes separate performance standards for (1) source control and site design practices, (2) storm water pollutant control BMPs, and (3) hydromodification management BMPs. Chapter 1 provided guidance for determining which performance standards apply to a given project. This chapter defines these performance standards based on the MS4 Permit, and presents concepts that provide the project applicant with technical background, explains why the performance standards are important, and gives a general description of how these performance standards can be met. Detailed procedures for meeting the performance standards are presented in Chapters 4, 5, and 6.

**Performance standards can be met through an integrated approach.**

While three separate performance standards are defined by this Manual, an overlapping set of design features can be used as part of demonstrating conformance to each standard. Further discussion of the relationship between performance standards is provided in Section 2.4.

## 2.1 Source Control and Site Design Requirements for All Development Projects

### 2.1.1 Performance Standards

#### *MS4 Permit Provision E.3.a*

This section defines performance standards for source control and site design practices that are applicable to all projects (regardless of project type or size; both Standard Projects and PDPs) when local permits are issued, including unpaved roads and flood management projects.

#### 2.1.1.1 General Requirements

All projects shall meet the following general requirements:

- (a) Onsite BMPs must be located so as to remove pollutants from runoff prior to its discharge to any receiving waters, and as close to the source as possible;

- (b) Structural BMPs must not be constructed within waters of the United States (U.S.); and
- (c) Onsite BMPs must be designed and implemented with measures to avoid the creation of nuisance or pollution associated with vectors (e.g. mosquitos, rodents, or flies).

### 2.1.1.2 Source Control Requirements

**Pollutant source control BMPs are features that must be implemented to address specific sources of pollutants.**

The following source control BMPs must be implemented at all development projects where applicable and technically feasible:

- (a) Prevention of illicit discharges into the MS4;
- (b) Storm drain system stenciling or signage;
- (c) Protection of outdoor material storage areas from rainfall, run-on, runoff, and wind dispersal;
- (d) Protection of materials stored in outdoor work areas from rainfall, run-on, runoff, and wind dispersal;
- (e) Protection of trash storage areas from rainfall, run-on, runoff, and wind dispersal; and
- (f) Use of any additional BMPs determined to be necessary by the City to minimize pollutant generation at each project.

Further guidance is provided in Section 2.1.2 and Chapter 4.

### 2.1.1.3 Site Design Requirements

**Site design requirements are qualitative requirements that apply to the layout and design of ALL development project sites (Standard Projects and PDPs).**

Site design performance standards define minimum requirements for how a site must incorporate LID BMPs, including the location of BMPs and the use of integrated site design practices. The following site design practices must be implemented at all development projects, where applicable and technically feasible:

- (a) Maintenance or restoration of natural storage reservoirs and drainage corridors (including topographic depressions, areas of permeable soils, natural swales, and ephemeral and intermittent streams)<sup>3</sup>;
- (b) Buffer zones for natural water bodies (where buffer zones are technically infeasible, require project applicant to include other buffers such as trees, access restrictions, etc.);
- (c) Conservation of natural areas within the project footprint including existing trees, other vegetation, and soils;
- (d) Construction of streets, sidewalks, or parking lot aisles to the minimum widths necessary, provided public safety is not compromised;

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<sup>3</sup> Development projects proposing to dredge or fill materials in waters of the U.S. must obtain a Clean Water Act Section 401 Water Quality Certification. Projects proposing to dredge or fill waters of the state must obtain waste discharge requirements.

## Chapter 2: Performance Standards and Concepts

- (e) Minimization of the impervious footprint of the project;
- (f) Minimization of soil compaction to landscaped areas;
- (g) Disconnection of impervious surfaces through distributed pervious areas;
- (h) Landscaped or other pervious areas designed and constructed to effectively receive and infiltrate, retain and/or treat runoff from impervious areas, prior to discharging to the MS4;
- (i) Small collection strategies located at, or as close as possible to, the source (i.e. the point where storm water initially meets the ground) to minimize the transport of runoff and pollutants to the MS4 and receiving waters;
- (j) Use of permeable materials for projects with low traffic areas and appropriate soil conditions;
- (k) Landscaping with native or drought tolerant species; and
- (l) Harvesting and using precipitation.

A key aspect of this performance standard is that these design features must be used where applicable and feasible. Responsible implementation of this performance standard depends on evaluating applicability and feasibility. Further guidance is provided in Section 2.1.2 and Chapter 4.

### **Additional site design requirements may apply to PDPs.**

Site design decisions may influence the ability of a PDP to meet applicable performance standards for pollutant control and hydromodification management BMPs (as defined in Section 2.2 and 2.3). For example, the layout of the site drainage and reservation of areas for BMPs relative to areas of infiltrative soils may influence the feasibility of capturing and managing storm water to meet storm water pollutant control and/or hydromodification management requirements. As such, the Copermittee City may require additional site design practices, beyond those listed above, to be considered and documented as part of demonstrating conformance to storm water pollutant control and hydromodification management requirements.

### **2.1.2 Concepts and References**

#### **Land development tends to increase the amount of pollutants in storm water runoff.**

Land development generally alters the natural conditions of the land by removing vegetative cover, compacting soil, and/or placement of concrete, asphalt, or other impervious surfaces. These impervious surfaces facilitate entrainment of urban pollutants in storm water runoff (such as pesticides, petroleum hydrocarbons, heavy metals, and pathogens) that are otherwise not generally found in high concentrations in the runoff from the natural environment. Pollutants that accumulate on impervious surfaces and actively landscaped pervious surfaces may contribute to elevated levels of pollutants in runoff relative to the natural condition.

#### **Land development also impacts site hydrology.**

Impervious surfaces greatly affect the natural hydrology of the land because they do not allow natural infiltration, retention, evapotranspiration and treatment of storm water runoff to take place. Instead, storm water runoff from impervious surfaces is typically and has traditionally been directed through pipes, curbs, gutters, and other hardscape into receiving waters, with little treatment, at significantly increased volumes and accelerated flow rates over what would occur naturally. The increased pollutant

## Chapter 2: Performance Standards and Concepts

loads, storm water volume, discharge rates and velocities, and discharge durations from the MS4 adversely impact stream habitat by causing accelerated, unnatural erosion and scouring within creek beds and banks. Compaction of pervious areas can have a similar effect to impervious surfaces on natural hydrology.

**Site Design LID involves attempting to maintain or restore the predevelopment hydrologic regime.**

LID is a comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds. LID designs seek to control storm water at the source, using small-scale integrated site design and management practices to mimic the natural hydrology of a site, retain storm water runoff by minimizing soil compaction and impervious surfaces, and disconnecting storm water runoff from conveyances to the storm drain system. Site Design LID BMPs may utilize interception, storage, evaporation, evapotranspiration, infiltration, and filtration processes to retain and/or treat pollutants in storm water before it is discharged from a site. Examples of Site Design LID BMPs include using permeable pavements, rain gardens, rain barrels, grassy swales, soil amendments, and native plants.

**Site design must be considered early in the design process.**

Site designs tend to be more flexible in the early stages of project planning than later on when plans become more detailed. Because of the importance of the location of BMPs, site design shall be considered as early as the planning/tentative design stage (check with the City requirements. Site design is critical for feasibility of storm water pollutant control BMPs (Section 2.2) as well as coarse sediment supply considerations associated with hydromodification management (introduced in Section 2.3).

**Source control and site design (LID) requirements help avoid impacts by controlling pollutant sources and changes in hydrology.**

Source control and site design practices prescribed by the MS4 Permit are the minimum management practices, control techniques and system, design and engineering methods to be included in the planning procedures to reduce the discharge of pollutants from development projects, regardless of size or purpose of the development. In contrast to storm water pollutant control BMPs and hydromodification control BMPs which are intended to mitigate impacts, source control and site design BMPs are intended to avoid or minimize these impacts by managing site hydrology, providing treatment features integrated within the site, and reducing or preventing the introduction of pollutants from specific sources. Implementation of site design BMPs will result in reduction in storm water runoff generated by the site. Methods to estimate effective runoff coefficients and the storm water runoff produced by the site after site design BMPs are implemented are presented in Appendix B.2. This methodology is applicable for PDPs that are required to estimate runoff produced from the site with site design BMPs implemented so that they can appropriately size storm water pollutant control BMPs and hydromodification control BMPs.

**The location of BMPs matters.**

The site design BMPs listed in the performance standard include practices that either prevent runoff from occurring or manage runoff as close to the source as possible. This helps create a more hydrologically effective site and reduces the requirements that pollutant control and hydromodification control BMPs must meet, where required. Additionally, because sites may have

spatially-variable conditions, the locations reserved for structural BMPs within the site can influence whether these BMPs can feasibly retain, treat, and/or detain storm water to comply with structural pollutant control and hydromodification control requirements, where applicable. Finally, the performance standard specifies that onsite BMPs must remove pollutants from runoff prior to discharge to any receiving waters or the MS4, be located/constructed as close to the pollutant generating source as possible and must not be constructed within waters of the U.S.

### **The selection of BMPs also matters.**

The lists of source control and site design BMPs specified in the performance standard must be used “where applicable and feasible.” This is an important concept – BMPs should be selected to meet the R9-2013-0001 permit requirements and are feasible with consideration of site conditions and project type. By using BMPs that are applicable and feasible, the project can achieve benefits of these practices, while not incurring unnecessary expenses (associated with using practices that do not apply or would not be effective) or creating undesirable conditions (for example, infiltration-related issues, vector concerns including mosquito breeding, etc.).

Methods to select and design BMPs and demonstrate compliance with source control and site design requirements are presented in Chapter 4 of this Manual.

## **2.2 Storm Water Pollutant Control Requirements for PDPs**

### **2.2.1 Storm Water Pollutant Control Performance Standard**

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#### *MS4 Permit Provision E.3.c.(1)*

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Storm Water Pollutant Control BMPs for PDPs shall meet the following performance standards:

- (a) Each PDP shall implement BMPs that are designed to retain (i.e. intercept, store, infiltrate, evaporate, and evapotranspire) onsite the pollutants contained in the volume of storm water runoff produced from a 24-hour, 85th percentile storm event (Design Capture Volume (DCV)). The 24-hour, 85th percentile storm event shall be based on Figure B.1-1 in Appendix B or an approved site-specific rainfall analysis.
  - (i) If it is not technically feasible to implement retention BMPs for the full DCV onsite for a PDP, then the PDP shall utilize biofiltration BMPs for the remaining volume not reliably retained. Biofiltration BMPs must be designed as described in Appendix F to have an appropriate hydraulic loading rate to maximize storm water retention and pollutant removal, as well as to prevent erosion, scour, and channeling within the BMP, and must be sized to:
    - [a]. Treat 1.5 times the DCV not reliably retained onsite, OR
    - [b]. Treat the DCV not reliably retained onsite with a flow-thru design that has a total volume, including pore spaces and pre-filter detention volume, sized to hold at least 0.75 times the portion of the DCV not reliably retained onsite.
  - (ii) If biofiltration BMPs are not technically feasible, then the PDP shall utilize flow-thru treatment control BMPs (selected and designed per Appendix B.6) to treat runoff

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leaving the site, AND participate in alternative compliance to mitigate for the pollutants from the DCV not reliably retained onsite pursuant to Section 2.2.1.(b). Flow-thru treatment control BMPs must be sized and designed to:

- [a]. Remove pollutants from storm water to the MEP (defined by the MS4 Permit) by following the guidance in Appendix B.6; and
  - [b]. Filter or treat either: 1) the maximum flow rate of runoff produced from a rainfall intensity of 0.2 inch of rainfall per hour, for each hour of a storm event, or 2) the maximum flow rate of runoff produced by the 85th percentile hourly rainfall intensity (for each hour of a storm event), as determined from the local historical rainfall record, multiplied by a factor of two (both methods may be adjusted for the portion of the DCV retained onsite as described in Appendix B.6) and
  - [c]. Meet the flow-thru treatment control BMP treatment performance standard described in Appendix B.6.
- (b) A PDP may be allowed to participate in an alternative compliance program in lieu of fully complying with the performance standards for storm water pollutant control BMPs onsite if an alternative compliance program is available in the jurisdiction the project is located, see Section 1.8. When an alternative compliance program is utilized:
- (i) The PDP must mitigate for the portion of the DCV not reliably retained onsite and
  - (ii) Flow-thru treatment control BMPs must be implemented to treat the portion of the DCV that is not reliably retained onsite. Flow-thru treatment control BMPs must be selected and sized in accordance with Appendix B.6.
  - (iii) A PDP may be allowed to propose an alternative compliance project not identified in the WMAA of the WQIP if the requirements in Section 1.8 are met at the discretion of the City Engineer.

Demonstrations of feasibility findings and calculations to justify BMP selection and design shall be provided by the project applicant in the SWQMP or jurisdiction's equivalent document(s) to the satisfaction of the City Engineer. Methodology to demonstrate compliance with the performance standards, described above, applicable to storm water pollutant control BMPs for PDPs is detailed in Chapter 5.

### 2.2.2 Concepts and References

**Retention BMPs are the most effective type of BMPs to reduce pollutants discharging to MS4s when they are sited and designed appropriately.**

Retention of the required DCV will achieve 100 percent pollutant removal efficiency (i.e. prevent pollutants from discharging directly to the MS4). Thus, retention of as much storm water onsite as technically feasible is the most effective way to reduce pollutants in storm water discharges to, and consequently from the MS4, and remove pollutants in storm water discharges from a site to the MEP.

However, in order to accrue these benefits, retention BMPs must be technically feasible and suitable for the project. Retention BMPs that fail prematurely, under-perform, or result in unintended consequences as a result of improper selection or siting may achieve performance that is inferior to

other BMP types while posing other issues for property owners and Copermittees. Therefore, this Manual provides criteria for evaluating feasibility and provides options for other types of BMPs to be used if retention is not technically feasible.

**Biofiltration BMPs can be sized to achieve approximately the same pollutant removal as retention BMPs.**

In the case, where the entire DCV cannot be retained onsite because it is not technically feasible PDPs are required to use biofiltration BMPs with specific sizing and design criteria listed in Appendix B.5 and Appendix F. These sizing and design criteria are intended to provide a level of long-term pollutant removal that is reasonably equivalent to retention of the DCV.

**Flow-thru treatment BMPs are required to treat the pollutant loads in the DCV not retained or biofiltered onsite to the MEP.**

If the pollutant loads from the full DCV cannot feasibly be retained or biofiltered onsite, then PDPs are required to implement flow-thru treatment control BMPs to remove the pollutants to the MEP for the portion of the DCV that could not be feasibly retained or biofiltered. Flow-thru treatment BMPs may only be implemented to address onsite storm water pollutant control requirements if coupled with an offsite alternative compliance project that mitigates for the portion of the pollutant load in the DCV not retained or biofiltered onsite.

**Offsite Alternative Compliance Program may be available.**

The MS4 Permit allows the City to grant PDPs permission to utilize an alternative compliance program for meeting the pollutant control performance standard. Onsite and offsite mitigation is required when a PDP is allowed to use an alternative compliance program. The existence and specific parameters of an alternative compliance program will be specific to each jurisdiction if one is available (Refer to Section 1.8).

Methods to design and demonstrate compliance with storm water pollutant control BMPs are presented in Chapter 5 of this Manual. Definitions and concepts that should be understood when sizing storm water pollutant control BMPs to be in compliance with the performance standards are explained below:

### **2.2.2.1 Best Management Practices**

To minimize confusion, this Manual considers all references to “facilities,” “features,” or “controls” to be incorporated into development projects as BMPs.

### **2.2.2.2 DCV**

The MS4 Permit requires pollutants be addressed for the runoff from the 24-hour 85th percentile storm event (“DCV”) as the design standard to which PDPs must comply.

The 85th percentile, 24-hour storm event is the event that has a precipitation total greater than or equal to 85 percent of all storm events over a given period of record in a specific area or location. For example, to determine what the 85th percentile storm event is in a specific location, the following steps would be followed:

- Obtain representative precipitation data, preferably no less than 30-years period if possible.

- Divide the recorded precipitation into 24-hour precipitation totals.
- Filter out events with no measurable precipitation (less than 0.01 inches of precipitation).
- Of the remaining events, calculate the 85th percentile value (i.e. 15 percent of the storms would be greater than the number determined to be the 85th percentile, 24-hour storm).

The 85th percentile, 24-hour storm event depth is then used in hydrologic calculations to calculate the DCV for sizing storm water pollutant control BMPs. An exhibit showing the 85th percentile, 24-hour storm depth across San Diego County and the methodology used to develop this exhibit is included in Appendix B.1.3. Guidance to estimate the DCV is presented in Appendix B.1.

### 2.2.2.3 Implementation of Storm Water Pollutant Control BMPs

The MS4 Permit requires that the PDP applicants proposing to meet the performance standards onsite implement storm water pollutant control BMPs in the order listed below. That is, the PDP applicant first needs to implement **all** feasible onsite retention BMPs needed to meet the storm water pollutant control BMP requirements prior to installing onsite biofiltration BMPs, and then onsite biofiltration BMPs prior to installing onsite flow-thru treatment control BMPs.

PDPs may be allowed to participate in an alternative compliance program. Refer to Section 1.8 for additional guidance.

**Retention BMPs:** Structural measures that provide retention (i.e. intercept, store, infiltrate, evaporate and evapotranspire) of storm water as part of pollutant control strategy. Examples include infiltration BMPs and cisterns, bioretention BMP's and biofiltration with partial retention BMP's.

**Biofiltration BMPs:** Structural measures that provide biofiltration of storm water as part of the pollutant control strategy. Example includes Biofiltration BMP's.

**Flow-thru treatment control BMPs:** Structural measures that provide flow-thru treatment as part of the pollutant control strategy. Examples include vegetated swales and media filters.

### 2.2.2.4 Technical Feasibility

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*MS4 Permit Requirement E.3.c.(5)*

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**Analysis of technical feasibility is necessary to select the appropriate BMPs for a site.**

PDPs are required to implement pollutant control BMPs in the order of priority in Section 2.2.2.3 based on determinations of technical feasibility. In order to assist the project applicant in selecting BMPs, this Manual includes a defined process for evaluating feasibility. Conceptually, the feasibility criteria contained in this Manual are intended to:

- Promote reliable and effective long-term operations of BMPs by providing a BMP selection process that eliminates the use of BMPs that are not suitable for site conditions, project type or other factors;
- Minimize significant risks to property, human health, and/or environmental degradation (e.g. geotechnical stability, groundwater quality) as a result of selection of BMPs that are undesirable for a given site; and

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- Describe circumstances under which regional and watershed-based strategies, as part of an approved WMAA **and** an alternative compliance program developed by the jurisdiction where the project resides, may be selected.

Specific guidance related to geotechnical investigation guidelines for feasibility of storm water infiltration and groundwater quality and water balance factors is provided in Appendices B and D, respectively.

### 2.2.2.5 Biofiltration BMPs

The MS4 Permit requires Biofiltration BMPs be designed to have an appropriate hydraulic loading rate to maximize storm water retention and pollutant removal, as well as to prevent erosion, scour, and channeling within the BMP. Appendix F of this Manual has guidance for hydraulic loading rates and other biofiltration design criteria to meet these required goals. Appendix F also has a checklist that will need to be completed by the project SWQMP preparer during plan submittal. Guidance for sizing Biofiltration BMPs is included in Chapter 5 and Appendices B.5 and F.

### 2.2.2.6 Flow-thru Treatment Control BMPs (for use with Alternative Compliance)

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#### *MS4 Permit Requirement E.3.d.2-3*

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The MS4 Permit requires that the flow-thru treatment control BMP selected by the PDP applicant be ranked with high or medium pollutant removal efficiency for the most significant pollutant of concern. Steps to select the flow-thru treatment control BMP include:

- Step 1: Identify the pollutant(s) of concern by considering the following at a minimum a) Receiving water quality; b) Highest priority water quality conditions identified in the Watershed Management Areas Water Quality Improvement Plan; c) Land use type of the project and pollutants associated with that land use type and d) Pollutants expected to be present onsite
- Step 2: Identify the most significant pollutant of concern. A project could have multiple most significant pollutants of concerns and shall include the highest priority water quality condition identified in the watershed WQIP and pollutants expected to be presented onsite/from land use.
- Step 3: Effectiveness of the flow-thru treatment control BMP for the identified most significant pollutant of concern

Methodology for sizing flow-thru treatment control BMPs and the resources required to identify the pollutant(s) of concern and effectiveness of flow-thru treatment control BMPs are included in Chapter 5 and Appendix B.6.

## 2.3 Hydromodification Management Requirements for PDPs

### 2.3.1 Hydromodification Management Performance Standards

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#### *MS4 Permit Provision E.3.c.(2)*

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This section defines performance standards for hydromodification management, including flow control of post-project storm water runoff and protection of critical sediment yield areas, that shall be met by all PDPs unless exempt from hydromodification management requirements per Section 1.6 of this Manual. Each PDP shall implement onsite BMPs to manage hydromodification that may be caused by storm water runoff discharged from a project as follows:

- (a) Post-project runoff conditions (flow rates and durations) must not exceed pre-development runoff conditions by more than 10 percent (for the range of flows that result in increased potential for erosion, or degraded instream habitat downstream of PDPs).
  - (i) In evaluating the range of flows that results in increased potential for erosion of natural (non-hardened) channels, the lower boundary must correspond with the critical channel flow that produces the critical shear stress that initiates channel bed movement or that erodes the toe of channel banks.
  - (ii) The Copermittees may use monitoring results collected pursuant to Provision D.1.a.(2) [of the MS4 Permit] to re-define the range of flows resulting in increased potential for erosion, or degraded instream habitat conditions, as warranted by the data.
- (b) Each PDP must avoid critical sediment yield areas known to the Copermittee or identified by the optional WMAA pursuant to Provision B.3.b.(4) [of the MS4 Permit], or implement measures that allow critical coarse sediment to be discharged to receiving waters, such that there is no net impact to the receiving water.
- (c) A PDP may be allowed to utilize alternative compliance under Provision E.3.c.(3) [of the MS4 Permit] in lieu of complying with the performance requirements of Provision E.3.c.(2)(a). The PDP must mitigate for the post-project runoff conditions not fully managed onsite if Provision E.3.c.(3) is utilized.

Hydromodification management requirements apply to both new development and redevelopment PDPs, except those that are exempt based on discharging to downstream channels or water bodies that are not subject to erosion, as defined in either the MS4 Permit (Provision E.3.c.(2).(d)) or the WMAA for the watershed in which the project resides. Exemptions from hydromodification management requirements are described in Section 1.6 of this Manual.

For undisturbed sites, the existing condition shall be taken to be the pre-development runoff condition. For redevelopment PDPs or sites that have been previously disturbed, pre-development runoff conditions shall be approximated by applying the parameters of a pervious area rather than an impervious area to the existing site, using the existing onsite grade and assuming the infiltration characteristics of the underlying soil.

For San Diego area watersheds, the range of flows that result in increased potential for erosion or degraded instream habitat downstream of PDPs and the critical channel flow shall be based on the "Final Hydromodification Management Plan Prepared for County of San Diego, California March 2011" (herein, "March 2011 Final HMP"). For PDPs subject to hydromodification management requirements, the range of flows to control depends on the erosion susceptibility of the receiving stream and shall be:

- 0.1Q<sub>2</sub> to Q<sub>10</sub> for streams with high susceptibility to erosion (this is the default range of flows to control when a stream susceptibility study has not been prepared);
- 0.3Q<sub>2</sub> to Q<sub>10</sub> for streams with medium susceptibility to erosion and which has a stream

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- susceptibility study prepared and approved by the City Engineer; or
- 0.5Q2 to Q10 for streams with low susceptibility to erosion and which has a stream susceptibility study prepared and approved by the City Engineer.

Tools for assessing stream susceptibility to erosion have been developed by Southern California Coastal Water Research Project (SCCWRP). The tools are presented in the March 2011 Final HMP and also available through SCCWRP's website. If a PDP intends to select the 0.3Q2 or 0.5Q2 threshold, the SCCWRP screening tool must be completed and submitted with other project documentation.

The March 2011 Final HMP does not provide criteria for protection of critical sediment yield areas. The standard as presented in the MS4 Permit and shown above is: avoid critical sediment yield areas or implement measures that allow critical coarse sediment to be discharged to receiving waters, such that there is no net impact to the receiving water.

Methods to demonstrate compliance with hydromodification management requirements, including protection of critical coarse sediment yield areas and flow control for post-project runoff from the project site, are presented in Chapter 6 of this Manual. Hydromodification management concepts, theories, and references are described below.

### **2.3.2 Hydromodification Management Concepts and References**

#### **2.3.2.1 What is Hydromodification?**

The MS4 Permit defines hydromodification as the change in the natural watershed hydrologic processes and runoff characteristics (i.e. interception, infiltration, overland flow, and groundwater flow) caused by urbanization or other land use changes that result in increased stream flows and sediment transport. In addition, alteration of stream and river channels, such as stream channelization, concrete lining, installation of dams and water impoundments, and excessive streambank and shoreline erosion are also considered hydromodification, due to their disruption of natural watershed hydrologic processes.

Typical impacts to natural watershed hydrologic processes and runoff characteristics resulting from new development and redevelopment include:

- Decreased interception and infiltration of rainfall at the project site due to removal of native vegetation, compaction of pervious area soils, and the addition of impervious area;
- Increased connectivity and efficiency of drainage systems serving the project site, including concentration of project-site runoff to discrete outfalls;
- Increased runoff volume, flow rate, and duration from the project site due to addition of impervious area, removal of native vegetation, and compaction of pervious area soils;
- Reduction of critical coarse sediment supply from the project site to downstream natural systems (e.g. streams) due to stabilization of developed areas, stabilization of streams, and addition of basins that trap sediment (either by design as a permanent desilting basin or storm water quality treatment basin that settles sediment, or incidentally as a peak flow management basin); and
- Interruption of critical coarse sediment transport in streams due to stream crossings such as

culverts or ford crossings that incidentally slow stream flow and allow coarse sediment to settle upstream of the crossing.

Any of these changes can result in increased potential for erosion, or degraded instream habitat downstream of PDPs. The changes to delivery of runoff to streams typically modify the timing, frequency, magnitude, and duration of both storm flows and baseflow. Changes to delivery of coarse sediment and transport of coarse sediment result in increased transport capacity and the potential for adverse channel erosion.

Note that this Manual is intended for design of permanent, post-construction BMPs, therefore this discussion is focused on the permanent, post-construction effects of development. The process of construction also has impacts, such as a temporary increase in sediment load produced from surfaces exposed by vegetation removal and grading, which is often deposited within stream channels, initiating aggradation and/or channel widening. Temporary construction BMPs to mitigate the sediment delivery are outside the purview of this Manual.

Channel erosion resulting from PDP storm water discharge can begin at the point where runoff is discharged to natural systems, regardless of the distance from the PDP to the natural system. It could also begin some distance downstream from the actual discharge point if the stream condition is stable at the discharge point but more susceptible to erosion at a downstream location. The March 2011 HMP defines a domain of analysis for evaluation of stream susceptibility to erosion from PDP storm water discharge.

### **2.3.2.2 How Can Hydromodification be Controlled?**

In the big picture, watershed-scale solutions are necessary to address hydromodification. Factors causing hydromodification are watershed-wide, and all of San Diego's major watersheds include some degree of legacy hydromodification effects from existing development and existing channel modifications, which cannot be reversed by onsite measures implemented at new development and redevelopment projects alone. As recommended by SCCWRP in Technical Report 667, "Hydromodification Assessment and Management in California," dated April 2012, "management strategies should be tailored to meet the objectives, desired future conditions, and constraints of the specific channel reach being addressed," and "potential objectives for specific stream reaches may include: protect, restore, or manage as a new channel form."

Development of such management strategies and objectives for San Diego watersheds will evolve over successive MS4 Permit cycles. The current MS4 Permit requires the Copermitees to prepare WQIPs for all Watershed Management Areas within the San Diego Region. The WQIPs may include WMAAs which would assess watershed-wide hydrologic processes. These documents may be used to develop watershed-specific requirements for structural BMP implementation, including watershed-scale hydromodification management strategies.

This Manual addresses development and redevelopment project-level hydromodification management measures currently required for PDPs by the MS4 Permit. Until optional watershed-specific performance recommendations or alternative compliance programs are developed, hydromodification management strategies for new development and redevelopment projects will consist of onsite measures designed to meet the performance requirements of Provisions E.3.c.(2).(a) and (b) of the MS4 Permit shown in Section 2.3.1. While development project-level measures alone will not reverse hydromodification of major streams, onsite measures are a necessary component of a watershed-wide

solution, particularly while watershed-wide management strategies are still being developed. Also, development project-level measures are necessary to protect a project's specific storm water discharge points, which are typically discharging in smaller tributaries not studied in detail in larger watershed studies. Typical measures for development projects include:

- Protecting critical sediment yield areas by designing the project to avoid them or implementing measures that would allow coarse sediment to be discharged to receiving waters, such that the natural sediment supply is unaffected by the project;
- Using site design/LID measures to minimize impervious areas onsite and reduce post-project runoff; and
- Providing structural BMPs designed using continuous simulation hydrologic modeling to provide flow control of post-project runoff (e.g. BMPs that store post-project runoff and infiltrate, evaporate, harvest and use, or discharge excess runoff at a rate below the critical flow rate).

Structural BMPs for hydromodification management provide volume to control a range of flows from a fraction of Q2 to Q10. The volume determined for hydromodification management is different from the DCV for pollutant control. Methodology to demonstrate compliance with hydromodification management requirements are presented in Chapter 6 of this BMP Design Manual. See Section 2.4 regarding the relationship between pollutant control and hydromodification management performance standards.

### **2.3.3 Avoidance and Bypass of Critical Coarse Sediment**

For many Priority Development Project sites, additional BMPs may be needed to preserve the supply of critical coarse sediment to water bodies. Any PDP that is not fully exempt from hydromodification management requirements must either comply with critical coarse sediment requirements or demonstrate that they do not apply. Documentation of applicability and compliance options is required in SWQMP forms and corresponding attachments. See Section 6.2 and Appendix H for additional description of these requirements.

## **2.4 Relationship between Performance Standards**

**An integrated approach can provide significant cost savings by utilizing design features that meet multiple standards.**

Site design/LID, storm water pollutant control, and hydromodification management are separate requirements to be addressed in development project design. Each has its own purpose and each has separate performance standards that must be met. However, effective project planning involves understanding the ways in which these standards are related and how single suites of design features can meet more than one standard.

**Site design features (aka LID) can be effective at reducing the runoff to downstream BMPs.**

Site design BMPs serve the purpose of minimizing impervious areas and therefore reducing post-project runoff, and reducing the potential transport of pollutants offsite and reducing the potential for downstream erosion caused by increased flow rates and durations. By reducing post-project runoff through, site design BMPs, the amount of runoff that must be managed for pollutant control and

hydromodification flow control can be reduced.

**Single structural BMPs, particularly retention BMPs, can meet or contribute to both pollutant control and hydromodification management objectives.**

The objective of structural BMPs for pollutant control is to reduce offsite transport of pollutants, and the objective of structural BMPs for hydromodification management is to control flow rates and durations for control of downstream erosion. In either case, the most effective structural BMP to meet the objective are BMPs that are based on retention of storm water runoff where feasible. Both storm water pollutant control and flow control for hydromodification management can be achieved within the same structural BMP(s). However, demonstrating that the separate performance requirements for pollutant control and hydromodification management are met must be shown separately.

**The design process should start with an assessment of the feasibility to retain or partially retain the DCV for pollutant control, then determine what kind of BMPs will be used for pollutant control and hydromodification management.**

A typical design process for a single structural BMP to meet two separate performance standards at once involves (1) initiating the structural BMP design based on the performance standard that is expected to require the largest volume of storm water to be retained, (2) checking whether the initial design incidentally meets the second performance standard, and (3) adjusting the design as necessary until it can be demonstrated that both performance standards are met.

## Development Project Planning and Design

Compliance with source control/site design, pollutant control, and hydromodification management BMPs, as applicable, requires coordination of site, landscape, and project storm water plans. It also involves provisions for O&M of structural BMPs. In order to effectively comply with applicable requirements, a stepwise approach is recommended. This chapter outlines a stepwise, systematic approach (Figure 3-1) to preparing a comprehensive storm water management design for Standard Projects and PDPs.

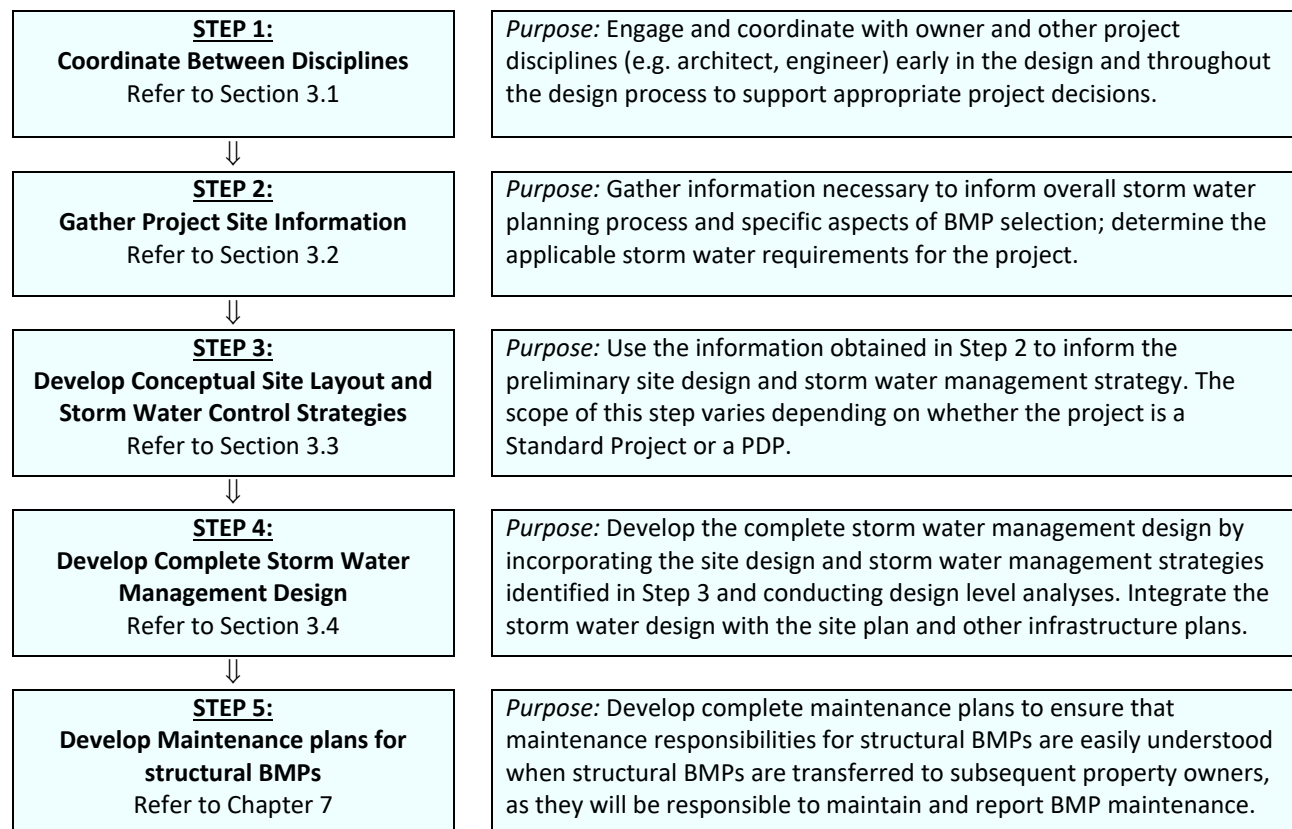


FIGURE 3-1. Approach for Developing a Comprehensive Storm Water Management Design

## Chapter 3: Development Project Planning and Design

A stepwise approach is not mandatory, and adaptation of this stepwise approach to better fit with unique project features is encouraged. However, taking a stepwise, systematic approach of some sort for planning and design has a number of advantages. First, it helps ensure that applicable requirements and design goals are identified early in the process. Secondly, it helps ensure that key data about the site, watershed, and project are collected at the appropriate time in the project development process, and the analyses are suited to the decisions that need to be made at each phase. Third, taking a systematic approach helps identify opportunities for retention of storm water that may not be identified in a less systematic process. Finally, a systematic approach helps ensure that constraints and unintended consequences are considered and used to inform BMP selection and design, and related project decisions.

City of Oceanside specific special requirements are listed in Section 3.5 and requirements for phased projects are in Section 3.6.

### 3.1 Coordination Between Disciplines

Storm water management design requires close coordination between multiple disciplines, as storm water management design will affect the site layout and should therefore be coordinated among the project team as necessary from the start. The following list describes entities/disciplines that are frequently involved with storm water management design and potential roles that these entities/disciplines may plan.

#### *Owner:*

- Engage the appropriate disciplines needed for the project and facilitate exchange of information between disciplines.
- Identify who will be responsible for long-term O&M of storm water management features, and initiate maintenance agreements when applicable.
- Ensure that whole lifecycle costs are considered in the selection and design of storm water management features and a source of funding is provided for long-term maintenance.
- Identify the party responsible to inspect structural BMPs at each significant construction stage and at completion in order to provide certification of structural BMPs following construction.

#### *Planner:*

- Communicate overall project planning criteria to the team, such as planned development density, parking requirements, project-specific planning conditions, conditions of approval from prior entitlement actions (e.g. CEQA, 401 certifications), etc. and locations of open space and conservation easements and environmentally sensitive areas that are protected from disturbance), etc.
- Consider location of storm water facilities early in the conceptual site layout process.
- Assist in developing the site plan.

#### *Architect:*

- Participate in siting and design (architectural elements) of storm water BMPs.

### *Civil Engineer:*

- Determine storm water requirements applicable to the site (e.g. Standard Project vs. PDP).
- Obtain site-specific information (e.g. watershed information, infiltration rates) and develop viable storm water management options that meet project requirements.
- Reconcile storm water management requirements with other site requirements (e.g. fire access, Americans with Disabilities Act accessibility, parking, open space).
- Develop site layout and site design including preliminary and final design documents or plans.
- Select and design BMPs; conduct and document associated analyses; prepare BMP design sheets, details, and specifications.
- Prepare project SWQMP submittals.

### *Landscape Architect and/or Horticulturist/Agronomist:*

- Select appropriate plants for vegetated storm water features, BMPs and prepare planting plans.
- Develop specifications for planting, vegetation establishment, and maintenance.
- Assist in developing irrigation plans/rates to minimize water application and non-storm water runoff from the project site.

### *Geotechnical Engineer*

- Assist in preliminary infiltration feasibility screening of the site to help inform project layout and initial BMP selection, including characterizing soil, groundwater, geotechnical hazards, utilities, and any other factors, as applicable for the site.
- Conduct detailed analyses at proposed infiltration BMP locations to confirm or revise feasibility findings and provide design infiltration rates.
- Provide recommendations for infiltration testing that must be conducted during the construction phase, if needed to confirm pre-construction infiltration estimates.

### *Geomorphologist and/or Geologist*

- Provide specialized services, as needed, related to sediment source assessment and/or channel stability or sensitivity assessment.

## 3.2 Gathering Project Site Information

In order to make decisions related to selection and design of storm water management BMPs, it is necessary to gather relevant project site information. This could include physical site information, proposed uses of the site, level of storm water management requirements (i.e. is it a Standard Project or a PDP?), proposed storm water discharge locations, potential/anticipated storm water pollutants based on the proposed uses of the site, receiving water sensitivity to pollutants and susceptibility to erosion, hydromodification management requirements, and other site requirements and constraints.

The amount and type of information that should be collected depends on the project type (i.e. is it a Standard Project, a PDP with all requirements or with only pollutant control requirements?). Refer to Figure 1-1 in Chapter 1 to identify the project type.

Information should only be gathered to the extent necessary to inform the storm water management

design. In some cases, it is not necessary to conduct site specific analyses to precisely characterize conditions. For example, if depth to groundwater is known to be approximately 100 feet based on regional surveys, it is not necessary to also conduct site specific assessment of depth to groundwater to determine whether it is actually 90 feet or 110 feet on the project site. The difference between these values would not influence the storm water management design. In other cases, some information will not be applicable. For example, on an existing development site, there may be no natural hydrologic features remaining, therefore these features do not need to be characterized. The lack of natural hydrologic features can be simply noted without further effort required.

Checklists (in Appendix I) and submittal templates (in Appendix A) are provided to facilitate gathering information about the project site for BMP selection and design. As part of planning for site investigation, it is helpful to review the subsequent steps (Section 3.3 and 3.4) to gain familiarity with how the site information will be used in making decisions about site layout and storm water BMP selection and design. This can help prioritize the data that are collected.

### **3.3 Developing Conceptual Site Layout and Storm Water Control Strategies**

Once preliminary site information has been obtained, the site can be assessed for storm water management opportunities and constraints that will inform the overall site layout. Considering the project site data discussed above, it is essential to identify potential locations for storm water management features at a conceptual level during the site planning phase. Storm water management requirements must be considered as a key factor in laying out the overall site. Preliminary design of permanent storm water BMPs is partially influenced by whether the project is a Standard Project or a PDP. Table 3-1 presents the applicability of different subsections in this Manual based on project type and must be used to determine which requirements apply to a given project.

**TABLE 3-1. Applicability of Section 3.3 Sub-sections for Different Project Types**

Project Type	Section 3.3.1	Section 3.3.2	Section 3.3.3	Section 3.3.4
Standard Project	☑	NA	NA	NA
PDP with only Pollutant Control Requirements	☑	NA	☑	☑
PDP with Pollutant and Hydromodification Management Requirements	☑	☑	☑	☑

#### **3.3.1 Preliminary Design Steps for All Development Projects**

All projects must incorporate source control and site design BMPs. The following systematic approach outlines these site planning considerations for all development projects:

- 1 Review Chapter 4 of this Manual to become familiar with the menu of source control and site design practices that are required.

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- 2 Review the preliminary site information gathered in Section 3.2, specifically related to:
  - a. Natural hydrologic features that can be preserved and/or protected;
  - b. Soil information;
  - c. General drainage patterns (i.e. general topography, points of connection to the storm drain or receiving water);
  - d. Pollutant sources that require source controls; and
  - e. Information gathered and summarized in the Site Information Checklist for Standard Projects (Appendix I-3A).
- 3 Create opportunities for source control and site design BMPs by developing an overall conceptual site layout that allocates space for site design BMPs and promotes drainage patterns that are effective for hydrologic control and pollutant source control. For example:
  - a. Locate pervious areas down gradient from buildings where possible to allow for dispersion.
  - b. Identify parts of the project that could be drained via overland vegetated conveyance rather than piped connections.
  - c. Develop traffic circulation patterns that are compatible with minimizing street widths.
- 4 As part of Section 3.4, refine the selection and placement of source control and site design BMPs and incorporate them into project plans. Compliance with site design and source control requirements shall be documented as described in Chapter 4.

### 3.3.2 Evaluation of Critical Coarse Sediment Yield Areas

For PDPs that are required to meet hydromodification management requirements, evaluate whether critical coarse sediment yield areas exist within or upstream of the project site. Detailed methods for the management of critical coarse sediment yield areas are presented in Chapter 6 of this Manual, additional guidance on identification and protection of critical coarse sediment yield areas is provided in Appendix H. Conceptual layout of the project site must consider the following items:

- a. Have onsite critical coarse sediment areas been identified within the project's property boundary? Does the proposed project impact these onsite critical coarse sediment areas? What measures are necessary to avoid impacts to these areas? What measures are necessary to allow soil loss from these areas to bypass through the site?
- b. Have upstream critical coarse sediment areas been identified upstream of the project's property boundary? Does the proposed project impact upstream critical coarse sediment areas? What measures are necessary to allow soil loss from these areas to bypass through the site?
- c. If onsite and/or upstream sources of critical coarse sediment are not avoided, what measures are necessary to demonstrate no net impact to the receiving water?
- d. If impacts to onsite critical coarse sediment areas are not avoided or mitigated for, will a site-specific analysis be performed to refine mapping for onsite and/or upstream critical coarse sediment areas? Can onsite critical coarse sediment yield areas be avoided?

### 3.3.3 Drainage Management Areas

Drainage management areas (DMAs) provide an important framework for feasibility screening, BMP prioritization, and storm water management system configuration. BMP selection, sizing, and feasibility determinations must be made at the DMA level; therefore, delineation of DMAs is highly recommended at the conceptual site planning phase and is mandatory for completing the project design and meeting submittal requirements. This section provides guidance on delineating DMAs that is intended to be used as part of Section 3.3 and 3.4.

DMAs are defined based on the proposed drainage patterns of the site and the BMPs to which they drain. During the early phases of the project, DMAs shall be delineated based onsite drainage patterns and possible BMP locations identified in the site planning process. DMAs should not overlap and should be similar with respect to BMP opportunities and feasibility constraints. More than one DMA can drain to the same BMP. However, because the BMP sizes are determined by the runoff from the DMA, a single DMA may not drain to more than one BMP. See Figure 3-2.

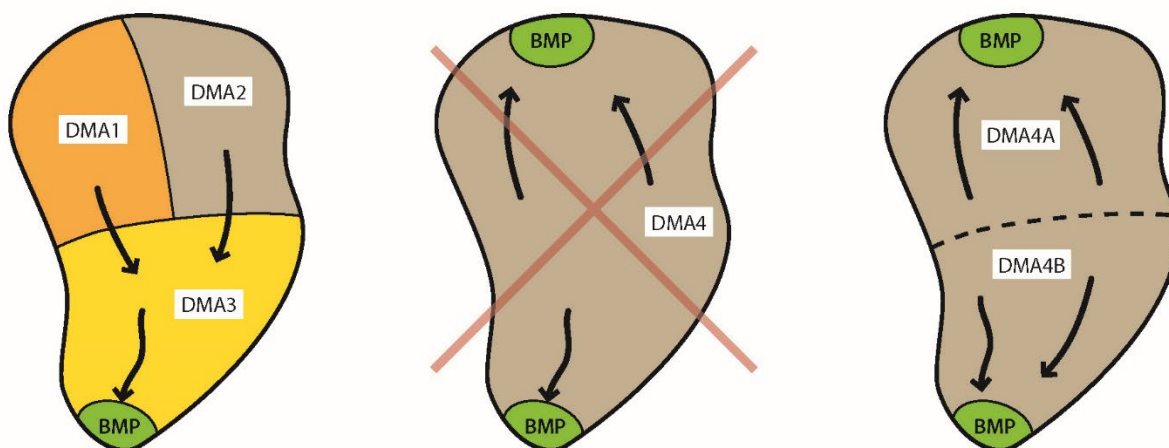
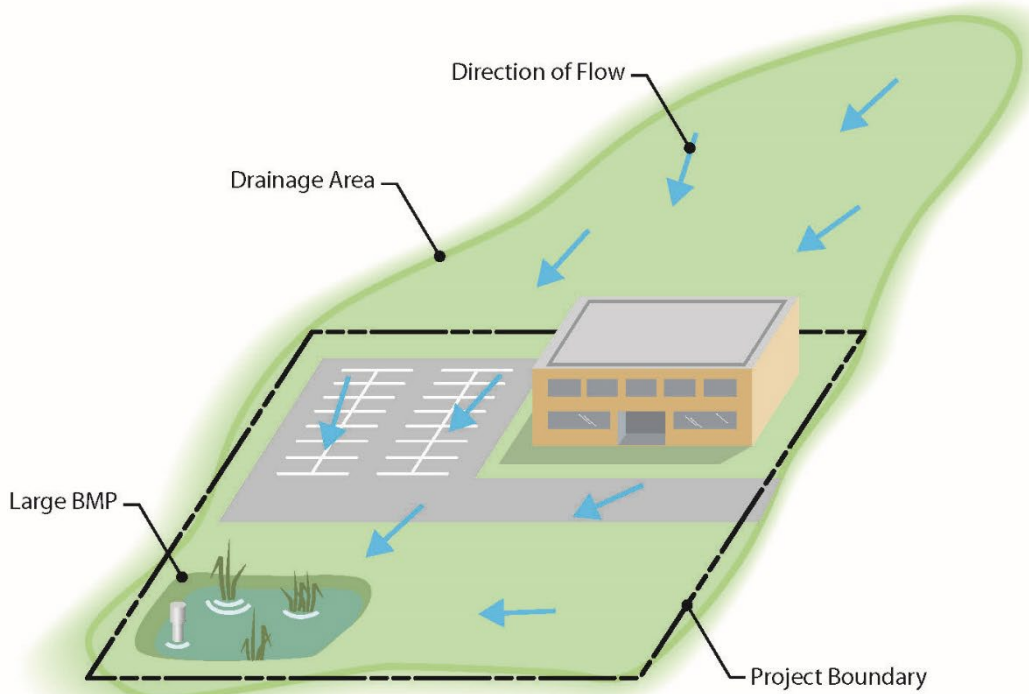


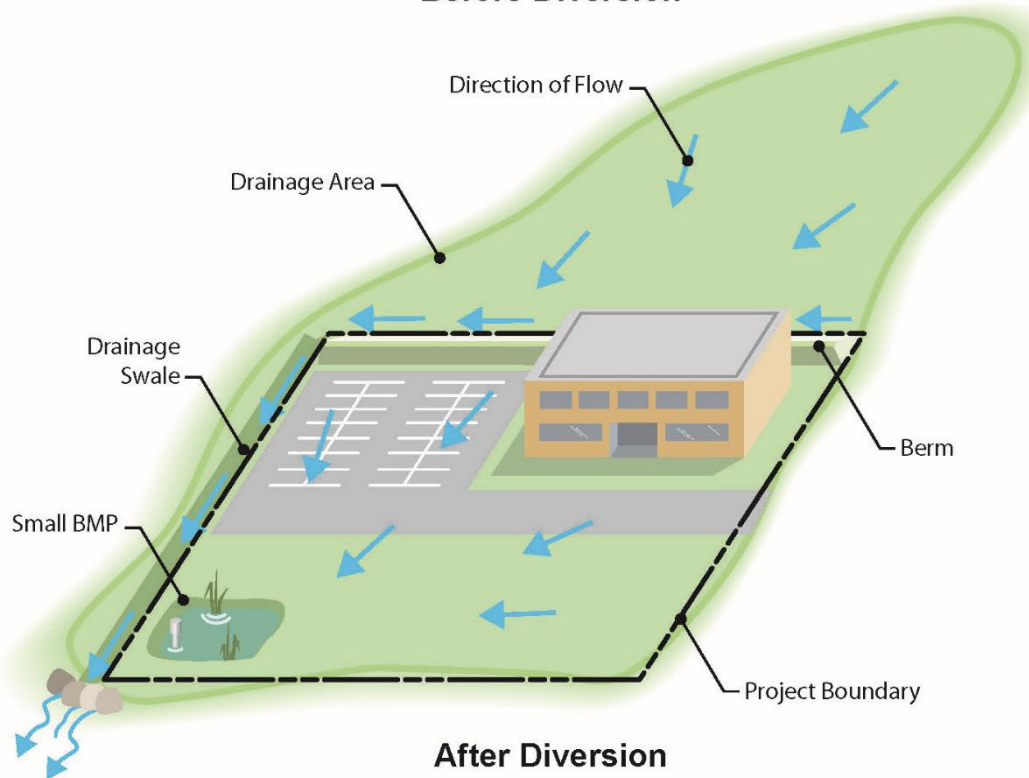
FIGURE 3-2. DMA Delineation

In some cases, in early planning phases, it may be appropriate to generalize the proposed treatment plan by simply assigning a certain BMP type to an entire planning area (e.g. Parking lot X will be treated with bioretention) and calculating the total sizing requirement without identifying the specific BMP locations at that time. This planning area would be later subdivided for design-level calculations. Section 5.2 provides additional guidance on DMA delineation. A runoff factor (similar to a “C” factor used in the rational method) should be used to estimate the runoff draining to the BMP. Appendix B.1 provides guidance in estimating the runoff factor for the drainage area draining to a BMP.

BMPs must be sized to treat the DCV from the total area draining to the BMP, including any offsite or onsite areas that comingle with project runoff and drains to the BMP. To minimize offsite flows treated by project BMPs, consider diverting upgradient flows subject to local drainage and flood control regulation. An example is shown in Figure 3-3.



**Before Diversion**



**After Diversion**

**FIGURE 3-3. Tributary Area for BMP Sizing**

### 3.3.4 Developing Conceptual Storm Water Control Strategies

This step applies to PDPs only. The goal of this step is to develop conceptual storm water control strategies that are compatible with the site conditions, including siting and preliminary selection of structural BMPs. At this phase of project planning, it is typically still possible for storm water considerations to influence the site layout to better accommodate storm water design requirements. The end product of this step should be a general, but concrete understanding of the storm water management parameters for each DMA, the compatibility of this approach with the site design, and preliminary estimates of BMP selection. For simpler sites, this step could be abbreviated in favor of skipping forward to design-level analyses in Section 3.4. However, for larger and/or more complex sites, this section can provide considerable value and help allow evaluation of storm water management requirements on common ground with other site planning considerations.

The following systematic approach is recommended:

1. Review the preliminary site information gathered in Section 3.2, specifically related to information gathered and summarized in the Site Information Checklist for PDPs (Appendix I-3B).
2. Identify self-mitigating, de minimis areas, and/or potential self-retaining DMAs that can be isolated from the remainder of the site (See Section 5.2).
3. Estimate DCV for each remaining DMAs (See Appendix B.1).
4. Determine if there is a potential opportunity for harvest and use of storm water from the project site. See Section 5.4.1 for harvest and use feasibility screening, which is based on water demand at the project site. For most sites, there is limited opportunity; therefore, evaluating this factor early can help simplify later decisions.
5. Estimate potential runoff reduction and the DCV that could be achieved with site design BMPs (See Appendix B.1).
6. Based on the remaining runoff after accounting for steps 2 to 5, estimate BMP space requirements. Identify applicable structural BMP requirements (i.e. storm water pollutant control versus hydromodification management) and conduct approximate sizing calculations to determine the overall amount of storage volume and/or footprint area required for BMPs. Use worksheets presented in Appendix B to estimate sizing requirements for different types of BMPs.
7. Conduct preliminary screening of infiltration feasibility conditions to identify areas that are more or less conducive to infiltration. Factors to consider include:
  - a. Soil types (determined from available geotechnical testing data, soil maps, site observations, and/or other data sources)
  - b. Approximate infiltration rates at various points on the site, obtained via approximate methods (e.g. simple pit test), if practicable
  - c. Groundwater elevations
  - d. Proposed depths of fill
  - e. New or existing utilities that will remain with development
  - f. Soil or groundwater contamination issues within the site or in the vicinity of the site

### Chapter 3: Development Project Planning and Design

- g. Slopes and other potential geotechnical hazards that are unavoidable as part of site development
- h. Safety and accessibility considerations

This assessment is not intended to be final or account for all potential factors. Rather, it is intended to help in identifying site opportunities and constraints as they relate to site planning. After potential BMP locations are established, a more detailed feasibility analysis is necessary (see Section 3.4). Additionally, Appendix C and D provide methods for geotechnical and groundwater assessment applicable for screening at the planning level and design-level requirements. The City may allow alternate assessment methods with appropriate documentation at the discretion of the City Engineer.

8. Identify tentative BMP locations based on preliminary feasibility screening, natural opportunities for BMPs (e.g. low areas of the site, areas near storm drain or stream connections), and other BMP sites that can potentially be created through effective site design (e.g. oddly configured or otherwise unbuildable parcels, easements and landscape amenities including open space and buffers which can double as locations for bioretention or biofiltration facilities).
9. Consider how storm water management BMPs will be accessed for inspection and maintenance and provide necessary site planning allowances (access roads, inspection openings, setbacks, etc.) and coordinate with the City's public works departments for additional design requirements or allowed BMPs if required for BMPs in public easements or are part of a community facilities district maintained by the City. In addition consider the use of the site. Some BMPs may not be suitable for maintenance by individual home owners.
10. Document site planning and opportunity assessment activities as a record of the decisions that led to the development of the final storm water management plan. The SWQMP primarily shows the complete design rather than the preliminary steps in the process. However, to comply with the requirements of this Manual, the applicant is required to describe how storm water management objectives have been considered as early as possible in the site planning process and how opportunities to incorporate BMPs have been identified.

## 3.4 Developing Complete Storm Water Management Design

The complete storm water management design consists of all of the elements describing the BMPs to be implemented, as well as integration of the BMPs with the site design and other infrastructure. The storm water management design shall be developed by taking into consideration the opportunities and/or constraints identified during the site planning phase of the project and then performing the final design level analysis. The scope of this step varies depending on whether the project is a Standard Project, PDP with only pollutant control BMP requirements or PDP with pollutant control and hydromodification management requirements. The following systematic approach is recommended to develop a final site layout and storm water management design. Table 3-2 presents the applicability of different subsections based on project type and must be used to determine which requirements apply to a given project.

**TABLE 3-2. Applicability of Section 3.4 Sub-sections for Different Project Types**

Project Type	Section 3.4.1	Section 3.4.2	Section 3.4.3
Standard Project	☑	NA	NA
PDP with only Pollutant Control Requirements	☑	☑	NA
PDP with Pollutant Control and Hydromodification Management Requirements	☑	NA	☑

### 3.4.1 Steps for All Development Projects

Standard Projects need to only satisfy the source control and site design requirements of Chapter 4 of this Manual, and then proceed to Chapter 8 of this Manual to determine submittal requirements.

1. Select, identify and detail specific source control BMPs. See Section 4.2.
2. Select, identify and detail specific site design BMPs. See Section 4.3.
3. Document that all applicable source control and site design BMPs have been used. See Chapter 8.

### 3.4.2 Steps for PDPs with only Pollutant Control Requirements

The steps below primarily consist of refinements to the conceptual steps completed as part of Section 3.3, accompanied by design-level detail and calculations. More detailed instructions for selection and design of storm water pollutant treatment BMPs are provided in Chapter 5.

1. Select locations for storm water pollutant control BMPs, and delineate and characterize DMAs using information gathered during the site planning phase.
2. Determine retention requirements per Appendix B.2.
3. Based on the results of steps 2 select the BMP category that is most appropriate for the site.
4. Calculate required BMP sizes and footprints. See Appendix B (sizing methods) and Appendix E (design criteria).
5. Evaluate if the required BMP footprints will fit within the site considering the site constraints; if not, then document infeasibility and move to the next step.
6. If using biofiltration BMPs, document conformance with the criteria for biofiltration BMPs found in Appendix F, including Appendix F.1, as applicable.
7. If needed, implement flow-thru treatment control BMPs (for use with Alternative Compliance) for the remaining DCV. See Section 5.5.4 and Appendix B.6 for additional guidance.
8. If flow-thru treatment control BMPs (for use with Alternative Compliance) were implemented refer to Section 1.8.

## Chapter 3: Development Project Planning and Design

9. Prepare SWQMP documenting site planning and opportunity assessment activities, final site layout and storm water management design. See Chapter 8.
10. Determine and document O&M requirements. See Chapters 7 and 8.

### **3.4.3 Steps for Projects with Pollutant Control and Hydromodification Management Requirements**

The steps below primarily consist of refinements to the conceptual steps completed as part of Section 3.3, accompanied by design-level detail and calculations. More detailed instruction for selection and design of storm water pollutant treatment and hydromodification control BMPs are provided in Chapter 5 and 6, respectively.

1. If critical coarse sediment yield areas were determined to exist within and/or upstream of the project's property boundary (Section 3.3.2) incorporate avoidance and bypass measures, or demonstrate no net impact to the receiving water when applicable (Section 6.2).
2. Select locations for storm water pollutant control and hydromodification management BMPs and delineate and characterize DMAs using information gathered during the site planning phase.
3. Determine retention requirements per Appendix B.2
4. Based on the results of steps 3, select the BMP category for pollutant treatment BMPs that is most appropriate for the site.
5. Follow the design approach described in Chapter 3 for integrating storm water pollutant treatment and hydromodification control. The same location(s) can serve both functions (e.g. a biofiltration area that provides both pollutant control and flow control), or separate pollutant control and flow control locations may be identified (e.g. several dispersed retention areas for pollutant control, with overflow directed to a single location of additional storage for flow control).
6. Calculate BMP sizing requirements for pollutant control and flow control. See Appendix B (sizing methods) and Appendix E (design criteria).
  - a. When the same BMP will serve both functions, Section 6.3.6 of this Manual provides recommendations for assessing the controlling design factor and initiating the design process.
7. Evaluate if the required BMP footprints will fit within the site considering the site constraints:
  - a. If they fit within the site, design BMPs to meet applicable sizing and design criteria. Document sizing and design separately for pollutant control and hydromodification management even when the same BMP is serving both functions.
  - b. If they do not fit the site then document infeasibility and move to the next step.
8. Implement flow-thru treatment control BMPs (for use with Alternative Compliance) for the remaining DCV. See Section 5.5.4 and Appendix B.6 for additional guidance.
9. If flow-thru treatment control BMPs (for use with Alternative Compliance) were implemented refer to Section 1.8.
10. Prepare a SWQMP documenting site planning and opportunity assessment activities, final site layout, storm water pollutant control design and hydromodification management design. See

Chapter 8.

11. Determine and document O&M requirements. See Chapters 7 and 8.

## 3.5 Project Planning and Design Requirements Specific to the City of Oceanside

**Offsite Improvements.** The term "offsite improvements" refers to improvements constructed offsite from the project area such as access roads, sidewalks, utility lines, and sewers that are within the scope of the project as a whole. Offsite improvements can either be physically directly connected from the project or in a separate location away from the project, typically dictated as a project condition to provide extension of utility lines such as water and sewer or as a measure to mitigate environmental impacts such as the provision of a trail, intersection improvements, or the widening of an existing road. Therefore offsite improvements constructed to support a project must be considered part of the whole of the action of the project (see Section 1.3). The new offsite impervious areas must be included as part of the collective impervious area of the project even when not contiguous with the project if they are part of the whole of the action of the project (See Section 1.4.1). Offsite improvements that generate pollutants and excess runoff must be addressed with storm water management features, which, at a minimum, include the Alternative PDP Requirements specified in Section 1.4.3.

**Interim Improvements** are those which are built to serve the project on an interim basis until they are later replaced with permanent or ultimate improvements. Interim improvements that generate pollutants and excess runoff must, like permanent improvements, be addressed with storm water management features for the life of the interim improvement. Temporary access roads during construction are not considered interim improvements if they are part of the construction site, and are removed at the termination of construction of the project. Generally, these roads would only be in place on an interim basis of less than one year.

## 3.6 Phased Projects

Phased projects add a layer of complexity to the application process because the master drainage plan often does not include sufficient detail regarding the sequence and details of construction. If the overall project was determined to be a PDP, applicants that phase work must still satisfy PDP and other applicable stormwater requirements. Applicants cannot phase work to bypass PDP requirements. To facilitate clarity, certain information will be required for each step in the development process of private projects.

**Pre-Application.** During the Pre-Application process, a handout or other materials describing the requirements to be met for stormwater compliance will be provided or made available to the applicant. These materials outline that the applicant should be aware that depending on construction timing not all phases may end up meeting requirements of the same MS4 Permit. In case a Pre-Application meeting does not occur, the materials will be made available to the applicant along with any other correspondence.

**Discretionary Phase.** During the discretionary phase, applicants are required to submit the Master PDP SWQMP, the Master HMP Study; the Master Preliminary Grading Plan & Plot Plan, and the Master Preliminary Landscape Plans. These Master Plans must outline the project phasing and demonstrate that required structural BMPs will be in place prior to the occupancy or intended use of

the applicable parcels or lots.

**Final Engineering Stage.** During the Final Engineering stage, with each phased Grading/Improvement Plan submittal (Unit I, etc.), all Discretionary phase Master Plans and Studies (PDP SWQMP, HMP) that originally identified planned structural BMPs should be provided for reference as an attachment. An outline of completed and future construction phases must also be provided. The applicant must demonstrate either (a) that the project phase currently in Final Engineering (e.g., Unit II) is consistent with assumptions (imperviousness, identified features, etc.)

made for that project phase when the Master Plans and Studies were prepared, or (b) that master planned or regional BMPs to serve the phased project area will be constructed to meet applicable performance standards for the project phase. If new impervious areas or other changes to project features will not be mitigated by the storm water features proposed in the Master Plans and Studies, additional storm water features will be required.

**Record Plan Stage.** At Record Plan stage and during the closeout of each phased portion, one or more Structural BMP Verification Acceptance Packages that include all BMPs identified in the Final Engineering Stage above will be required. The Verification Acceptance Package(s) must identify which BMPs for the phase have previously been constructed and certified, which are being submitted for verification sign-off and, which have yet to be constructed. Phased projects typically require a conceptual or master PDP SWQMP followed by more detailed submittals.

### 3.7 BMPs in the Public Right-of-Way

At its discretion, the City may allow Structural BMPs and/or Site Design BMPs to be constructed in the Public Right-of-way. Permissions to place BMPs in the right-of-way should not be assumed. Applicants are encouraged to check with staff as early as the Pre-Application Meeting or early Discretionary Stage.

# Source Control and Site Design Requirements for All Development Projects

This chapter presents the source control and site design requirements to be met by all projects, inclusive of Standard Projects and PDPs. Checklists I.4 for source control and I.5 for site design included in Appendix I can be used by both Standard Projects and PDPs to document conformance with the requirements.

## 4.1 General Requirements (GR)

**4.1.1: Onsite BMPs must be located so as to remove pollutants from runoff prior to its discharge to any receiving waters, and as close to the source as possible.**

BMP location affects the ability of the BMP to retain, and/or treat, the pollutants from the contributing drainage area. BMPs must remove pollutants from runoff and should be placed as close to the pollutant source as possible.

**How to comply:** Projects shall comply with this requirement by implementing source control (Section 4.2) and site design BMPs (Section 4.3) that are applicable to their project and site conditions.

**4.1.2: Structural BMPs must not be constructed within the Waters of the U.S.**

Construction, operation, and maintenance of a structural BMP in a water body can negatively impact the physical, chemical, and biological integrity, as well as the beneficial uses, of the water body. However, alternative compliance opportunities involving restoration of areas within Waters of the U.S. may be identified by the City.

**How to comply:** Projects shall comply with this requirement by preparing project plans that illustrate the location of all storm water BMPs on project plans and describing or depicting the location of receiving waters.

**4.1.3: Onsite BMPs must be designed and implemented with measures to avoid the creation of nuisances or pollutions associated with vectors (e.g. mosquitos, rodents, or flies).**

According to the California Department of Health, structural BMPs that retain standing water for

## Chapter 4: Source Control and Site Design Requirements for All Development Projects

over 96 hours are particularly concerning for facilitating mosquito breeding. Certain site design features that hold standing water may similarly produce mosquitoes.

**How to comply:** Projects shall comply with this requirement by incorporating design, construction, and maintenance principles to drain retained water within 96 hours and minimize standing water. Design calculations shall be provided to demonstrate the potential for standing water ponding at surface level and accessible to mosquitoes has been addressed. For water retained in biofiltration facilities that are not accessible to mosquitoes these criteria are not applicable (i.e. water ponding in the gravel layer, water retained in the amended soil, etc.).

### 4.2 Source Control (SC) BMP Requirements

Source control BMPs avoid and reduce pollutants in storm water runoff. Everyday activities, such as recycling, trash disposal and irrigation, generate pollutants that have the potential to drain to the storm water conveyance system. Source control BMPs are defined as an activity that reduces the potential for storm water runoff to come into contact with pollutants. An activity could include an administrative action, design of a structural facility, usage of alternative materials, and operation, maintenance and inspection of an area. Where applicable and feasible, all development projects are required to implement source control BMPs. Source control BMPs (SC-1 through SC-6) are discussed below.

**How to comply:** Projects shall comply with this requirement by implementing source control BMPs listed in this section that are applicable to their project. Applicability shall be determined through consideration of the development project's features and anticipated pollutant sources. Appendix E provides guidance for identifying source control BMPs applicable to a project. The "Source Control BMP Checklist for All Development Projects" located in Appendix I-4 shall be used to document compliance with source control BMP requirements.

#### SC-1: Prevent illicit discharges into the MS4

An illicit discharge is any discharge to the MS4 that is not composed entirely of storm water except discharges pursuant to a National Pollutant Discharge Elimination System permit and discharges resulting from firefighting activities. Projects must effectively eliminate discharges of non-storm water into the MS4. This may involve a suite of housekeeping BMPs which could include effective irrigation, dispersion of non-storm water discharges into landscaping for infiltration, and controlling wash water from vehicle washing.

#### SC-2: Identify the storm drain system using stenciling or signage

Storm drain signs and stencils are visible source controls typically placed adjacent to the inlets. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Stamping or placards shall be provided for all storm water conveyance system inlets and catch basins within the project area. In addition to storm drain placards, projects are encouraged to post signs and prohibitive language (with graphical icons) which prohibit illegal dumping at trailheads, parks, building entrances and public access points along channels and creeks within the project area.

#### SC-3: Protect *outdoor material storage areas* from rainfall, run-on, runoff, and wind dispersal

Materials with the potential to pollute storm water runoff shall be stored in a manner that prevents contact with rainfall and storm water runoff. All development projects shall incorporate the following structural or pollutant control BMPs for outdoor material storage areas, as applicable and feasible:

## Chapter 4: Source Control and Site Design Requirements for All Development Projects

- The storage areas shall be paved and sufficiently impervious to contain leaks and spills, where necessary.
- The storage area shall be sloped towards a sump or another equivalent measure that is effective to contain spills.
- Runoff from downspouts/roofs shall be directed away from storage areas.
- The storage area shall have a roof or awning that extends beyond the storage area to minimize collection of storm water within the secondary containment area. A manufactured storage shed may be used for small containers.
- Use other methods approved by the City.

### **SC-4: Protect materials stored in outdoor work areas from rainfall, run-on, runoff, and wind dispersal**

Outdoor work areas have an elevated potential for pollutant loading and spills. All development projects shall include the following structural or pollutant control BMPs for any outdoor work areas with potential for pollutant generation, as applicable and feasible:

- Create an impermeable surface such as concrete or asphalt, or a prefabricated metal drip pan, depending on the size needed to protect the materials.
- Cover the area with a roof or other acceptable cover.
- Berm the perimeter of the area to prevent water from adjacent areas from flowing on to the surface of the work area.
- Directly connect runoff to sanitary sewer or other specialized containment system(s), as needed and where feasible. This allows the more highly concentrated pollutants from these areas to receive special treatment that removes particular constituents. Approval for this connection must be obtained from the appropriate sanitary sewer agency.
- Locate the work area away from storm drains or catch basins.
- Use other methods approved by the City.

### **SC-5: Protect trash storage areas from rainfall, run-on, runoff, and wind dispersal**

Storm water 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. All development projects shall include the following structural or pollutant control BMPs, as applicable:

- Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This can include berming or grading the waste handling area to prevent run-on of storm water.
- Ensure trash container areas are screened or walled to prevent offsite transport of trash.
- Provide roofs, awnings, or attached lids on all trash containers to minimize direct precipitation and prevent rainfall from entering containers.

## Chapter 4: Source Control and Site Design Requirements for All Development Projects

- Locate storm drains away from immediate vicinity of the trash storage area and vice versa.
- Post signs on all dumpsters informing users that hazardous materials are not to be disposed.
- Use other methods approved by the City.

### **SC-6: Use any additional BMPs determined to be necessary by the City to minimize pollutant generation at each project site**

At its discretion, the City may determine that additional on-site controls are necessary to minimize pollutant generation. These determinations will be made on a project-specific basis. Appendix E provides guidance on permanent controls that are applicable at a project site based on potential sources of runoff pollutants at the project site. Applicants must implement all applicable and feasible source control BMPs listed in Appendix E.

## **4.3 Site Design (SD) BMP Requirements**

Site design BMPs (also referred to as LID BMPs) are intended to reduce the rate and volume of storm water runoff and associated pollutant loads. Site design BMPs include practices that reduce the rate and/or volume of storm water runoff by minimizing surface soil compaction, reducing impervious surfaces, and/or providing flow pathways that are “disconnected” from the storm drain system, such as by routing flow over pervious surfaces. Site design BMPs may incorporate interception, storage, evaporation, evapotranspiration, infiltration, and/or filtration processes to retain and/or treat pollutants in storm water before it is discharged from a site.

**Per MS4 Permit Provision E.3.a.(3), site design BMPs shall be applied to all development projects as appropriate and feasible for the project site and project conditions.**

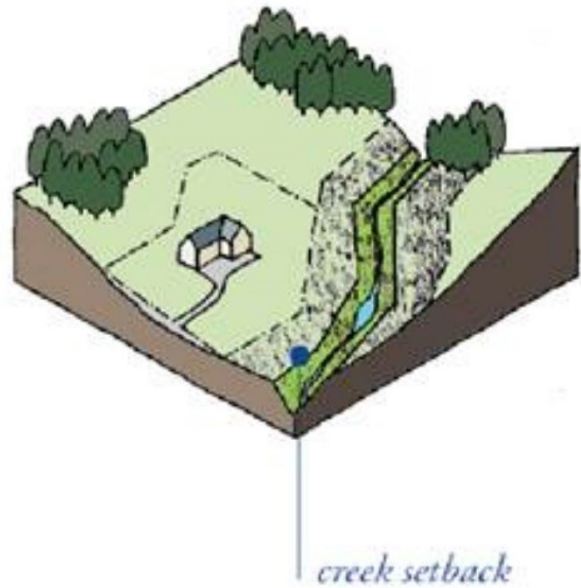
How to comply: Projects shall comply with this requirement by using all of the site design BMPs listed in this section that are applicable and practicable to their project type and site conditions. Applicability of a given site design BMP shall be determined based on project type, soil conditions, presence of natural features (e.g. streams), and presence of site features (e.g. parking areas). Explanation shall be provided by the applicant when a certain site design BMP is considered to be not applicable or not practicable/feasible. Site plans shall show site design BMPs and provide adequate details necessary for effective implementation of site design BMPs. The "Site Design BMP Checklist for All Development Projects" located in Appendix I-5 shall be used to document compliance with site design BMP requirements.

### **SD-1: Maintain natural drainage pathways and hydrologic features**

- Maintain or restore natural storage reservoirs and drainage corridors (including topographic depressions, areas of permeable soils, natural swales, and ephemeral and intermittent streams)
- Buffer zones for natural water bodies (where buffer zones are technically infeasible, require project applicant to include other buffers such as trees, access restrictions, etc.)

## Chapter 4: Source Control and Site Design Requirements for All Development Projects

During the site assessment, natural drainages must be identified along with their connection to creeks and/or streams, if any. Natural drainages offer a benefit to storm water management as the soils and habitat already function as a natural filtering/infiltrating swale. When determining the development footprint of the site, altering natural drainages should be avoided. By providing a development envelope set back from natural drainages, the drainage can retain some water quality benefits to the watershed. In some situations, site constraints, regulations, economics, or other factors may not allow avoidance of drainages and sensitive areas. Projects proposing to dredge or fill materials in Waters of the U.S. must obtain Clean Water Act, Section 401 Water Quality Certification. Projects proposing to dredge or fill waters of the State must obtain waste discharge requirements. Both the 401 Certification and the Waste Discharge Requirements are administered by the San Diego Water Board. The project applicant shall consult the City for other specific requirements.



Source: County of San Diego LID Handbook

Projects can incorporate SD-1 into a project by implementing the following planning and design phase techniques as applicable and practicable:

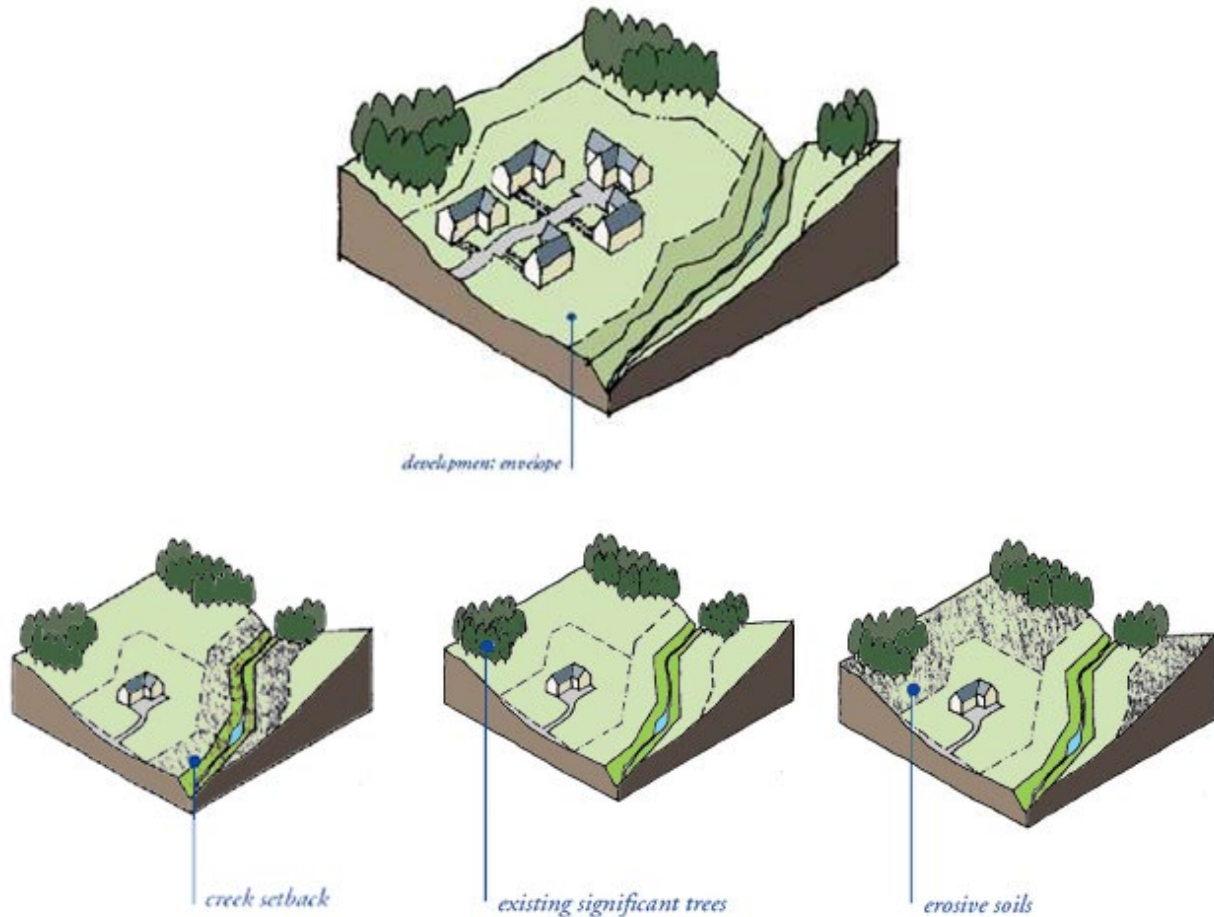
- Evaluate surface drainage and topography in considering selection of Site Design BMPs that will be most beneficial for a given project site. Where feasible, maintain topographic depressions for infiltration.
- Optimize the site layout and reduce the need for grading. Where possible, conform the site layout along natural landforms, avoid grading and disturbance of vegetation and soils, and replicate the site's natural drainage patterns. Integrating existing drainage patterns into the site plan will help maintain the site's predevelopment hydrologic function.
- Preserve existing drainage paths and depressions, where feasible and applicable, to help maintain the time of concentration and infiltration rates of runoff, and decrease peak flow.
- Structural BMPs cannot be located in buffer zones if a State and/or Federal resource agency (e.g. SDRWQCB, California Department of Fish and Wildlife; U.S. Army Corps of Engineers, etc.) prohibits maintenance or activity in the area.

### SD-2: Conserve natural areas, soils and vegetation

- Conserve natural areas within the project footprint including existing trees, other vegetation, and soils

To enhance a site's ability to support source control and reduce runoff, the conservation and restoration of natural areas must be considered in the site design process. By conserving or restoring the natural drainage features, natural processes are able to intercept storm water, thereby reducing the amount of runoff.

## Chapter 4: Source Control and Site Design Requirements for All Development Projects



Source: County of San Diego LID Handbook

The upper soil layers of a natural area contain organic material, soil biota, vegetation, and a configuration favorable for storing and slowly conveying storm water and establishing or restoring vegetation to stabilize the site after construction. The canopy of existing native trees and shrubs also provide a water conservation benefit by intercepting rain water before it hits the ground. By minimizing disturbances in these areas, natural processes are able to intercept storm water, providing a water quality benefit. By keeping the development concentrated to the least environmentally sensitive areas of the site and set back from natural areas, storm water runoff is reduced, water quality can be improved, environmental impacts can be decreased, and many of the site's most attractive native landscape features can be retained. In some situations, site constraints, regulations, economics, and/or other factors may not allow avoidance of all sensitive areas on a project site. Project applicant shall consult the City for jurisdictional specific requirements for mitigation of removal of sensitive areas.

## Chapter 4: Source Control and Site Design Requirements for All Development Projects

Projects can incorporate SD-2 by implementing the following planning and design phase techniques as applicable and practicable:

- Identify areas most suitable for development and areas that should be left undisturbed. Additionally, reduced disturbance can be accomplished by increasing building density and increasing height, if possible.
- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.
- Avoid areas with thick, undisturbed vegetation. Soils in these areas have a much higher capacity to store and infiltrate runoff than disturbed soils, and reestablishment of a mature vegetative community can take decades. Vegetative cover can also provide additional volume storage of rainfall by retaining water on the surfaces of leaves, branches, and trunks of trees during and after storm events.
- Preserve trees, especially native trees and shrubs, and identify locations for planting additional native or drought tolerant trees and large shrubs.
- In areas of disturbance, topsoil should be removed before construction and replaced after the project is completed. When handled carefully, such an approach limits the disturbance to native soils and reduces the need for additional (purchased) topsoil during later phases.
- Avoid sensitive areas, such as wetlands, biological open space areas, biological mitigation sites, streams, floodplains, or particular vegetation communities, such as coastal sage scrub and intact forest. Also, avoid areas that are habitat for sensitive plants and animals, particularly those, State or federally listed as endangered, threatened or rare. Development in these areas is often restricted by federal, state and local laws.

LEAST SENSITIVE



MOST SENSITIVE

1. AREAS DEVOID OF VEGETATION, INCLUDING PREVIOUSLY GRADED AREAS AND AGRICULTURAL FIELDS
2. AREAS OF NON-NATIVE VEGETATION, DISTURBED HABITATS AND EUCALYPTUS WOODLANDS WHERE RECEIVING WATERS ARE NOT PRESENT
3. AREAS OF CHAMISE OR MIXED CHAPARRAL, AND NON-NATIVE GRASSLANDS.
4. AREAS CONTAINING COASTAL SCRUB COMMUNITIES
5. ALL OTHER UPLAND COMMUNITIES
6. OCCUPIED HABITAT OF SENSITIVE SPECIES AND ALL WETLANDS (AS BOTH ARE DEFINED BY THE LOCAL JURISDICTION)

### SD-3: Minimize impervious area

- Construct streets, sidewalks or parking lots aisles to the minimum widths necessary, provided public safety is not compromised
- Minimize the impervious footprint of the project

One of the principal causes of environmental impacts by development is the creation of impervious surfaces. Imperviousness links urban land development to degradation of aquatic ecosystems in two ways:

- First, the combination of paved surfaces and piped runoff efficiently collects urban pollutants and transports them, in suspended or dissolved form, to surface waters. These pollutants may originate as airborne dust, be washed from the atmosphere during rains, or may be generated by automobiles and outdoor work activities.

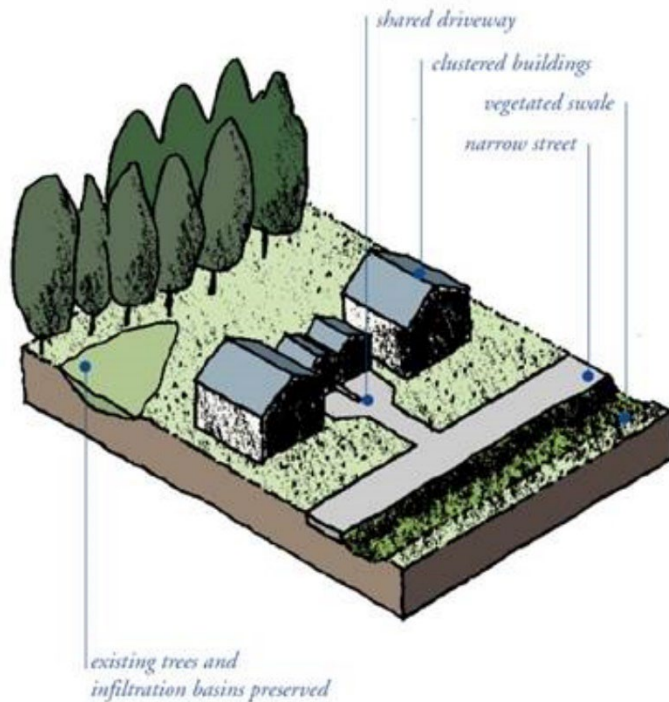
## Chapter 4: Source Control and Site Design Requirements for All Development Projects

- Second, increased peak flows and runoff durations typically cause erosion of stream banks and beds, transport of fine sediments, and disruption of aquatic habitat. Measures taken to control stream erosion, such as hardening banks with riprap or concrete, may permanently eliminate habitat.

Impervious cover can be minimized through identification of the smallest possible land area that can be practically impacted or disturbed during site development. Reducing impervious surfaces retains the permeability of the project site, allowing natural processes to filter and reduce sources of pollution.

Projects can incorporate SD-3 by implementing the following planning and design phase techniques as applicable and practicable:

- Decrease building footprint through (the design of compact and taller structures when allowed by local zoning and design standards and provided public safety is not compromised).
- Construct walkways, trails, patios, overflow parking lots, alleys and other low-traffic areas with permeable surfaces.
- Construct streets, sidewalks and parking lot aisles to the minimum widths necessary, provided that public safety and alternative transportation (e.g. pedestrians, bikes) are not compromised.
- Consider the implementation of shared parking lots and driveways where possible.
- Landscaped area in the center of a cul-de-sac can reduce impervious area depending on configuration. Design of a landscaped cul-de-sac must be coordinated with fire department personnel to accommodate turning radii and other operational needs.
- Design smaller parking lots with fewer stalls, smaller stalls, more efficient lanes.
- Design indoor or underground parking.
- Minimize the use of impervious surfaces in the landscape design.



Source: County of San Diego LID Handbook

### SD-4: Minimize soil compaction

- Minimize soil compaction in landscaped areas

The upper soil layers contain organic material, soil biota, and a configuration favorable for storing and slowly conveying storm water down gradient. By protecting native soils and vegetation in appropriate

## Chapter 4: Source Control and Site Design Requirements for All Development Projects

areas during the clearing and grading phase of development the site can retain some of its existing beneficial hydrologic function. Soil compaction resulting from the movement of heavy construction equipment can reduce soil infiltration rates. It is important to recognize that areas adjacent to and under building foundations, roads and manufactured slopes must be compacted with minimum soil density requirements in compliance with local building and grading ordinances.

Projects can incorporate SD-4 by implementing the following planning and design phase techniques as applicable and practicable:

- Avoid disturbance in planned green space and proposed landscaped areas where feasible. These areas that are planned for retaining their beneficial hydrological function should be protected during the grading/construction phase so that vehicles and construction equipment do not intrude and inadvertently compact the area.
- In areas planned for landscaping where compaction could not be avoided, re-till the soil surface to allow for better infiltration capacity. Soil amendments are recommended and may be necessary to increase permeability and organic content. Soil stability, density requirements, and other geotechnical considerations associated with soil compaction must be reviewed by a qualified landscape architect or licensed geotechnical, civil or other professional engineer.

### SD-5: Disperse impervious areas

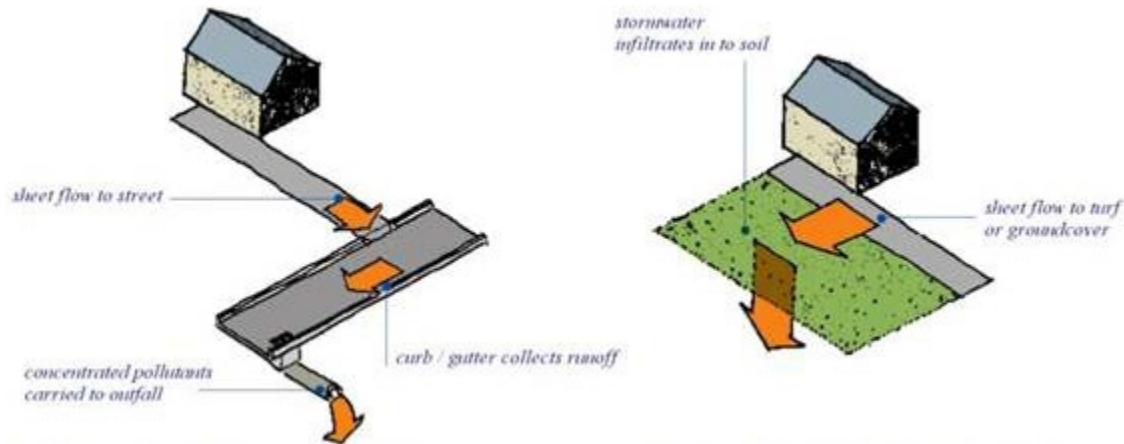
- Disconnect impervious surfaces through disturbed pervious areas
- Design and construct landscaped or other pervious areas to effectively receive and infiltrate, retain and/or treat runoff from impervious areas prior to discharging to the MS4

Impervious area dispersion (dispersion) refers to the practice of essentially disconnecting impervious areas from directly draining to the storm drain system by routing runoff from impervious areas such as rooftops, walkways, and driveways onto the surface of adjacent pervious areas. The intent is to slow runoff discharges, and reduce volumes while achieving incidental treatment. Volume reduction from dispersion is dependent on the infiltration characteristics of the pervious area and the amount of impervious area draining to the pervious area. Treatment is achieved through filtration, shallow sedimentation, sorption, infiltration, evapotranspiration, biochemical processes and plant uptake.

The effects of imperviousness can be mitigated by disconnecting impervious areas from the drainage system and by encouraging detention and retention of runoff near the point where it is generated. Detention and retention of runoff reduces peak flows and volumes and allows pollutants to settle out or adhere to soils before they can be transported downstream. Disconnection practices may be applied in almost any location, but impervious surfaces must discharge into a suitable receiving area for the practices to be effective. Information gathered during the site assessment will help determine appropriate receiving areas.

Project designs should direct runoff from impervious areas to adjacent landscaping areas that have higher potential for infiltration and surface water storage. This will limit the amount of runoff generated, and therefore the size of the mitigation BMPs downstream. The design, including consideration of slopes and soils, must reflect a reasonable expectation that runoff will soak into the soil and produce no runoff of the DCV. On hillside sites, drainage from upper areas may be collected in conventional catch basins and piped to landscaped areas that have higher potential for infiltration. Or use low retaining walls to create terraces that can accommodate BMPs.

## Chapter 4: Source Control and Site Design Requirements for All Development Projects



Source: County of San Diego LID Handbook

Projects can incorporate SD-5 by implementing the following planning and design phase techniques as applicable and practicable:

- Implement design criteria and considerations listed in impervious area dispersion fact sheet (SD-5) presented in Appendix E.
- Drain rooftops into adjacent landscape areas.
- Drain impervious parking lots, sidewalks, walkways, trails, and patios into adjacent landscape areas.
- Reduce or eliminate curb and gutters from roadway sections, thus allowing roadway runoff to drain to adjacent pervious areas.
- Replace curbs and gutters with roadside vegetated swales and direct runoff from the paved street or parking areas to adjacent LID facilities. Such an approach for alternative design can reduce the overall capital cost of the site development while improving the storm water quantity and quality issues and the site's aesthetics.
- Plan site layout and grading to allow for runoff from impervious surfaces to be directed into distributed permeable areas such as turf, landscaped or permeable recreational areas, medians, parking islands, planter boxes, etc.
- Detain and retain runoff throughout the site. On flatter sites, landscaped areas can be interspersed among the buildings and pavement areas. On hillside sites, drainage from upper areas may be collected in conventional catch basins and conveyed to landscaped areas in lower areas of the site.
- Pervious area that receives run on from impervious surfaces shall have a minimum width of 10 feet and a maximum slope of 5%.

### SD-6: Collect runoff

- Use small collection strategies located at, or as close to as possible to the sources (i.e. the point where storm water initially meets the ground) to minimize the transport of runoff and pollutants to the MS4 and receiving waters

## Chapter 4: Source Control and Site Design Requirements for All Development Projects

- Use permeable material for projects with low traffic areas and appropriate soil conditions

Distributed control of storm water runoff from the site can be accomplished by applying small collection techniques (e.g. green roofs), or integrated management practices, on small sub-catchments or on residential lots. Small collection techniques foster opportunities to maintain the natural hydrology provide a much greater range of control practices. Integration of storm water management into landscape design and natural features of the site, reduce site development and long-term maintenance costs, and provide redundancy if one technique fails. On flatter sites, it typically works best to intersperse landscaped areas and integrate small scale retention practices among the buildings and paving.

Permeable pavements contain small voids that allow water to pass through to a gravel base. They come in a variety of forms; they may be a modular paving system (concrete pavers, grass-pave, or gravel-pave) or poured in place pavement (porous concrete, permeable asphalt). Project applicants should identify locations where permeable pavements could be substituted for impervious concrete or asphalt paving. The O&M of the site must ensure that permeable pavements will not be sealed in the future. In areas where infiltration is not appropriate, permeable paving systems can be fitted with an under drain to allow filtration, storage, and evaporation, prior to drainage into the storm drain system.

Projects can incorporate SD-6 by implementing the following planning and design phase techniques as applicable and practicable:

- Implementing distributed small collection techniques to collect and retain runoff
- Installing permeable pavements (see SD-6B in Appendix E)

### **SD-7: Landscape with native or drought tolerant species**

All development projects are required to select a landscape design and plant palette that minimizes required resources (irrigation, fertilizers and pesticides) and pollutants generated from landscape areas. Native plants require less fertilizers and pesticides because they are already adapted to the rainfall patterns and soils conditions. Plants should be selected to be drought tolerant and not require watering after establishment (2 to 3 years). Watering should only be required during prolonged dry periods after plants are established. Final selection of plant material needs to be made by a landscape architect experienced with LID techniques. Microclimates vary significantly throughout the region and consulting local municipal resources will help to select plant material suitable for a specific geographic location.

Projects can incorporate SD-7 by landscaping with native and drought tolerant species. Recommended plant list is included in Appendix E (Fact Sheet PL).

### SD-8: Harvest and use precipitation

Harvest and use BMPs capture and stores storm water runoff for later use. Harvest and use can be applied at smaller scales (Standard Projects) using rain barrels or at larger scales (PDPs) using cisterns. This harvest and use technique has been successful in reducing runoff discharged to the storm drain system conserving potable water and recharging groundwater.

Rain barrels are above ground storage vessels that capture runoff from roof downspouts during rain events and detain that runoff for later reuse for irrigating landscaped areas. The temporary storage of roof runoff reduces the runoff volume from a property and may reduce the peak runoff velocity for small, frequently occurring storms. In addition, by reducing the amount of storm water runoff that flows overland into a storm water conveyance system (storm drain inlets and drain pipes), less pollutants are transported through the conveyance system into local creeks and the ocean. The reuse of the detained water for irrigation purposes leads to the conservation of potable water and the recharge of groundwater. SD-8 fact sheet in Appendix E provides additional detail for designing Harvest and Use BMPs. Projects can incorporate SD-8 by installing rain barrels or cisterns, as applicable.

Photograph Courtesy of Arid Solutions, Inc.



# **Storm Water Pollutant Control Requirements for PDPs**

PDPs are required to implement storm water pollutant control BMPs to maximize retention of stormwater and reduce the quantity of pollutants in storm water discharges. This chapter outlines the process for PDPs to demonstrate compliance with these requirements.

This chapter should be followed after referencing project planning elements and site design/source control elements discussed in Chapters 3 and 4 respectively. The steps in this chapter pertain specifically to storm water pollutant control BMPs. These criteria must be met regardless of whether hydromodification management applies; however, the overall sequencing of project development may be different if hydromodification management applies. For guidance on how to integrate both hydromodification management and pollutant control BMPs (in cases where both requirements apply), see Sections 3.4.3, 5.4 and Chapter 6.

## **5.1 Steps for Selecting and Designing Storm Water Pollutant Control BMPs**

- Step 1. Determine DCV per Appendix B.1
  - A. Determine rainfall depth per Appendix B.1.1.
  - B. Delineate tributary areas per Appendix B.1.2.
  - C. Determine runoff factors per Appendix B.1.3.
  - D. Determine site design volume reductions per Appendix B.1.4
- Step 2. Determine Retention Requirements Appendix B.2
  - A. Determine if capture and use analysis is required per Appendix B.2.1
  - B. Evaluate infiltration restrictions per Appendix B.2.2
  - C. Determine design infiltration rate per Appendix B.2.3
  - D. Determine retention requirements per Appendix B.2.4

## Chapter 5: Storm Water Pollutant Control Requirements for PDPs

- Step 3. Determine BMP Performance per Appendix B.3
- A. Identify proposed BMP characteristics per Appendix B.3.1.
  - B. Calculate retention processes per Appendix B.3.2
  - C. Calculate biofiltration processes per Appendix B.3.3
  - D. Satisfaction of pollutant control requirements per Appendix B.3.4
  - E. Satisfaction of minimum retention requirements per Appendix B.3.5.

### 5.2 DMAs Excluded from DCV Calculation

This Manual provides project applicants the option to exclude DMAs from DCV calculations if they meet the criteria specified below. These DMAs must implement source control and site design BMPs from Chapter 4 as applicable and feasible. These exclusions will be evaluated on a case-by-case basis and approvals of these exclusions are at the discretion of the City Engineer.

#### 5.2.1 Self-mitigating DMAs

Self-mitigating DMAs consist of natural or landscaped areas that drain directly offsite or to the public storm drain system. Self-mitigating DMAs must meet **ALL** the following characteristics to be eligible for exclusion:

- Vegetation in the natural or landscaped area is native and/or non-native/non-invasive drought tolerant species that do not require regular application of fertilizers and pesticides.
- Soils are undisturbed native topsoil, or disturbed soils that have been amended and aerated to promote water retention characteristics equivalent to undisturbed native topsoil.
- The incidental impervious areas are less than 5 percent of the self-mitigating area.
- Impervious area within the self-mitigated area should not be hydraulically connected to other impervious areas unless it is a storm water conveyance system (such as brow ditches).
- The self-mitigating area is hydraulically separate from DMAs that contain permanent storm water pollutant control BMPs.

Figure 5.1 illustrates the concept of self-mitigating DMAs.

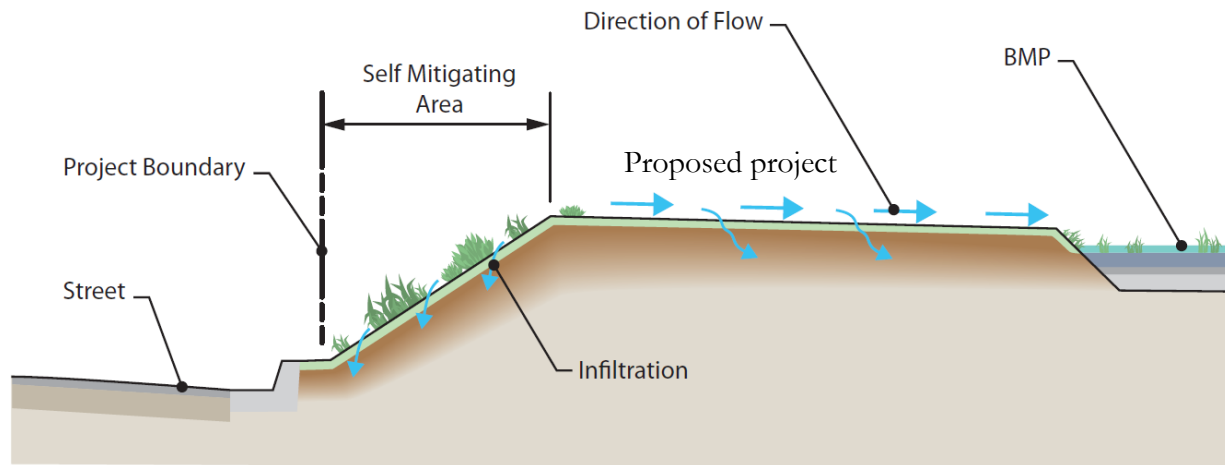


FIGURE 5-1. Self Mitigating Area

### 5.2.2 De Minimis DMAs

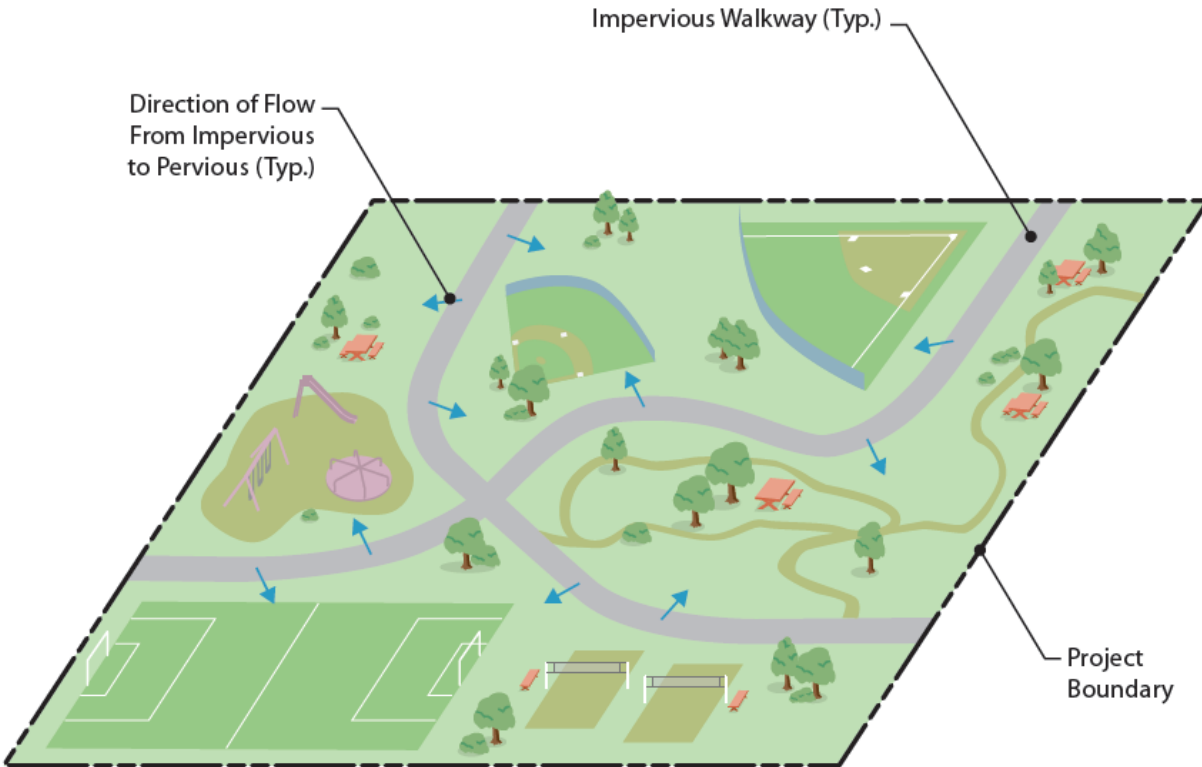
De minimis DMAs consist of areas that are very small, and therefore are not considered to be significant contributors of pollutants, and are considered by the owner and the City Engineer not practicable to drain to a BMP. It is anticipated that only a small subset of projects will qualify for de minimis DMA exclusion. Examples include driveway aprons connecting to existing streets, portions of sidewalks, retaining walls at the external boundaries of a project, and similar features. De minimis DMAs must include **ALL** of the following characteristics to be eligible for exclusion:

- Areas about the perimeter of the development site.
- Topography and land ownership constraints make BMP construction to reasonably capture runoff technically infeasible.
- The portion of the site falling into this category is minimized through effective site design
- Each DMA should be less than 250 square feet and the sum of all de minimis DMAs should represent less than 2 percent of the total added or replaced impervious surface of the project. Except for projects where 2 percent of the total added or replaced impervious surface of the project is less than 250 square feet, a de minimis DMA of 250 square feet or less is allowed.
- Two de minimis DMAs cannot be adjacent to each other and hydraulically connected.

The SWQMP must document the reason that each de minimis area could not be addressed otherwise.

### 5.2.3 Self-retaining DMAs via Qualifying Site Design BMPs

Self-retaining DMAs are areas that are designed with site design BMPs to retain runoff to a level determined to constitute full retention of, at a minimum, the entire DCV. Figure 5.4 illustrates the concept of self-retaining DMAs.



**FIGURE 5-2. Self-Retaining Site**

To satisfy pollutant control requirements only, self-retaining means retention of the entire DCV. However, under some circumstances, a DMA may also satisfy hydromodification management requirements by implementing BMPs that retain a greater volume of runoff. BMPs used individually or in combination to fully retain the volume required to satisfy either standard within a DMA are classified as Significant Site Design BMPs, or SSD-BMPs. Sizing requirements for SSD-BMPs both for pollutant control and hydromodification management are addressed in their respective BMP Fact Sheets as applicable.

Two types of site design BMPs may currently be used in the design of self-retaining DMAs. Basic performance criteria are summarized below.

Tree Wells (SD-1 in Appendix E)

DMA can be designed using Tree Wells to satisfy both pollutant control and hydromodification management performance standards.

- For pollutant control only, the DMA must retain the entire DCV.
- For hydromodification management, an additional volume must be retained in accordance with the sizing requirements presented in the DCV multiplier table in SD-A.

Impervious Area Dispersion (SD-5 in Appendix E)

The following apply if the dispersion area is native soil (SD-B in Appendix E):

## Chapter 5: Storm Water Pollutant Control Requirements for PDPs

- For pollutant control only, the DMA is considered self-retaining if the impervious to pervious area ratio is:
  - 2:1 when the pervious area is composed of Hydrologic Soil Group A
  - 1:1 when the pervious area is composed of Hydrologic Soil Group B

The following applies if the dispersion area includes amended soil (SD-B in Appendix E):

- DMAs using impervious area dispersion can be considered to meet both pollutant control and hydromodification flow control requirements if the impervious to pervious area ratio is 1:1 or less and all other design requirements of SD-B are satisfied, including 11 inches of amended soil.

The following apply if the dispersion area is permeable pavement (SD-D in Appendix E):

- For pollutant control only, a DMA is considered self-retaining if the ratio of total drainage area (including permeable pavement) to area of permeable pavement is 1.5:1 or less, and all other design requirements of SD-D are satisfied.
- Hydromodification management performance standards can be satisfied using permeable pavement only if constructed to Structural BMP specifications. In this case, the permeable pavement must be sized and constructed in accordance with the requirements of INF-3.

All of the criteria described above are conservatively developed to anticipate potential changes in DMA characteristics with time. Each BMP must be designed in accordance with the requirements and limitations described in its applicable BMP Fact Sheet (Appendix E). The City may accept or reject a proposed self-retaining DMA meeting these criteria at its discretion. Examples of rationales for rejection may include the potential for negative impacts (such as infiltration or vector issues), potential for significant future alteration of this feature, or inability to visually inspect and confirm the feature.

For pollutant control only, Structural Site BMPs can be used either individually or in combination. However, only a single site design BMP type can be used to satisfy hydromodification management requirements in a DMA because their sizing factors cannot be combined.

Site design BMPs used as part of a self-retaining DMA or as part of reducing runoff coefficients from a DMA must be clearly called out on project plans and in the SWQMP.

PDPs subject to hydromodification requirements should note that Self-retaining DMAs must be included in hydromodification analysis. Reductions in DCV realized through Site Design BMPs are applicable to treatment control only and do not relax hydromodification requirements.

Other site design BMPs can be considered self-retaining for meeting storm water pollutant control obligations if the long-term annual runoff volume (estimated using continuous simulation following guidelines listed in Appendix G) from the DMA is reduced to a level equivalent to pervious land and the applicant provides supporting analysis and rationale for the reduction in long-term runoff volume.

## Chapter 5: Storm Water Pollutant Control Requirements for PDPs

Approval of other self-retaining areas is at the discretion of the City Engineer. DCV Reduction through Site Design BMPs

Approval of the claimed reduction of runoff factors is at the discretion of the City Engineer.

### 5.3 Structural BMP Design

The BMP designs described in the BMP Fact Sheets (Appendix E) constitute allowable storm water pollutant control BMPs for the purpose of meeting storm water management requirements. Table 5-1 maps the BMP category to the fact sheets provided in Appendix E. Criteria specifically described in these fact sheets override guidance contained in outside referenced source documents. Where criteria are not specified, the applicant and the project review staff should use best professional judgment based on the recommendations of the referenced guidance material or other published and generally accepted sources. When an outside source is used, the preparer must document the source in the SWQMP.

**TABLE 5-1. Permanent Structural BMPs for PDPs**

MS4 Permit Category	Manual Category	BMPs
Retention	Harvest and Use (HU)	HU-1: Cistern
Retention	Infiltration (INF)	INF-1: Infiltration basin INF-2: Bioretention INF-3: Permeable pavement
NA	Partial Retention (PR)	PR-1: Biofiltration with partial retention
Biofiltration	Biofiltration (BF)	BF-1: Biofiltration BF-2: Nutrient Sensitive Media Design BF-3: Proprietary Biofiltration
Flow-thru treatment control	Flow-thru treatment control with Alternative Compliance (FT)	FT-1: Vegetated swales FT-2: Media filters FT-3: Sand filters FT-4: Dry extended detention basins FT-5: Proprietary flow-thru treatment control

## **5.4 Documenting Storm Water Pollutant Control BMP Compliance when Hydromodification Management Applies**

The steps and guidance presented in Chapter 5 apply to all PDPs for demonstrating conformance to storm water pollutant control requirements regardless of whether hydromodification management applies. However, when hydromodification management applies, the approach for project design may be different. The following process can be used to document compliance with storm water pollutant control BMPs in cases when hydromodification management also applies:

1. Develop a combined BMP or treatment train (BMPs constructed in series) based on both storm water pollutant control and hydromodification management requirements. Appendix E provides specific examples of how storm water pollutant control BMPs can be configured to also address hydromodification management.
2. Dedicate a portion of the combined BMP or treatment train as the portion that is intended to comply with storm water pollutant control requirements.
3. Follow all of the steps in this chapter related to demonstrating that the dedicated portion of the BMP or treatment train meets the applicable storm water pollutant control criteria.
4. Check BMP design criteria in Appendix E and F to ensure that the hydromodification management design features (additional footprint, additional depth, modified outlet structure, lower discharge rates, etc.) do not compromise the treatment function of the BMP.
5. On project plans and in the O&M Plan, clearly denote the portion of the BMP that serves the storm water pollutant control function.

Alternative approaches that meet both the storm water pollutant control and hydromodification management requirements may be acceptable at the discretion of the City Engineer and shall be documented in the SWQMP. Also refer to Section 6.3.6 for additional guidance.

# Hydromodification Management Requirements for PDPs

**The purpose of hydromodification management requirements for PDPs is to minimize the potential of storm water discharges from the MS4 from causing altered flow regimes and excessive downstream erosion in receiving waters.** Hydromodification management implementation for PDPs includes two components: protection of critical coarse sediment yield areas and flow control for post-project runoff from the project site. For PDPs subject to hydromodification management requirements, this Chapter provides guidance to meet the performance standards for the two components of hydromodification management.

The civil engineer preparing the hydromodification management study for a project will find within this Chapter and Appendix G of this Manual, along with watershed-specific information in the WMAA, all necessary information to meet the MS4 Permit standards. Should unique project circumstances require an understanding beyond what is provided in this Manual, then consult the March 2011 Final HMP, which documents the historical development of the hydromodification management requirements.

Guidance for flow control of post-project runoff is based on the March 2011 Final HMP, with modifications in this Manual based on updated requirements in the MS4 Permit. The March 2011 Final HMP was prepared based on the 2007 MS4 Permit, not the MS4 Permit that drives this Manual. In instances where there are changes to hydromodification management criteria or procedures based on the MS4 Permit, the criteria and procedures presented in this Manual supersede the March 2011 Final HMP.

Protection of critical coarse sediment yield areas is a new requirement of the MS4 Permit and is not covered in the March 2011 Final HMP. The standards and management practices for protection of critical coarse sediment yield areas are presented here in the Manual.

## 6.1 Hydromodification Management Applicability and Exemptions

As noted in Chapter 1, Section 1.6 a project may be exempt from hydromodification

## Chapter 6: Hydromodification Management Requirements for PDPs

management requirements if it meets any one of the following conditions:

- The project is not a PDP;
- The proposed project will discharge runoff directly to existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean;
- The proposed project will discharge runoff directly to conveyance channels whose bed and bank are concrete lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean; or
- The proposed project will discharge runoff directly to an area identified by the Copermittees as appropriate for an exemption by the WMAA for the watershed in which the project resides.

The above criteria reflects the latest list of exemptions that are allowed under the MS4 Permit and therefore supersedes criteria found in earlier publications.

Exempt water storage reservoirs and lakes in San Diego County are shown in the WMAA for each watershed.

Detailed criteria for determining a "direct discharge" to an exempt water body are presented in Section 1.6.

In addition to discharge to the Pacific Ocean, the City of Oceanside shall consider a PDP that discharges directly to the following waterbodies via existing underground storm drains or conveyance channels whose bed and bank are concrete lined as being exempt from hydromodification management requirements.

### Exempt Waterbodies Identified in the Regional WMAA:

- San Luis Rey River from upstream river limit of Basin Plan Sub-watershed 903.1 upstream of Bonsall and near Interstate 15 to the Pacific Ocean.

Direct discharges to the San Luis Rey River may be exempt, provided that the outlet elevation of the project's outfall(s) to the river reach are between the river bottom elevation and the 100-year floodplain elevation, and properly sized energy dissipation is provided at the outfall(s).

### Exempt Waterbodies Identified in the Carlsbad Watershed Management Area WMAA:

- Buena Vista Lagoon

Direct discharges to the San Luis Rey River may be exempt, provided that the outlet elevation of the project's outfall(s) to the river reach are between the river bottom elevation and the 100-year floodplain elevation, and properly sized energy dissipation is provided at the outfall(s).

## 6.2 Protection of Critical Coarse Sediment Yield Areas

When hydromodification management requirements are applicable, the applicant must determine if the project will impact any areas that are determined to be critical coarse sediment yield areas (CCSYAs). A CCSYA is an area that has been identified as an active or potential source of coarse sediment to downstream channel reaches. The process for demonstrating that the PDP does not

## Chapter 6: Hydromodification Management Requirements for PDPs

impact CCSYAs is illustrated in Figure 6-1 below, and supplemented with detailed methodologies presented in Appendix H of this Manual. PDPs complying with this MS4 Permit requirement are not subject to the provisions of the Total Maximum Daily Load for Sediment in Los Peñasquitos Lagoon, post construction. However, PDPs may be subject to Total Maximum Daily Load requirements during construction.

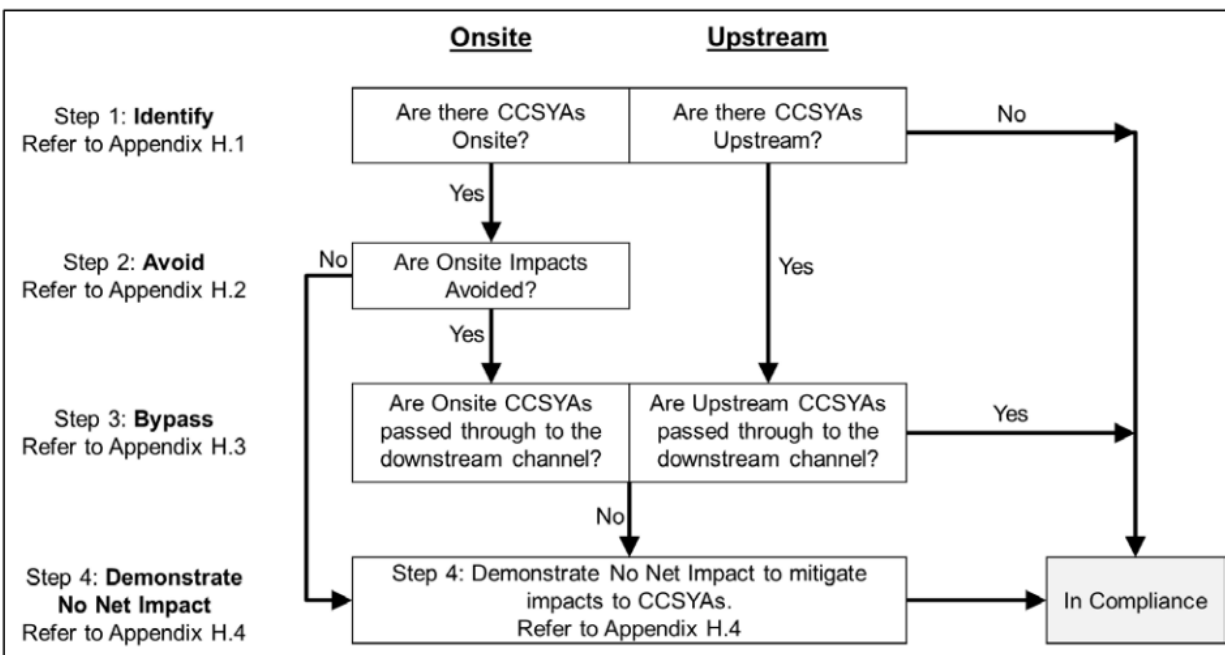


FIGURE 6-1. Pathways to Meet CCSYA Requirements

### Description of Steps:

- Step 1. Applicants must identify CCSYAs located onsite and/or upstream of the project's property boundary per the guidance presented in Appendix H.1. If no CCSYAs are identified in this step, no further consideration of critical coarse sediment supply is necessary.
- Step 2. Applicants should avoid impacts to onsite CCSYAs through effective site design techniques discussed in Appendix H.2.
- Step 3. Applicants should bypass bed sediment from onsite and/or upstream CCSYAs to downstream receiving waters per guidance presented in Appendix H.3.
- Step 4. When impacts to CCSYAs are not avoided or bypassed through the site, the applicant must demonstrate that the project generates no net impact to the receiving water per guidance presented in Appendix H.4

## 6.3 Flow Control for Hydromodification Management

**PDPs subject to hydromodification management requirements must provide flow control for post-project runoff to meet the flow control performance standard.**

This is typically accomplished using structural BMPs that may include any combination of infiltration basins; bioretention, biofiltration with partial retention, or biofiltration basins; or detention basins.

## Chapter 6: Hydromodification Management Requirements for PDPs

This Section will discuss design of flow control measures for hydromodification management. This Section is intended to be used following the source control and site design processes described in Chapter 4 and the storm water pollutant control design process described in Chapter 5.

The flow control performance standard is as follows:

- 1 For flow rates ranging from 10 percent, 30 percent or 50 percent of the pre-development 2-year runoff event ( $0.1Q_2$ ,  $0.3Q_2$ , or  $0.5Q_2$ ) to the pre-development 10-year runoff event ( $Q_{10}$ ), the post-project discharge rates and durations must not exceed the pre-development rates and durations by more than 10 percent. The specific lower flow threshold will depend on the erosion susceptibility of the receiving stream for the project site (see Section 6.3.4).

In this context,  $Q_2$  and  $Q_{10}$  refer to flow rates determined based on either continuous simulation hydrologic modeling or an approved regression equation. The range from a fraction of  $Q_2$  to  $Q_{10}$  represents the range of geomorphically significant flows for hydromodification management in San Diego. The upper bound of the range of flows to control is pre-development  $Q_{10}$  for all projects. The lower bound of the range of flows to control, or "lower flow threshold" is a fraction of pre-development  $Q_2$  that is based on the erosion susceptibility of the stream and depends on the specific natural system (stream) that a project will discharge to. Tools have been developed in the March 2011 Final HMP for assessing the erosion susceptibility of the stream (see Section 6.3.4 below for further discussion of the lower flow threshold).

**When selecting the type of structural BMP to be used for flow control, consider the types of structural BMPs that will be utilized onsite for pollutant control.**

Both storm water pollutant control and flow control for hydromodification management can be achieved within the same structural BMPs. For example, a full infiltration BMP that infiltrates the DCV for pollutant control could include additional storage volume above or below ground to provide either additional infiltration of storm water or control of outflow for hydromodification management. If possible, the structural BMPs for pollutant control should be modified to meet flow control performance standards in addition to the pollutant control performance standards. See Section 6.3.6 for further discussion of integrating structural BMPs for pollutant control and flow control.

### 6.3.1 Point(s) of Compliance

**For PDPs subject to hydromodification management requirements, the flow control performance standard must be met for each natural or un-lined channel that will receive runoff from the project.**

This may require multiple structural BMPs within the project site if the project site discharges to multiple discrete outfalls. When runoff is discharged to multiple natural or un-lined channels within a project site, each natural or un-lined channel must be considered separately and points of compliance (POCs) for flow control must be provided for each natural or un-lined channel, including situations where the channels will confluence before leaving the project boundary. When runoff from the project site does not meet a natural or un-lined channel onsite, instead traveling some distance downstream of the project in storm drain systems or lined channels prior to discharge to natural or un-lined channels, the POC(s) for flow control analysis shall be placed at the project boundary (i.e., comparing the pre-development and post-project flows from the project area only, not analyzing the total watershed draining to the offsite POC), unless the project is draining to and accommodated by an

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approved master planned or regional flow control BMP.

**For individual projects draining to approved master planned or regional flow control BMPs, the POC for flow control analysis may be offsite of the specific project application.**

In these instances, the individual project draining to a master planned or regional flow control BMP shall reference the approved design documents for the BMP, and shall demonstrate that either (a) the individual project design is consistent with assumptions made for imperviousness and features of the project area when the master planned or regional BMP was designed, or (b) the master planned or regional BMP still meets performance standards when the actual proposed imperviousness and features of the project area are considered.

### 6.3.2 Offsite Area Restrictions

**Runoff from offsite undeveloped areas should be routed around structural BMPs for flow control whenever feasible.**

Methods to route flows around structural BMPs include designing the site to avoid natural drainage courses, or using parallel storm drain systems. If geometric constraints prohibit the rerouting of flows from undeveloped areas around a structural BMP, a detailed description of the constraints must be submitted to the City Engineer.

**Structural BMPs for flow control must be designed to avoid trapping sediment from natural areas regardless of whether the natural areas are critical coarse sediment yield areas or not.**

Reduction in coarse sediment supply contributes to downstream channel instability. Capture and removal of natural sediment from the downstream watercourse can create "hungry water" conditions and the increased potential for downstream erosion. Additionally, coarse or fine sediment from natural areas can quickly fill the available storage volume in the structural BMP and/or clog a small flow control outlet, which can cause the structural BMP to overflow during events that should have been controlled, and will require frequent maintenance. Failure to prevent clogging of the principal control orifice defeats the purpose of a flow control BMP, since basin inflows would simply overtop the control structure and flow unattenuated downstream, potentially worsening downstream erosion.

### 6.3.3 Requirement to Control to Pre-Development (Not Pre-Project) Condition

**The MS4 Permit requires that post-project runoff must be controlled to match pre-development runoff conditions, not pre-project conditions, for the range of flow rates to be controlled.**

Pre-development runoff conditions are defined in the MS4 Permit as "approximate flow rates and durations that exist or existed onsite before land development occurs."

- **Redevelopment PDPs:** Use available maps or development plans that depict the topography of the site prior to development, otherwise use existing onsite grades if historic topography is not available. Assume the infiltration characteristics of the underlying soil. Use available information pertaining to existing underlying soil type such as soil maps published by the Natural Resource Conservation Service (NRCS). Do not use runoff parameters for concrete or asphalt to estimate pre-development runoff conditions. If compacted soils condition exists, however, infiltration

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characteristics (refer to Appendix G, Table G.1.4 for allowable adjustments) for that runoff condition may be assumed.

- **New development PDPs:** The pre-development condition typically equates to runoff conditions immediately before project construction. However, if there is existing impervious area onsite, as with redevelopment, the new development project must not use runoff parameters for concrete or asphalt to estimate pre-development runoff conditions. If compacted soils condition exists, however, infiltration characteristics (refer to Appendix G, Table G.1.4 for allowable adjustments) for that runoff condition may be assumed.

When it is necessary for runoff from offsite impervious area (not a part of the project) to co-mingle with project site runoff and be conveyed through a project's structural flow control BMP, the offsite impervious area may be modeled as impervious in both the pre- and post- condition models. A project is not required to provide flow control for storm water from offsite. This also means that for redevelopment projects not subject to the 50% rule (i.e., redevelopment projects that result in the creation or replacement of impervious surface in an amount of less than 50% of the area of impervious surface of the previously existing development), comingled runoff from undisturbed portions of the previously existing development (i.e., areas that are not a part of the project) will not require flow control. Flow control facilities for comingled offsite and onsite runoff would be designed to process the total volume of the comingled runoff through the facility, but would provide mitigation for the excess runoff (difference of developed to pre-developed condition) based on onsite impervious areas only. The project applicant must clearly explain why it was not feasible or practical to provide a bypass system for storm water from offsite. The City Engineer may request that the project applicant provide a supplemental analysis of onsite runoff only (i.e., supplemental model of the project area only).

### 6.3.4 Determining the Low Flow Threshold for Hydromodification Flow Control

**The range of flows to control for hydromodification management depends on the erosion susceptibility of the receiving stream.**

The range of flows to control is either:

- $0.1Q_2$  to  $Q_{10}$  for projects discharging to streams with high susceptibility to erosion (and this is the default range of flows to control when a stream susceptibility study has not been prepared),
- $0.3Q_2$  to  $Q_{10}$  for projects discharging to streams with medium susceptibility to erosion as determined by a stream susceptibility study approved by the City Engineer, or
- $0.5Q_2$  to  $Q_{10}$  for projects discharging to streams with low susceptibility to erosion as determined by a stream susceptibility study approved by the City Engineer.

**The project applicant may opt to design to the default low flow threshold of  $0.1Q_2$ , or provide assessment of the receiving stream ("channel screening" a.k.a. "geomorphic assessment"), which may result in a higher low flow threshold of  $0.3Q_2$  or  $0.5Q_2$  for project hydromodification management.**

Use of a higher low flow threshold of  $0.3Q_2$  or  $0.5Q_2$  must be supported by a channel screening report. Channel screening is based on a tool developed by the Southern California Coastal Water Research Project (SCCWRP), documented in SCCWRP's Technical Report 606 dated March 2010, "Hydromodification Screening Tools: Field Manual for Assessing Channel Susceptibility." The SCCWRP channel screening tool considers channel conditions including channel braiding, mass

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wasting, and proximity to the erosion threshold. SCCWRP's Technical Report 606 is included in Appendix B of the March 2011 Final HMP, and can also be accessed through SCCWRP's website. The result of applying the channel screening tool will be classification of high, medium, or low susceptibility to erosion, corresponding to low flow thresholds of 0.1Q<sub>2</sub>, 0.3Q<sub>2</sub>, and 0.5Q<sub>2</sub>, respectively, for the receiving stream. Note that the City Engineer may require that the channel screening study has been completed within a specific time frame prior to their review, and/or may apply a sunset date to their approval of a channel screening study.

**The receiving stream is the location where runoff from the project is discharged to natural or un-lined channels.**

The receiving stream may be onsite or offsite. The POC for channel screening is the point where runoff initially meets an un-lined or natural channel, regardless of whether the POC for flow control facility sizing is at or within the project boundary or is offsite. A project may have a different POC for channel screening vs. POC for flow control facility sizing if runoff from the project site is conveyed in hardened systems from the project site to the un-lined or natural channel. The erosion susceptibility of the receiving stream must be evaluated at the POC for channel screening, and for an additional distance known as the domain of analysis, defined in SCCWRP's Technical Report 606.

### 6.3.5 Designing a Flow Control Facility

**Flow control facilities for hydromodification management must be designed based on continuous simulation hydrologic modeling, which may be accomplished as a project-specific continuous simulation model, or by using sizing factors previously developed for this purpose in the March 2011 Final HMP.**

Continuous simulation hydrologic modeling uses an extended time series of recorded precipitation data and evapotranspiration data as input and generates hydrologic output, such as surface runoff, groundwater recharge, and evapotranspiration, for each model time step. Using the continuous flow output, peak flow frequency and duration statistics can be generated for the pre-development and post-project conditions for the purpose of matching pre-development hydrologic conditions in the range of geomorphically significant flow rates. Peak flow frequency statistics estimate how often flow rates will exceed a given threshold. Flow duration statistics determine how often a particular flow rate is exceeded. To determine if a flow control facility meets hydromodification management performance standards, peak flow frequency and flow duration curves must be generated and compared for pre-development and post-project conditions.

Flow control facilities may be designed using either sizing factors presented in Appendix B of this Manual, or using project-specific continuous simulation modeling. The sizing factors were developed based on unit-area continuous simulation models. This means the continuous simulation hydrologic modeling has already been done and the project applicant needs only to apply the sizing factors to the project's effective impervious area to size a facility that meets flow control performance standards. The sizing factor method is intended for simple studies that do not include diversion, do not include significant offsite area draining through the project from upstream, and do not include offsite area downstream of the project area. Use of the sizing factors is limited to the specific structural BMPs for which sizing factors were prepared. Project-specific continuous simulation modeling offers the most flexibility in the design, but requires the project applicant to prepare and submit a complete continuous simulation hydrologic model for review.

### 6.3.5.1 Sizing Factor Method

**A project applicant may use sizing factors that were created to facilitate sizing of certain specific BMPs for hydromodification management.**

The sizing factors included in G.2 have been updated based on the requirements in the 2013 MS4 permit and are different than the sizing factors presented in previous manuals. These updated values replace the previous sizing factors which shall no longer be used for sizing of hydromodification flow control BMPs. A discussion of the rationale for the update is included in Appendix G.2.

The sizing factor method is intended for simple studies that do not include diversion, do not include significant offsite area draining through the project from upstream, and do not include offsite area downstream of the project area. Use of the sizing factors is limited to the specific structural BMPs described in Appendix G.2.

### 6.3.5.2 Project-Specific Continuous Simulation Modeling

**A project applicant may prepare a project-specific continuous simulation model to demonstrate compliance with hydromodification management performance standards.**

This option offers the most flexibility in the design. In this case, the project applicant shall prepare continuous simulation hydrologic models for pre-development and post-project conditions, and compare the pre-development and post-project (with hydromodification flow control BMPs) runoff rates and durations until compliance with the flow control performance standards is demonstrated. The project applicant will be required to quantify the long-term pre-development and post-project runoff response from the site and establish runoff routing and stage-storage-discharge relationships for the planned flow control BMPs. There are several available hydrologic models that can perform continuous simulation analyses. Refer to Appendix G.1 of this Manual for guidance for continuous simulation hydrologic modeling.

### 6.3.6 Integrating HMP Flow Control Measures with Pollutant Control BMPs

**Both storm water pollutant control and flow control for hydromodification management can be achieved within the same structural BMP(s) or by a series of structural BMP(s).**

The design process should start with an assessment of the controlling design factor, then the typical design process for an integrated structural BMP or series of BMPs to meet two separate performance standards at once involves (1) initiating the design based on the performance standard that is expected to require the largest volume of storm water to be retained, (2) checking whether the initial design incidentally meets the second performance standard, and (3) adjusting the design as necessary until it can be demonstrated that both performance standards are met. The following are recommendations for initiating the design process:

- **Full infiltration condition:** retention for pollutant control performance standard is the controlling design factor. For a system that is based on full retention for storm water pollutant control, first design an initial retention area to meet storm water pollutant control standards for retention, then check whether the facility meets flow control performance standards. If the initial retention facility does not meet flow control performance standards: increase the volume of the facility, increasing retention if feasible or employing outflow control for runoff to be discharged from the facility; as needed to meet the flow control performance standards.

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- **Partial infiltration condition:** retention for pollutant control performance standard is the controlling design factor. For a system that is based on partial retention for storm water pollutant control, first design the retention area to maximize retention as feasible. Then design an additional runoff storage area with outflow control for runoff to be discharged from the facility; as needed to meet the flow control performance standards. Then address pollutant control needs for the portion of the storm water pollutant control DCV that could not be retained onsite.
- **No infiltration condition:** flow control for hydromodification management standard is the controlling design factor. For a system that is based on biofiltration with no infiltration for storm water pollutant control, first design the facility to meet flow control performance standards, then check whether the facility meets biofiltration design standards for storm water pollutant control. If the flow control biofiltration facility does not meet performance standards for storm water pollutant control by biofiltration, increase the volume of the biofiltration facility as needed to meet pollutant control performance standards, or identify other methods to address pollutant control needs for the portion of the storm water pollutant control DCV that could not be processed with biofiltration onsite.

When an integrated structural BMP or series of BMPs is used for both storm water pollutant control and flow control for hydromodification management, separate calculations are required to demonstrate that pollutant control performance standards and hydromodification management standards are met.

When an integrated structural BMP or series of BMPs is proposed to meet the storm water pollutant control and flow control for hydromodification management obligations, the applicant shall either:

- Perform separate calculations to show that both hydromodification management and pollutant control performance standards are met independently by using guidance from Appendices B and G. Calculations performed shall be documented in the SQWMP. **or**
- Develop an integrated design that meets the separate performance standards presented in Chapter 2 for both hydromodification management and pollutant control. In this option the BMP requirements to meet the pollutant control performance standard are optimized to account for the BMP storage provided for flow control, and vice versa. Calculations performed to develop an integrated design shall be documented in the SQWMP. Project approval when this option is selected is at the discretion of the City Engineer.

Appendix B.5.2 provides a methodology to optimize the footprint of the downstream biofiltration BMP that is required to meet the pollutant control performance standard, when there is an upstream hydromodification flow control BMP (e.g. cistern, vault, etc.)

### 6.3.7 Drawdown Time

**The maximum recommended drawdown time for hydromodification management facilities is 96 hours based on Section 6.4.6 of the March 2011 Final HMP.**

This is based on instruction from the County of San Diego Department of Environmental Health for mitigation of potential vector breeding issues and the subsequent risk to human health. This standard applies to, but is not limited to, detention basins, underground storage vaults, and the above-ground storage portion of LID facilities. When this standard cannot be met due to large stored runoff volumes with limited maximum release rates, a vector management plan may be an acceptable solution if

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approved by the governing municipality.

In cases where a Vector Management Plan is necessary, it shall be incorporated into the SWQMP as an attachment. A Vector Management Plan will only be accepted after the applicant has proven infeasibility of meeting the required drawdown time using any and all allowable BMPs. The information included in the plan will vary based on the nature, extent and variety of potential vector sources. It is recommended that preparers consult with the Department of Environmental Health Vector Control Program for technical guidance. Plans should include the following information at a minimum:

- Project identification information;
- A description of the project, purpose of the report, and existing environmental conditions;
- A description of the management practices that will be employed to minimize vector breeding sources and any associated employee education required to run facilities and operations;
- A discussion of long-term maintenance requirements;
- A summary of mitigation measures;
- References; and
- A list of persons and organizations contacted (project proponents are expected to obtain review and concurrence of proposed management practices from Department of Environmental Health Vector control program staff prior to submission).

The property owner and applicant must include and sign the following statement: “The measures identified herein are considered part of the proposed project design and will be carried out as part of project implementation. I understand the breeding of mosquitoes is unlawful under the State of California Health and Safety Code Section 2060-2067. I will permit the Vector Surveillance and Control program to place adult mosquito monitors and to enforce this document as needed.”

Refer to the sources below for additional guidance:

Report Guidance

[https://www.sandiegocounty.gov/content/dam/sdc/pds/docs/vector\\_report\\_formats.pdf](https://www.sandiegocounty.gov/content/dam/sdc/pds/docs/vector_report_formats.pdf)

Department of Environmental Health Vector Control Program Department of Environmental Health

[http://www.sandiegocounty.gov/deh/pests/vector\\_disease.html](http://www.sandiegocounty.gov/deh/pests/vector_disease.html)

It should be noted that other design factors may influence the required drawdown when hydromodification management BMPs are integrated with storm water pollutant control BMPs. Since hydromodification flow control BMPs are designed based on continuous simulation modeling, which is based on a continuous rainfall record and analyzes a continuous inflow and outflow of the BMPs, inter-event drawdown time and availability of the BMP for subsequent event inflow has been accounted for in the sizing. Therefore, drawdown recommendations for hydromodification management are based on public safety, not availability of the BMP for the next inflow event. Storm water pollutant control BMPs are designed on a single-event basis for a DCV (the 85<sup>th</sup> percentile storm event). Some of the design standards presented in Chapter 5 or Appendix B require that the pollutant control portion of the BMP drain within a specific time frame to ensure the pollutant control portion of the BMP is available for subsequent storm events. When hydromodification management BMPs are integrated with storm water pollutant control BMPs, the designer must evaluate drawdown time based on both standards.

## 6.4 In-Stream Rehabilitation

**An alternative to onsite flow control for post-project runoff may be in-stream rehabilitation.**

Project applicant may be allowed to participate in an in-stream rehabilitation project in lieu of implementing onsite flow control BMPs. Refer to section 1.8 and local alternative compliance guidance document to determine if this option is available in the project watershed.

# **Long-Term Operation & Maintenance**

**Permanent structural BMPs require on-going inspection and maintenance into perpetuity to preserve the intended pollution control and/or flow control performance.**

This Chapter addresses procedural requirements for implementation of long-term O&M and the typical maintenance requirements of structural BMPs presented in the Manual. Specific requirements for O&M Plan reports will be discussed in Chapter 8 with the Submittal Requirements.

## **7.1 Need for Permanent Inspection and Maintenance**

### **7.1.1 MS4 Permit Requirements**

**The MS4 Permit requires that each Copermitttee implement a program that requires and confirms structural BMPs on all PDPs are designed, constructed, and maintained to remove pollutants in storm water to the MEP.**

Routine inspection and maintenance of BMPs will preserve the design and MS4 Permit objective to remove pollutants in storm water to the MEP. The MS4 Permit requirement specifically applies to PDP structural BMPs. However, source control BMPs and site design / LID BMPs within a PDP are components in the storm water management scheme that determine the amount of runoff to be treated by structural BMPs; and when source control, site design, or LID BMPs are not maintained, this can lead to clogging or failure of structural BMPs due to greater delivery of runoff and pollutants than intended. Therefore, the City Engineer may also require confirmation of maintenance of source control BMPs and site design / LID BMPs as part of their PDP structural BMP maintenance documentation requirements (see Section 7.4).

### **7.1.2 Practical Considerations**

**Why do permanent structural BMPs require on-going inspection and maintenance into perpetuity?**

By design, structural BMPs will trap pollutants transported by storm water. Structural BMPs are subject to deposition of solids such as sediment, trash, and other debris. Some structural BMPs are also subject to growth of vegetation, either by design (e.g. biofiltration) or incidentally. The pollutants

and any overgrown vegetation must be removed on a periodic basis for the life of the BMP to maintain the capacity of the structural BMP to process storm water and capture pollutants from every storm event. Structural BMP components are also subject to clogging from trapped pollutants and growth of vegetation. Clogged BMPs can result in flooding, standing water and mosquito breeding habitat. Maintenance is critical to ensure the ongoing drainage of the facility. All components of the BMP must be maintained, including both the surface and any sub-surface components.

Vegetated structural BMPs, including vegetated infiltration or partial infiltration BMPs, and above-ground detention basins, also require routine maintenance so that they don't inadvertently become wetlands, waters of the state, or sensitive species habitat under the jurisdiction of the United States Army Corps of Engineers, SDRWQCB, California Department of Fish and Wildlife, or the United States Fish and Wildlife Service. A structural BMP that is constructed in the vicinity of, or connected to, an existing jurisdictional water or wetland could inadvertently result in creation of expanded waters or wetlands. As such, vegetated structural BMPs have the potential to come under the jurisdiction of one or more of the above-mentioned resource agencies. This could result in the need for specific resource agency permits and costly mitigation to perform maintenance of the structural BMP. Along with proper placement of a structural BMP, routine maintenance is key to preventing this scenario.

## 7.2 Summary of Steps to Maintenance Agreement

**Ownership and maintenance responsibility for structural BMPs should be discussed at the beginning of project planning, typically at the pre-application meeting with the planning and zoning agency.**

Experience has shown provisions to finance and implement maintenance of BMPs can be a major stumbling block to project approval, particularly for *small residential subdivisions*. Project owners shall be aware of their responsibilities regarding storm water BMP maintenance and need to be familiar with the contents of the O&M Plan prepared for the project. Chapter 8 provides the guidelines for preparation of a site-specific O&M Plan. A maintenance mechanism must be determined prior to the issuance of any construction, grading, building permit, site development permit, or any other applicable permit. Below are typical steps and schedule for establishing a plan and mechanism to ensure on-going maintenance of structural BMPs.

**TABLE 7-1. Schedule for Developing O&M Plan and Agreement**

Item	Description	Time Frame
1	Determine structural BMP ownership, party responsible for permanent O&M, and maintenance funding mechanism	Prior to first submittal of a project application – discuss with staff at pre-application meeting
2	Identify expected maintenance actions	First submittal of a project application – identify in SWQMP
3	Develop detailed O&M Plan	As required by City Engineer, prior to issuance of construction, grading, building, site development, or other applicable permits
4	Update/finalize O&M Plan to reflect constructed structural BMPs with as-built plans and baseline photos	As required by City Engineer, upon completion of construction of structural BMPs

Item	Description	Time Frame
5	[For private maintenance] Prepare draft O&M Agreement (legal agreement to be recorded against the property by the County Assessor)	As required by City Engineer
6	[For private maintenance] Execute and record O&M Agreement	As required by City Engineer

The City Standard Storm Water Facilities Maintenance Agreement with Access Rights and Covenants (SWFMA) is a recorded agreement for the maintenance and repair of storm water management facilities, entered into between the Owner and the City of Oceanside. The SWFMA provides the City with access rights for the purpose of annual inspections, as required by the Municipal Permit, and to possibly perform BMP maintenance should the owner default. The SWFMA and additional information can be found at the following link as of the date of this Manual and should be submitted prior to approval of the final design:

<http://www.ci.oceanside.ca.us/gov/dev/eng/stormwater/review/maint.asp>

### 7.3 Maintenance Responsibility

**Who is responsible for the maintenance of the permanent structural BMPs into perpetuity?**

The property owner is responsible to ensure inspection, O&M of permanent structural BMPs on their property unless responsibility has been formally transferred to an agency, community facilities district, homeowners’ association, property owners’ association, or other special district. When property ownership changes (i.e. the property is sold or otherwise transferred to a new owner), maintenance responsibility also transfers to the new owner, typically by transfer of a maintenance agreement recorded against the property by the County Assessor. For structural BMPs that will be transferred to an agency, community facilities district, homeowners’ association, property owners’ association, or other special district, there may be an interim period during which the property owner is responsible until maintenance responsibility is formally transferred.

From the time that the structural BMP is constructed and activated (i.e. it is operating and processing storm water from storm events), it requires inspection and maintenance to ensure it continues to function as designed. Because of this, the MS4 Permit requires that each jurisdiction must "require the project applicant to submit proof of the mechanism under which ongoing long-term maintenance of all structural BMPs will be conducted." The various jurisdictions have different allowable maintenance mechanisms (e.g. privately funded or publicly funded maintenance) and/or requirements for proof of the maintenance mechanism (e.g. maintenance agreements). Requirements for proof of the maintenance mechanism may also differ depending on whether the long-term O&M will be provided by a public or private party.

**Conditional Use Permit** – For discretionary projects only, the City may assure maintenance of storm water BMPs through the inclusion of maintenance conditions in the conditional use permit. A non-refundable security deposit may be required.

**Project Proponent Agreement to Maintain Storm Water BMPs** – The City may enter into a contract with the project proponent obliging the project proponent to maintain, repair and replace the storm water BMP as necessary into perpetuity. A non-refundable security may be required.

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**Lease Provision** – In those cases where the City holds title to the land in question and the land is being leased to another party for private or public use, the City may assure storm water BMP maintenance, repair and replacement through conditions in the lease.

**Assessment District** – The City may approve an Assessment District or other funding mechanism created by the project proponent to provide funds for storm water BMP maintenance, repair and replacement on an ongoing basis. Any agreement with such a District shall be subject to the Public Entity Maintenance Provisions below.

**Public Entity Maintenance** – The City may approve a public or acceptable quasi-public entity (e.g., the County Flood Control District, or annex to an existing assessment district, an existing utility district, a state or federal resource agency, or a conservation conservancy) to assume responsibility for maintenance, repair and replacement of the BMP. Public entity maintenance agreements shall ensure estimated costs and front-funded or reliably guaranteed, (e.g., through a trust fund, assessment district, fees, bond, letter of credit or similar means). In addition, the City may seek protection from liability by appropriate releases and indemnities. The City Engineer shall have the authority to approve storm water BMPs proposed for transfer to any other public entity within its jurisdiction before installation. The City shall be involved in the negotiation of maintenance requirements with any other public entities accepting maintenance responsibilities within their respective jurisdictions; and in negotiations with the resource agencies responsible for issuing permits for the construction and/or maintenance of the facilities. The City must be identified as a third-party beneficiary empowered to enforce any such maintenance agreement within their respective jurisdictions.

**Alternative Mechanism** – The City may accept an alternative maintenance mechanism if such mechanism is as protective as those listed above. An alternative mechanism must be approved by the City Attorney and the City Engineer.

### 7.4 Long-Term Maintenance Documentation

**As part of on-going structural BMP maintenance into perpetuity, property owners are required to provide documentation of maintenance for the structural BMPs on their property to support the Copermittees' reporting requirements to the SDRWQCB.**

The MS4 Permit requires each Copermittee to verify that structural BMPs on each PDP "are adequately maintained, and continue to operate effectively to remove pollutants in storm water to the MEP through inspections, self-certifications, surveys, or other equally effective approaches." Each Copermittee must also identify the party responsible for structural BMP maintenance for the PDP and report the dates and findings of structural BMP maintenance verifications, and corrective actions and/or resolutions when applicable, in their PDP inventory. The PDP inventory and findings of maintenance verifications must be reported to the SDRWQCB annually. Based on these MS4 Permit requirements, the City Engineer will require property owners to provide annual self-certification that inspection and maintenance has been performed, provide details of the inspection results and maintenance activities, and confirm or update the contact information for the party responsible to ensure inspection and maintenance is performed.

A City of Oceanside Operations & Maintenance (O&M) plan template has been developed and is available on the City website. Guidance for long-term maintenance is provided but the Applicant is responsible for the verification of the applicability.

## 7.5 Inspection and Maintenance Frequency

### **How often is a property owner required to inspect and maintain permanent structural BMPs on their property?**

The minimum inspection and maintenance frequency is annual and must be reported annually. However, actual maintenance needs are site specific, and maintenance may be needed more frequently than annually. The need for maintenance depends on the amount and quality of runoff delivered to the structural BMP. Maintenance must be performed whenever needed, based on maintenance indicators presented in Section 7.7. The optimum maintenance frequency is each time the maintenance threshold for removal of materials (sediment, trash, debris or overgrown vegetation) is met. If this maintenance threshold has been exceeded by the time the structural BMP is inspected, the BMP has been operating at reduced capacity. This would mean it is necessary to inspect and maintain the structural BMP more frequently. Routine maintenance will also help avoid more costly rehabilitative maintenance to repair damages that may occur when BMPs have not been adequately maintained on a routine basis.

During the first year of normal operation of a structural BMP (i.e. when the project is fully built out and occupied), inspection by the property owner's representative is recommended at least once prior to August 31 and then monthly from September through May. Inspection during a storm event is also recommended. It is during and after a rain event when one can determine if the components of the BMP are functioning properly. After the initial period of frequent inspections, the minimum inspection and maintenance frequency can be determined based on the results of the first year inspections.

The City of Oceanside requires that inspection frequencies and maintenance requirements for individual structural BMPs be based on recommendations given in Section 4 of the CASQA Municipal Stormwater BMP Handbook. For proprietary devices, inspection frequencies and maintenance requirements should follow recommendations given by the manufacturer.

## **Submittal Requirements**

**It is necessary for the City Engineer to review project plans for compliance with applicable requirements of this Manual and the MS4 Permit.**

The review process must verify that storm water management objectives were considered in the project planning process and that opportunities to incorporate BMPs have been identified. The review process must confirm the site plan, landscape plan, and project storm water documents are congruent. Therefore, the City of Oceanside requires a submittal documenting the storm water management design for every project that is subject to the requirements of this Manual. Herein the submittal is called a "SWQMP." A complete and thorough project submittal will facilitate and expedite the review and approval, and may result in fewer submittals by the applicant. The Sections below discuss submittal requirements.

### **8.1 Submittal Requirement for Standard Projects**

#### **8.1.1 Standard Project SWQMP**

**For Standard Projects, the project submittal shall include a "Standard Project SWQMP."**

The Standard Project SWQMP is a compilation of checklists that document that all permanent source control and site design BMPs have been considered for the project and implemented where feasible. All applicable features shall be shown on site plans and landscaping plans.

The Standard Project SWQMP shall also include copies of the relevant plan sheets showing source control and site design BMPs.

Standard Projects shall use the City of Oceanside SDP SWQMP Template provided in Appendix A. BMP exhibits shall be provided in 24"x36" format.

### **8.2 Submittal Requirements for PDPs**

#### **8.2.1 PDP SWQMP**

**For PDPs, the project submittal shall include a "PDP SWQMP."**

The PDP SWQMP shall document that all permanent source control and site design BMPs have been

considered for the project and implemented where feasible; document the planning process and the decisions that led to the selection of structural BMPs; provide the calculations for design of structural BMPs to demonstrate that applicable performance standards are met by the structural BMP design; identify O&M requirements of the selected structural BMPs; and identify the maintenance mechanism (see Sections 7.2 and 7.3) for long-term O&M of structural BMPs. PDPs shall use the PDP SWQMP Template provided in Appendix A, which will include forms and/or checklists included in Appendix I of this Manual as well as checklists for documentation of pollutant control and hydromodification management structural BMP design. The PDP SWQMP shall include copies of the relevant plan sheets showing site design, source control, and structural BMPs, and structural BMP maintenance requirements.

**A PDP SWQMP must be provided with the first submittal of a project application.**

Storm water requirements will directly affect the layout of the project. Storm water requirements must be considered from the initial project planning or in project concept stage, and will be reviewed upon each submittal, beginning with the first submittal. The process from initial project application through approval of the project plans often includes design changes to the site layout and features. Changes may be driven by storm water management requirements or other site requirements. Each time the site layout is adjusted, whether the adjustment is directly due to storm water management requirements identified during the City Engineer's review of the storm water submittal, or is driven by other site requirements, the storm water management design must be revisited to ensure the revised project layout and features meet the requirements of this Manual and the MS4 Permit. An updated PDP SWQMP must be provided with each submittal of revised project plans. The updated PDP SWQMP should include documentation of changes to the site layout and features, and reasons for the changes. In the event that other site requirements identified during plan review render certain proposed storm water features infeasible (e.g. if fire department access requirements were identified that precluded use of certain surfaces or landscaping features that had been proposed), this must be documented as part of the decisions that led to the development of the final storm water management design.

Priority Projects shall use the City of Oceanside PDP SWQMP Template provided in Appendix A, which will include the required forms and/or checklists included in Appendix I of this Manual as well as other checklists, exhibits, and documentation required by the City. BMP exhibits shall be provided in 24"x36" format.

### **8.2.1.1 PDP O&M Plan**

**While the PDP SWQMP must include general O&M requirements for structural BMPs, the PDP SWQMP may not be the final O&M Plan.**

The O&M requirements documented in the PDP SWQMP must be sufficient to show that O&M requirements have been considered in the project planning and design. However, a final O&M Plan should reflect actual constructed structural BMPs to be maintained. Photographs and as-built plans for the constructed structural BMPs should be included. Local jurisdictions may have varying requirements for a final O&M Plan. Requirements may also vary depending on whether long-term O&M will be furnished by a public agency or private entity. See Section 8.2.3 for project closeout procedures including City requirements for final O&M Plans, and Section 8.2.4 for additional requirements for private entity O&M of structural BMPs.

## **8.2.2 Requirements for Construction Plans**

### **8.2.2.1 BMP Identification and Display on Construction Plans**

Plans for construction of the project (grading plans, improvement plans, and landscaping plans, as applicable) must show all permanent site design, source control, and structural BMPs, and must be congruent with the PDP SWQMP.

Local jurisdictions may have varying requirements for identification and display of BMPs on plans.

Details and cross sections shall be provided showing the thickness of soil profiles, underdrain specifications, ponding depths, and proprietary devices.

### **8.2.2.2 Structural BMP Maintenance Information on Construction Plans**

Plans for construction of the project must provide sufficient information to describe maintenance requirements (thresholds and actions) for structural BMPs such that in the event all other separate O&M documents were lost, a new party studying plans for the project could identify the structural BMPs and identify the required maintenance actions based on the plans.

For the purpose of long-term O&M, the project plans must identify the following:

- How to access the structural BMP to inspect and perform maintenance;
- Features that are provided to facilitate inspection (e.g. observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds);
- Manufacturer and part number for proprietary parts;
- Maintenance thresholds specific to the structural BMP, with a location-specific frame of reference (e.g. level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP);
- Recommended equipment to perform maintenance; and
- When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management.

Specific requirements for providing storm water maintenance information on construction plans may vary by jurisdiction.

## **8.2.3 Design Changes During Construction and Project Closeout Procedures**

### **8.2.3.1 Design Changes During Construction**

Prior to occupancy and/or intended use of any portion of a PDP, the site must be in compliance with the requirements of this Manual and the MS4 Permit.

During construction, any changes that affect the design of storm water management features must be reviewed and approved by the City. Approved documents and additional design may be required prior to implementation of design changes during construction. This might include changes to drainage patterns that occurred based on actual site grading and construction of storm water conveyance structures or substitutions to storm water management features. Just as during the design phase, when there are changes to the site layout and features, the storm water management design must be revisited to ensure the revised project layout and features meet the requirements of this Manual and the MS4 Permit.

Construction changes that affect structural BMPs should be evaluated and if necessary, a Plan Change with a SWQMP Addendum must be processed. Submittal documents for a Plan Change and SWQMP Addendum may include (but not be limited) to the following:

- Original permitted set of plans redlined with changes shown bubbled and deltas added to identify proposed changes;
- Original approved SWQMP with revisions; and
- Revisions to the Drainage Study (if applicable).

### 8.2.3.2 Certification of Constructed BMPs

**As part of the "Structural BMP Approval and Verification Process" required by the MS4 Permit, each structural BMP must be inspected to verify that it has been constructed and is operating in compliance with all of its specifications, plans, permits, ordinances, and the requirements of the MS4 Permit.**

Since some portions of the structural BMP will not be readily visible after completion of construction (e.g. subsurface layers), the City Engineer will require inspections during construction, photographs taken during construction, and/or other certification that the BMP has been constructed in conformance with the approved plans. The City Engineer may require forms or other documentation be submitted prior to the inspection in order to facilitate the structural BMP inspection. Specific requirements for this process during construction of a project may vary by jurisdiction.

The applicant should anticipate the City of Oceanside performing interim and final inspection of all installed BMPs.

### 8.2.3.3 Final O&M Plan

**Upon completion of project construction, the City may require a final O&M Plan to be submitted.**

A final O&M Plan reflects project-specific constructed structural BMPs with project-specific drawings, photographs, and maps, and identifies specific maintenance requirements and actions for the constructed structural BMPs. Specific requirements and review procedures for this process may vary by jurisdiction, or vary based on the planned maintenance entity (public or private).

A final O&M plan is required to be approved, with the final SWQMP, to obtain an administrative permit.

## **8.2.4 Additional Requirements for Private Entity O&M**

This Section discusses private structural BMPs to be operated and maintained on private property by the property owner or manager.

### **8.2.4.1 O&M Agreements for Private Structural BMP Maintenance**

**For privately owned and operated structural BMPs, the City requires execution of an O&M Agreement document.**

An O&M Agreement is a recorded document signed by the City and the property owner committing the property owner to maintain the permanent structural BMPs into perpetuity. The O&M Agreement may provide that, if the property owner fails to maintain the storm water facilities, the City may enter the property, restore the storm water facilities to operable condition, and obtain reimbursement, including administrative costs, from the property owner. Specific requirements and procedures for this process may vary by jurisdiction.

The City Standard Storm Water Facilities Maintenance Agreement with Access Rights and Covenants (SWFMA) is a recorded agreement for the maintenance and repair of storm water management facilities, entered into between the Owner and the City of Oceanside. The SWFMA provide the City with access rights for the purpose of annual inspections, as required by the Municipal Permit, and to possibly perform BMP maintenance should the owner default. The SWFMA and additional information can be found through the following link as of the date of this Manual:

<http://www.ci.oceanside.ca.us/gov/dev/eng/stormwater/review/maint.asp>

### **8.2.4.2 Interim Security Period of Maintenance Funding for Private Structural BMP Maintenance**

The SWFMA includes a non-refundable security to assure faithful performance of the obligations of the agreement. The security is based upon a Storm Water Facilities BMP Maintenance Estimate prepared by a Registered Civil Engineer. The security amount is based upon annual BMP maintenance costs multiplied by a factor of ten (10); not to exceed \$25,000.00.

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# CITY OF OCEANSIDE

## BMP DESIGN MANUAL

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**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

# **Submittal Templates**

# Appendix A Submittal Templates

The following templates were developed to assist the project applicant and the plan reviewer:

- Standard SWQMP
- PDP SWQMP

Please refer to the City of Oceanside website to download the applicable template.

## A.1 Standard SWQMP

The Standard SWQMP template can be accessed through the following links as of the date of this Manual:

Microsoft Word (.doc) version:

<https://www.ci.oceanside.ca.us/civica/filebank/blobdload.asp?BlobID=44159>

Portable Document Format (.pdf) version:

<https://www.ci.oceanside.ca.us/civica/filebank/blobdload.asp?BlobID=41676>

## A.2 PDP SWQMP

The PDP SWQMP template can be accessed through the following links as of the date of this Manual:

Microsoft Word (.doc) version:

<https://www.ci.oceanside.ca.us/civica/filebank/blobdload.asp?BlobID=44158>

Portable Document Format (.pdf) version:

<https://www.ci.oceanside.ca.us/civica/filebank/blobdload.asp?BlobID=41675>

Appendix

**B**

**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

# **Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods**

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January 2022

# Appendix B Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

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- B.2. Adjustments to Account for Site Design BMPs
- B.3. Harvest and Use BMPs
- B.4. Infiltration BMPs
- B.5. Biofiltration BMPs
- B.6. Flow-Thru Treatment Control BMPs (for use with Alternative Compliance)

## B.1 DCV

The DCV represents the volume of storm water runoff that must be retained and/or biofiltered in order to satisfy pollutant control requirements. The DCV can be calculated through use of the [Automated Stormwater Pollutant Control Worksheets](#), or can be calculated manually by following hydrologic method:

$$DCV = C \times d \times A \times 43,560 \text{ sf/ac} \times 1/12 \text{ in/ft}$$

$$DCV = 3,630 \times C \times d \times A$$

Where:

DCV = Design Capture Volume in cubic feet

C = Runoff factor (unitless); refer to section B.1.1

d = 85<sup>th</sup> percentile, 24-hr storm event rainfall depth (inches), refer to section B.1.3

A = Tributary area (acres) which includes the total area draining to the BMP, including any offsite or onsite areas that comingles with project runoff and drains to the BMP. Refer to Chapter 3, Section 3.3.3 for additional guidance. Street redevelopment projects consult section 1.4.3.

### B.1.1 Runoff Factor

Estimate the area weighted runoff factor for the tributary area to the BMP using runoff factor (from Table B.1-1) and area of each surface type in the tributary area and the following equation:

$$C = \frac{\sum C_x A_x}{\sum A_x}$$

Where:

C<sub>x</sub> = Runoff factor for area X

A<sub>x</sub> = Tributary area X (acres)

These runoff factors apply to areas receiving direct rainfall only. For conditions in which runoff is routed onto a surface from an adjacent surface, see Section B.2 for determining composite runoff factors for these areas.

**Table B.1-1: Runoff factors for surfaces draining to BMPs – Pollutant Control BMPs**

Surface	Runoff Factor
Roofs <sup>1</sup>	0.90
Concrete or Asphalt <sup>1</sup>	0.90
Unit Pavers (grouted) <sup>1</sup>	0.90
Decomposed Granite	0.30
Cobbles or Crushed Aggregate	0.30

1. Surface is considered impervious and could benefit from use of Site Design BMPs and adjustment of the runoff factor per Section B.2.1.

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Surface	Runoff Factor
Amended, Mulched Soils or Landscape	0.10
Compacted Soil (e.g., unpaved parking)	0.30
Natural (A Soil)	0.10
Natural (B Soil)	0.14
Natural (C Soil)	0.23
Natural (D Soil)	0.30

### B.1.2 85th Percentile, 24-Hour Storm Event

The rainfall depth (D) used to calculate the DCV is determined through examination of the 85th percentile, 24-hour isopluvial map provided in Figure B.1-1. The isopluvial map represents rainfall depths as blue line work provided at 0.02” intervals. Appropriate rainfall depths should be determined by plotting the project location on the map, examining adjacent rainfall depths, and interpolating an appropriate depth to the nearest hundredth of an inch (i.e. 0.71 inch). GIS versions of the map are also available for download at the following links.

GIS Shapefile: (Under Ecology category)

<http://www.sangis.org/download/index.html>

GIS Viewer:

<https://gis-portal.sandiegocounty.gov/arcgis/home/webmap/viewer.html?webmap=86acb8999b1942f49ce3271078cb8716&extent=-117.7893,32.5252,-115.761,33.5143>

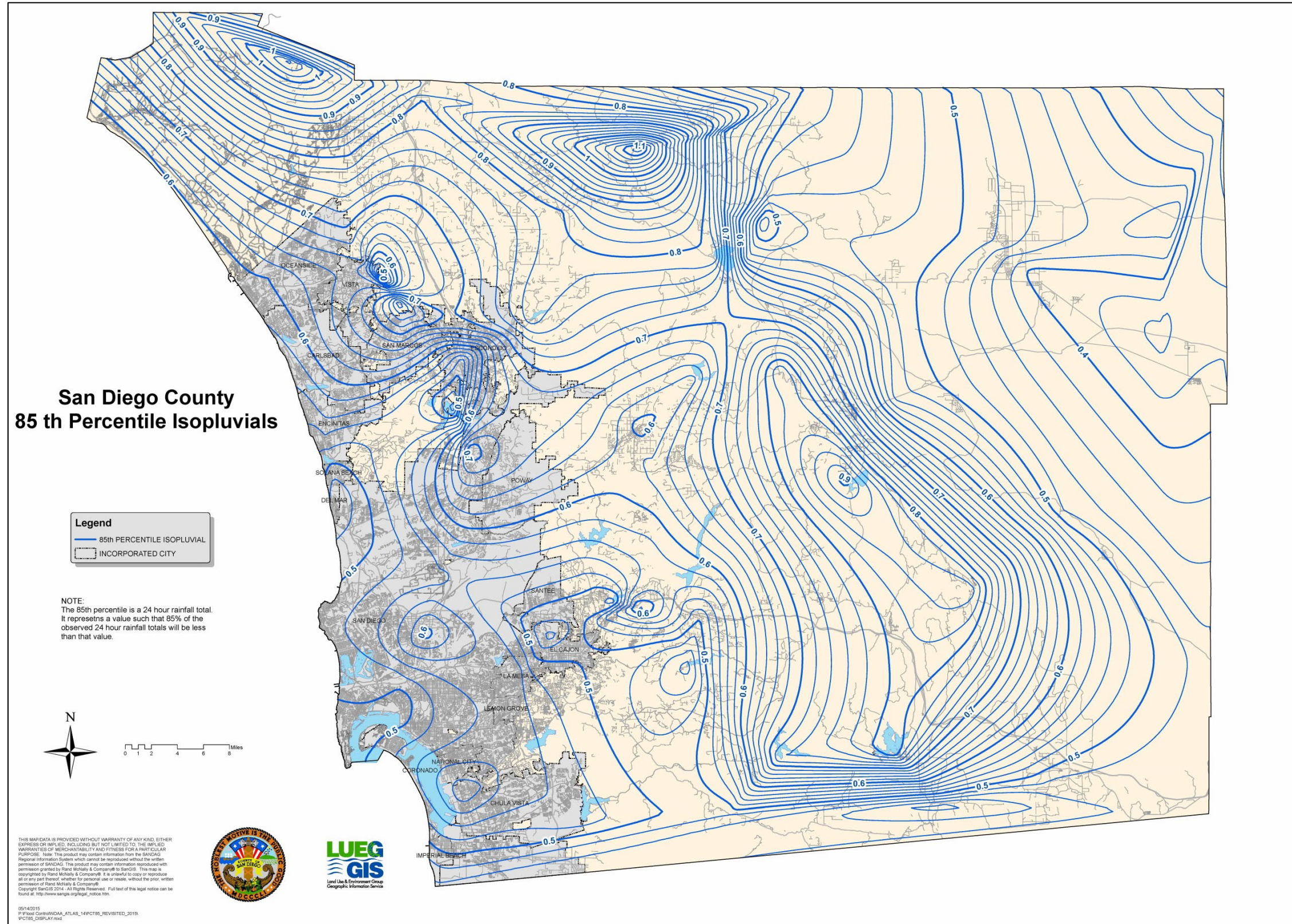


Figure B.1-1: 85th Percentile 24-hour Isopluvial Map

### B.1.3 Adjustments to Account for Site Design BMPs

This section provides methods to adjust the DCV (for sizing pollutant control BMPs) as a result of implementing site design BMPs. The adjustments are provided by one of the following two methods:

- Adjustment to impervious runoff factor
- Adjustment to DCV

#### Adjustment to Impervious Runoff Factor

When one of the following site design BMPs is implemented the runoff factor of 0.9 for impervious surfaces identified in Table B.1-1 should be adjusted using the factors listed below and an adjusted area weighted runoff factor shall be estimated following guidance from Section B.1.1 and used to calculate the DCV.

- SD-5 Impervious area dispersion
- SD-6A Green roofs
- SD-6B Permeable pavement

#### Impervious area dispersion (SD-5)

Dispersion of impervious areas through pervious areas: The following adjustments are allowed to impervious runoff factors when dispersion is implemented in accordance with the SD-5 fact sheet (Appendix E). Adjustments are only credited up to a 4:1 maximum ratio of impervious to pervious areas. In order to adjust the runoff factor, the pervious area shall have a minimum width of 10 feet and a maximum slope of 5%. Based on the ratio of **impervious area to pervious area** and the hydrologic soil group of the pervious area, the adjustment factor from Table B.2-1 shall be multiplied with the unadjusted runoff factor (Table B.1-1) of the impervious area to estimate the adjusted runoff factor for sizing pollutant control BMPs. The adjustment factors in Table B.2-1 are **only** valid for impervious surfaces that have an unadjusted runoff factor of 0.9.

Table B.1-2: Impervious area adjustment factors that accounts for dispersion

Pervious Area Hydrologic Soil Group	Ratio = Impervious Area/Pervious Area			
	<=1	2	3	4
A	0.00	0.00	0.21	0.32
B	0.00	0.24	0.38	0.48
C	0.31	0.50	0.60	0.67
D	0.77	0.84	0.87	0.90

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Continuous simulation modeling in accordance with Appendix G is required to develop adjustment factors for surfaces that have an unadjusted runoff factor less than 0.9. Approval of adjustment factors for surfaces that have an unadjusted runoff factor less than 0.9 is at the discretion of the City Engineer.

When using adjustment factors from Table B.2-1:

- **Linear interpolation** shall be performed if the impervious to pervious area ratio of the site is in between one of ratios for which an adjustment factor was developed;
- Use adjustment factor for a ratio of 1 when the impervious to pervious area ratio is less than 1; and
- Adjustment factor is not allowed when the impervious to pervious area ratio is greater than 4, when the pervious area is designed as a site design BMP.

### Green Roofs

When green roofs are implemented in accordance with the SD-6A factsheet the green roof footprint shall be assigned a runoff factor of 0.10 for adjusted runoff factor calculations.

### Permeable Pavement

When a permeable pavement is implemented in accordance with the SD-6B factsheet and it does not have an impermeable liner and has storage greater than the 85<sup>th</sup> percentile depth below the underdrain, if an underdrain is present, then the footprint of the permeable pavement shall be assigned a runoff factor of 0.10 for adjusted runoff factor calculations.

Permeable Pavement can also be designed as a structural BMP to treat run on from adjacent areas. Refer to INF-3 factsheet and Appendix B.4 for additional guidance.

### B.1.4 Adjustment to DCV

When the following site design BMPs are implemented the anticipated volume reduction from these BMPs shall be deducted from the DCV to estimate the volume for which the downstream structural BMP should be sized for:

- SD-1: Street trees
- SD-8 Rain barrels

### Tree Wells

Street tree credit volume from tree trenches or boxes (tree BMPs) is a sum of three runoff reduction volumes provided by trees that decrease the required DCV for a tributary area. The following reduction in DCV is allowed per tree based on the mature diameter of the tree canopy, when trees are

## Appendix B: Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

implemented in accordance with SD-1 factsheet and meet the following criteria:

- Total tree credit volume is less than 0.25DCV of the project footprint and
- Single tree credit volume is less than 400 ft<sup>3</sup>

Credit for trees that do not meet the above criteria shall be based on the criteria for sizing the tree as a storm water pollutant control BMP in SD-1 fact sheet.

Mature Tree Canopy Diameter (ft)	Tree Credit Volume (ft <sup>3</sup> /tree)
5	10
10	40
15	100
20	180
25	290
30	420

### *Basis for the reduction in DCV:*

Tree credit volume was estimated based on typical characteristics of street trees as follows:

It is assumed that each tree and associated trench or box is considered a single BMP, with calculations based on the media storage volume and/or the individual tree within the tree BMP as appropriate. Tree credit volume is calculated as:

$$TCV = TIV + TCIV + TETV$$

Where:

- $TCV$  = Tree credit volume (ft<sup>3</sup>)
- $TIV$  = Total infiltration volume of all storage layers within tree BMPs (ft<sup>3</sup>)
- $TCIV$  = Total canopy interception volume of all individual trees within tree BMPs (ft<sup>3</sup>)
- $TETV$  = Total evapotranspiration volume, sums the media evapotranspiration storage within each tree BMP (ft<sup>3</sup>)

Total infiltration volume was calculated as the total volume infiltrated within the BMP storage layers. Infiltration volume was assumed to be 20% of the total BMP storage layer volume, the available pore space in the soil volume (porosity – field capacity). Total canopy interception volume was calculated for all street trees within the tributary area as the average interception capacity for the entire mature tree total canopy projection area. Interception capacity was determined to be 0.04 inches for all street tree sizes, an average from the findings published by Breuer et al (2003) for coniferous and deciduous trees. Total evapotranspiration volume is the available evapotranspiration storage volume (field

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capacity – wilting point) within the BMP storage layer media. TEVT is assumed to be 10% of the minimum soil volume. The minimum soil volume as required by SD-1 fact sheet of 2 cubic feet per unit canopy projection area was assumed for estimating reduction in DCV.

### **Rain Barrels**

Rain barrels are containers that can capture rooftop runoff and store it for future use. Credit can be taken for the full rain barrel volume when each barrel volume is smaller than 100 gallons, implemented per SD-8 fact sheet and meet the following criteria:

- Total rain barrel volume is less than 0.25 DCV and
- Landscape areas are greater than 30 percent of the project footprint.

Credit for harvest and use systems that do not meet the above criteria shall be based on the criteria in Appendix B.3 and HU-1 fact sheet.

## B.2 Determine Retention Requirements

The second step in performing storm water pollutant control calculations is to determine the retention requirements for each drainage area. Retention requirements can be calculated through use of the automated Worksheet B.2, or can be calculated manually by following guidance in Sections B.3.1 through B.3.4 below.

### B.2.1 Capture and Use Analysis

**Projects that do not proposed habitable structures over 9 stories tall may skip this step (Proceed to B.3.2)**

Projects that propose habitable structures over 9 stories tall are required to perform a capture and use analysis to identify whether the DCV from the project site can be utilized for onsite toilet flushing and/or irrigation within 36 hours of the storm. If the results indicate capture and use is possible, then the project is required to implement capture and use. Guidance for performing this analysis is provided in B.3.8.

### B.2.2 Infiltration Restrictions

The SWQMP Preparer is responsible for evaluating the infiltration restrictions in Form 4 of the PDP SWQMP Template and characterizing each drainage area as Restricted or Unrestricted for infiltration.

Restriction elements are divided into Mandatory Considerations and Optional Considerations. Mandatory Considerations include elements that may pose a significant risk to human health and safety. These elements must always be evaluated and discretion regarding the setbacks is not permitted. Optional Considerations include elements that are not necessarily associated with human health and safety, so analysis is not mandated through this guidance document.

Analysis of these elements is outside of the scope of typical geotechnical engineering investigations; therefore, it is the responsibility of the SWQMP Preparer to perform this evaluation. If a geotechnical engineer is consulted to complete this portion of the analysis, additional discretion on the mandatory considerations may be permitted if supported by the geotechnical reporting.

### B.2.3 Design Infiltration Rate

The design infiltration rate for each drainage area must be determined through either a basic or advanced analysis. The basic analysis allows the SWQMP Preparer to assign a default design infiltration rate based on the predominant NRCS soil type present within the proposed BMP footprint. The advanced analysis allows for a geotechnical engineer to assign a more specific design infiltration

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rate based on field testing outlined in Appendix D. Table B.2-3 below identifies the design infiltration rates that can be used for each analysis. Please note that the basic analysis is not permitted for BMPs that lack an underdrain.

**Table B.2-1: Design Infiltration Rate**

Infiltration Restrictions	Design Infiltration Rate (in/hr)	
	Option 1: Basin Analysis	Option 2: Advanced Analysis
Unrestricted	Type A Soil = 0.300	Rate recommended by geotechnical engineer (Reference Appendix D)
Unrestricted	Type B Soil = 0.200	
Unrestricted	Type C Soil = 0.100	
Unrestricted	Type D Soil = 0.025	
Restricted	Any Soil = 0.000	0.000

### B.2.4 Retention Requirements

Using information determined in previous steps, the retention requirements for each drainage area can now be determined. Retention requirements can be expressed as a function of the DCV or as a percentage of annual runoff that must be retained within the drainage area.

**Part 1)** Using Figure B.2-1, locate the applicable Design Infiltration Rate (determined in Step 2A) along the x-axis. Trace vertically from the x-axis result to the intersect with the plot representing the project's 85th Percentile Rainfall Depth (determined in Step 1A).

Note: Data presented in Figure B.2-1 represents ranges of rainfall depth. Users should choose the range that includes their specific rainfall depth rather than interpolating or extrapolating discrete values between the plotted lines.

**Part 2)** Trace horizontally from the intersect result to the right hand y-axis to identify the fraction of the DCV that must be retained to satisfy retention requirements (F).

Note: Retention requirements can also be expressed as a fraction of annual runoff by tracing horizontally from the intersect result to the left hand y-axis. This method is appropriate if the proposed retention elements have drawdown times significantly different than 36-hours.

**Part 3)** Determine the total volume required to be retained for the drainage as follows.

$$V_{REQ} = DCV \times F_{DCV}$$

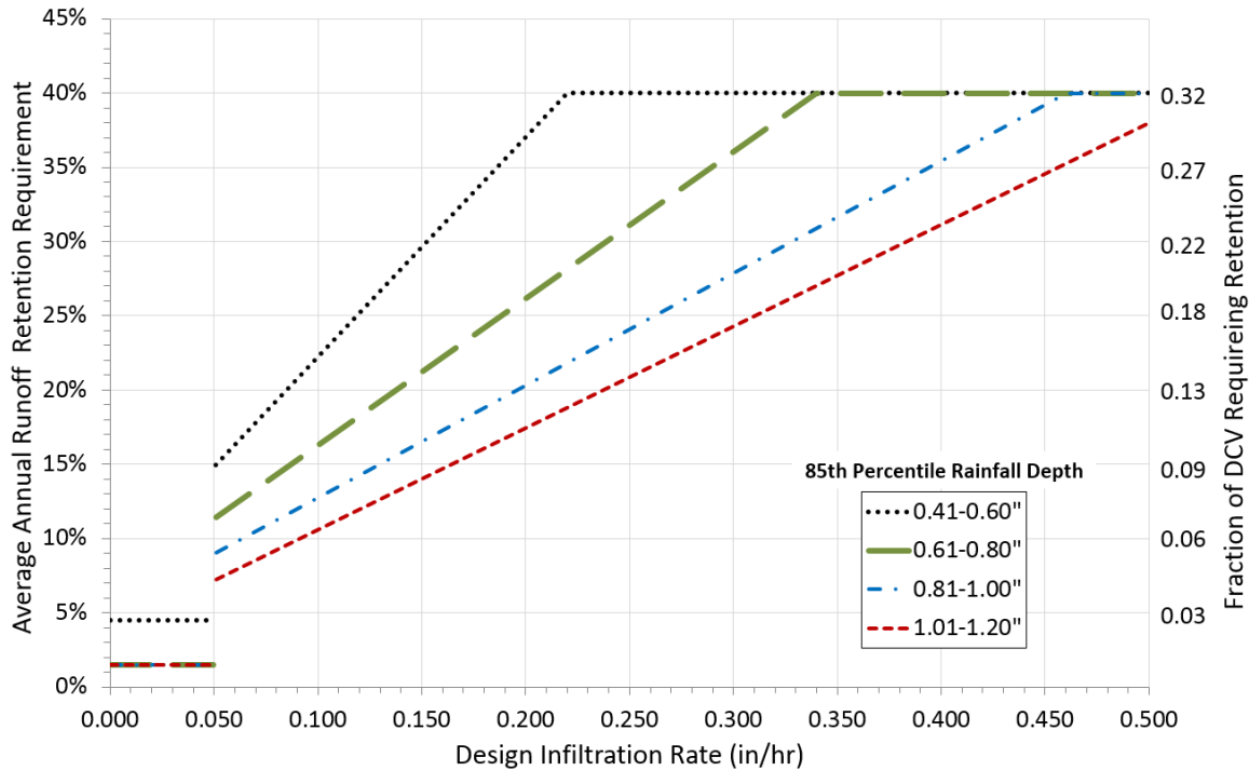
Where:

$V_{REQ}$ : Total volume that must be retained within the drainage area (ft<sup>3</sup>)

DCV: Design capture volume (ft<sup>3</sup>)

$F_{DCV}$ : Fraction of DCV requiring retention (unitless)

Figure B.2-1: Retention Requirements



## B.3 BMP Performance

The third step in performing stormwater pollutant control calculations is to design a structural BMP with the characteristics that provide stormwater treatment for the DCV and meet the minimum retention requirements for the drainage area. Demonstration of appropriate BMP design can be calculated through use of Automated Worksheet B.3, or can be calculated manually by following the steps presented in this section.

### B.3.1 BMP Characteristics

The performance of a BMP is a function of its retention and biofiltration processes, which are directly related to the proposed BMP geometry and design components. The SWQMP Preparer should design the BMP characteristics summarized below to satisfy pollutant control performances standards for treatment of the DCV and minimum retention requirements.

- BMP geometries identify the area and depth over which retention and/or biofiltration processes occur. Critical BMP geometries include: BMP surface area, surface ponding depth, biofiltration soil media depth, gravel depth, underdrain depth, and underdrain diameter.

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- BMP components dictate how retention and biofiltration processes occur over the BMP footprint. Critical BMP components include: vegetation vs no vegetation, standard biofiltration soil media vs non-standard biofiltration soil media, impermeable liner vs no impermeable liner, underdrain vs no underdrain, and design infiltration rates.

The most common BMPs proposed for storm water compliance are infiltration BMPs, bioretention BMPs, and biofiltration BMPs. By default, these BMPs must be sized to provide a surface area that is equal to at least 3% of the tributary effective impervious area. If a smaller BMP surface area is desired, the applicant must complete Major Maintenance Interval calculations presented in Appendix B.4.1.

### B.3.2 Retention Processes

BMP retention processes include infiltration and evapotranspiration occurring within the BMP. This section presents how to calculate the retention processes.

**Part 1)** Determine the volume of infiltration occurring within the BMP during a 6 hour storm event. This volume is a function of the design infiltration rate, BMP surface area, and duration of the storm event as shown below.

$$V_{R6} = I/12 \times B \times 6 \text{ hours}$$

Where:

$V_{R6}$ : Volume infiltrated during a 6 hour storm event (ft<sup>3</sup>)

I: Design infiltration rate (in/hr)

B: BMP surface area (ft<sup>2</sup>)

**Part 2)** Determine the static retention capacity of the BMP assuming it is entirely full. This volume is a function of the BMP surface area and the effective retention depth as shown below.

$$V_{RS} = B \times E_D$$

Where:

$V_{RS}$ : Static retention capacity of the BMP (ft<sup>3</sup>)

B: BMP surface area (ft<sup>2</sup>)

$E_D$ : The effective retention depth within all layers of the BMP (ft). This depth is calculated by multiplying the geometric depth (ft) of each BMP layer by the appropriate retention pore space factor in Table B.3-x below and summing all of the layers.

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**Table B.3-1: Design Infiltration Rate**

BMP Characteristics	Unlined BMPs Without Underdrain	All Other Biofiltration/Retention BMPs
Ponding Pore Space	1.00	0.00
Media Pore Space	0.25 vegetated 0.40 non-vegetated	0.05
Gravel Pore Space Above Uderdrain	0.40	0.00
Gravel Pore Space Below	n/a	0.40

**Part 3)** Determine the fraction of the DCV retained by the BMP. This value is a function of the DCV, volume infiltrated during the 6 hour storm event, and static retention capacity of the BMP as shown below.

$$F_{DCV} = (V_{R6} + V_{RS})/DCV$$

Where:

$F_{DCV}$ : Fraction of the DCV retained by the BMP (decimal)

$V_{R6}$ : Volume infiltrated during a 6 hour storm event (ft<sup>3</sup>)

$V_{RS}$ : Static retention capacity of the BMP (ft<sup>3</sup>)

DCV: Design Capture Volume (ft<sup>3</sup>)

**Part 4)** Determine the drawdown time for the effective retention depth. This value is a function of the effective retention depth and the design infiltration rate of the BMP as shown below.

$$T_R = E_D/(I/12)$$

Where:

$T_R$ : Drawdown time for effective retention depth (hrs)

$E_D$ : The effective retention depth within all layers of the BMP (ft).

I: Design infiltration rate (in/hr). If this rate is 0.000 (i.e. lined BMP), a 120 hour drawdown time for the effective retention depth may be assumed.

**Part 5)** Determine the average annual percent capture provided by the BMP using Figure B.3-1 on the next page.

- a) Identify the fraction of the DCV retained by the BMP ( $F_{DCV}$ ) on the x axis.
- b) Trace vertically from the x-axis result to the intersect with the plot representing the drawdown time for the effective retention depth ( $T_R$ ). Interpolation between the plotted drawdown times may be necessary.
- c) Trace horizontally from the intersect result to identify the average annual percent capture of the proposed BMP.

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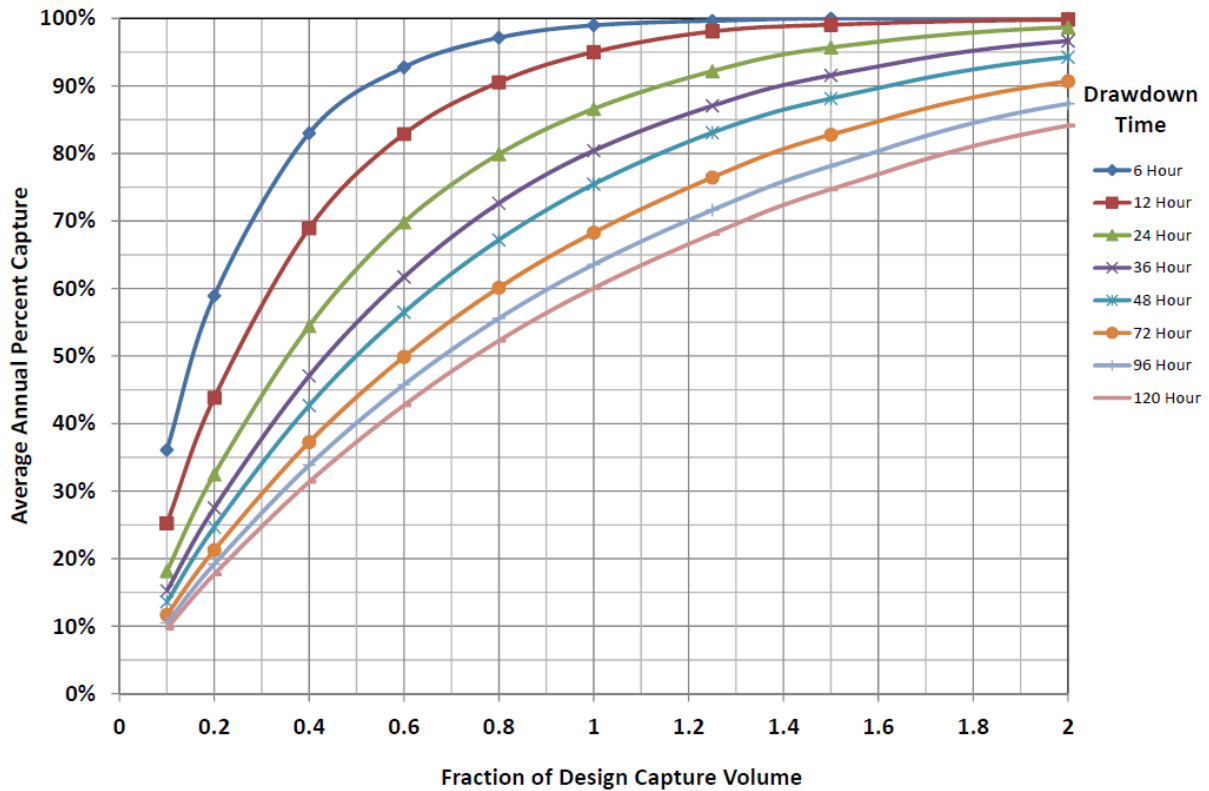


Figure B.3-1: Percent Capture Nomograph

**Part 6)** Determine the efficacy of the retention processes provided by the BMP. This value represents the portion of the pollutant control performance standard that is satisfied through retention processes of the BMP and is calculated as follows.

$$E_R = P_C / 80\%$$

Where:

$E_R$ : Efficacy of retention processes (decimal)

$P_C$ : Average Annual Percent Capture (%)

**Part 7)** Determine the total volume retained by the proposed BMP.

$$V_{RBMP} = DCV \times E_R$$

Where:

$V_{RBMP}$ : Total volume retained by BMP ( $ft^3$ )

DCV: Design capture volume ( $ft^3$ )

$E_R$ : Efficacy of retention processes (decimal)

**Part 8)** Determine the volume of storm water runoff still available for biofiltration treatment as shown

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below. If the entire volume is retained, then consideration of biofiltration processes in the next step are not required.

$$V_A = DCV - V_{RBMP}$$

Where:

$V_A$ : Volume of storm water runoff still available for biofiltration treatment (ft<sup>3</sup>)

DCV: Design capture volume (ft<sup>3</sup>)

$V_{RBMP}$ : Total volume retained by BMP (ft<sup>3</sup>)

### B.3.3 Biofiltration Processes

Any portion of the DCV that has not been retained within site design or structural BMP elements must be biofiltered. BMP biofiltration processes include filtration, sedimentation, sorption, biochemical processes and/or vegetative uptake. This section presents how to calculate the biofiltration processes occurring within the proposed BMP.

**Part 1)** Determine the filtration rate (in/hr) of the proposed BMP. This is the rate in which storm water biofilters through the BMP and exits through the underdrain. Filtration rates can be governed by characteristics of the biofiltration soil media or by flow restrictions experienced due to the design of the BMP underdrain/orifice. Applicants must evaluate the rates associated with each of these components per the equations below and then select the lowest filtration rate for use in determining the BMP performance.

$$F_{\text{underdrain}} = (43,200CA_0\sqrt{2GH})/B$$

$$F_{\text{soil}} = 5 \text{ in/hr}$$

$$F_{\text{BMP}} = \text{MINIMUM } (F_{\text{underdrain}}, F_{\text{soil}})$$

Where:

$F_{\text{underdrain}}$ : The filtration rate (in/hr) accommodated by the proposed BMP underdrain/orifice.

C: Orifice Coefficient (default 0.60)

$A_0$ : Area of Underdrain/Orifice (ft<sup>2</sup>)

G: Gravitational acceleration (32.2 ft/sec<sup>2</sup>)

H: Height of water from underdrain invert to top of surface ponding (ft)

B: BMP Surface Area (ft<sup>2</sup>)

$F_{\text{soil}}$ : The filtration rate (in/hr) accommodated by the proposed biofiltration soil media in typical conditions. The default soil media filtration rate is 5 in/hr; however, a higher rate may be used if supported per criteria in Section F.2.

$F_{\text{BMP}}$ : The filtration rate (in/hr) of the proposed BMP

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**Part 2)** Determine the volume of biofiltration occurring within the BMP during a 6 hour storm event. This volume is a function of the BMP filtration rate, BMP surface area, and the rainfall duration as shown below.

$$V_{BS} = B \times E_{DB}$$

Where:

$V_{BS}$ : Volume of water (ft<sup>3</sup>) biofiltered during a 6 hour storm event.

$F_{BMP}$ : Filtration rate (in/hr) of the proposed BMP.

B: BMP surface area (ft<sup>2</sup>)

**Part 3)** Determine the static biofiltration capacity of the BMP assuming it is entirely full. This volume is a function of the BMP surface area and the effective biofiltration depth as shown below.

$$V_{BS} = B \times E_{DB}$$

Where:

$V_{BS}$ : Static biofiltration capacity of the BMP (ft<sup>3</sup>)

B: BMP surface area (ft<sup>2</sup>)

$E_{DB}$ : The effective biofiltration depth within all layers of the BMP (ft). This depth is calculated by multiplying the geometric depth (ft) of each BMP layer by the appropriate biofiltration pore space factor in Table B.3-2 below and summing all of the layers.

**Table B.3-2: Biofiltration Pore Space Factors**

BMP Characteristics	Unlined BMPs Without Underdrain	All Other Biofiltration/Retention BMPs
Ponding Pore Space	n/a	1.00
Media Pore Space	n/a	0.20 vegetated 0.35 non-vegetated
Gravel Pore Space Above Underdrain	n/a	0.40
Gravel Pore Space Below underdrain	n/a	0.00

**Part 4)** Determine the drawdown time (hours) for surface ponding. This is the ponding depth divided by the sum of the design infiltration rate and BMP filtration rate. Surface ponding depths of 24 hours or less are typically required; however, longer drawdown times up to 96 hours may be proposed if supported by a landscape architect/agronomist and no safety hazards are anticipated due to excessive ponding. Surface ponding drawdown times over 96 hours are not permitted due to vector concerns.

$$T_P = D_P / (I + F_{BMP})$$

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Where:

$T_p$ : Time (hours) for the BMP surface ponding depth to draw down.

$D_p$ : Surface ponding depth (inches) of the proposed BMP.

$I$ : Design infiltration rate (in/hr)

$F_{BMP}$ : BMP filtration rate (in/hr)

**Part 5)** Determine the efficacy of the biofiltration processes provided by the BMP. This value represents the portion of the pollutant control standard that is satisfied through the biofiltration processes of the BMP. There are two options available for establishing the biofiltration performance standard. Applicants may select the option of their choice. Option 1 requires that the BMP treat 1.5 times the portion of the DCV not reliably retained onsite (assuming a 6 hour routing period). Option 2 requires that the BMP treat 1.0 times the portion of the DCV not reliably retained onsite; and additionally check that the system has a total static (i.e., non-routed) storage volume, including pore spaces and pre-filter detention volume, equal to at least 0.75 times the portion of the DCV not reliably retained onsite.

$$E_{B1} = (V_{B6} + V_{BS}) / (1.50 \text{ DCV} - V_{RT})$$

$$E_{B2} = (V_{BS} / (0.75 \text{ DCV} - V_{RT}))$$

$$E_B = \text{Maximum } (E_{B1}, E_{B2})$$

Where:

$E_{B1}$ : Efficacy of biofiltration processes under option 1 (decimal).

$V_{B6}$ : The volume biofiltered (ft<sup>3</sup>) during the 6 hour storm event.

$V_{BS}$ : The static biofiltration capacity (ft<sup>3</sup>) of the BMP.

DCV: Design capture volume (ft<sup>3</sup>) delivered to BMP.

$V_{RT}$ : The volume retained (ft<sup>3</sup>) within the BMP.

$E_{B2}$ : Efficacy of biofiltration processes under option 2 (decimal).

$E_B$ : Efficacy of biofiltration processes provided by the BMP (decimal).

### B.3.4 Satisfaction of Pollutant Control Requirements

The performance of a BMP with respect to the pollutant control performance standards is referred to as the BMP efficacy. The total BMP efficacy is a function of the previously calculated retention efficacy and biofiltration efficacy as shown below.

$$E_T = E_R + (1.00 - E_R) \times E_B$$

Where:

$E_T$ : Total BMP Efficacy (decimal)

$E_R$ : Efficacy of retention processes (decimal)

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$E_B$ : Efficacy of biofiltration processes (decimal)

To satisfy pollutant control performance standards, the total BMP efficacy must be 100%. If this level of efficacy is not achieved, applicants should consider reconfiguring drainage layout and/or BMP designs as needed.

### B.3.5 Satisfaction of Minimum Retention Requirements

Minimum retention requirements can be satisfied by demonstrating that all of the retention elements incorporated within a drainage area (rain barrels, tree wells, dispersion areas, and BMPs) retain a volume of water that is greater than or equal to what is required.

**Part 1)** Determine the total volume retained through site design and structural BMP elements as follows.

$$V_{RT} = V_{RRB} + V_{RTW} + V_{RD} + V_{RBMP}$$

Where:

$V_{RT}$ : Total volume retained within the drainage area (ft<sup>3</sup>)

$V_{RRB}$ : Volume retained by rain barrels (ft<sup>3</sup>)

$V_{RTW}$ : Volume retained by tree wells (ft<sup>3</sup>)

$V_{RD}$ : Volume retained by dispersion areas (ft<sup>3</sup>)

$V_{RBMP}$ : Volume retained by the BMP (ft<sup>3</sup>)

**Part 2)** Demonstrate that the total volume retained through site design and structural BMP elements meets retention requirements.

$$V_{RT} \geq V_{REQ}$$

Where:

$V_{RT}$ : Total volume retained within the drainage area (ft<sup>3</sup>)

$V_{REQ}$ : Total volume that must be retained within the drainage area (ft<sup>3</sup>)

## B.4 Less Common Pollutant Control Calculations

This section presents methodologies for performing less common pollutant control calculations including: determination of BMP major maintenance intervals, capture and use evaluation, use of offline BMPs, and BMPs located downstream of a storage unit.

### B.4.1 Major Maintenance Intervals for Reduced Size BMPs

BMPs with a surface area sized at less than 3% of the tributary effective impervious area must perform additional calculations to determine the anticipated major maintenance intervals.

Major maintenance activities include items such as rehabilitation and/or replacement of the entire BMP or BMP components, which are independent of regularly scheduled annual maintenance. BMP major maintenance intervals can be calculated through use of automated Worksheet B.4 below, or can be calculated manually by following the steps presented in this section.

#### Annual Sediment Load Delivered to BMP

The annual sediment load delivered to a BMP is a function of the average annual storm water runoff, land use characteristics, and pretreatment elements applicable to the drainage area.

**Part 1)** Determine the average sediment concentration in storm water runoff from the land uses present within the drainage area by referring to the total suspended solid (TSS) concentrations listed for various land uses in Table B.4-1 below.

**Table B.4-1: TSS Concentrations by Land Use**

Land Use	TSS EMC, mg/L	C	Source
Single Family Residential	123	0.40	San Diego SBPAT EMC Dataset
Commercial	128	0.80	
Industrial	125	0.90	
Education (Municipal)	132	0.50	
Multi-family Residential	40	0.60	
Open Space	216	0.10	
Transportation	78	0.90	LASBAT EMC Dataset
Roof Runoff	14	0.90	Charters et al. (2015)
Low Traffic Areas	50	0.50	Davis and McCuen (2005)
Steep Hillslopes	797	0.30	Model BMPDM

If a drainage area is comprised of more than one land use type, a runoff-weighted TSS concentration

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must be calculated.

**Part 2)** Determine the average sediment concentration in storm water runoff as it enters the BMP. This is the concentration of TSS determined in part 1 after consideration of any “pretreatment” elements incorporated as shown below.

$$TSS_{BMP} = TSS_{AVG} \times (1 - P)$$

Where:

$TSS_{BMP}$ : Average sediment concentration in runoff entering the BMP (mg/L)

$TSS_{AVG}$ : Average sediment concentration in storm water from all tributary land uses (mg/L)

P: Pretreatment removal efficiency (%).

- P value of 0.00 should be used if there is no pretreatment.
- P value of 0.25 should be used when pretreatment is included.
- P value of 0.50 should be used if pretreatment consistent with Washington TAPE “Pre-treatment” BMP performance criteria are satisfied (>50% TSS removal)
- P value of 0.80 should be used if pretreatment consistent with Washington TAPE “Basic Treatment” performance criteria are satisfied (>80% TSS removal)

**Part 3)** Determine the average annual runoff volume entering the BMP. This is a function of the average annual precipitation, runoff factor, and drainage area as shown below.

$$V_{annual} = (D_{annual}/12) \times A \times C$$

Where:

$V_{annual}$ : Average annual runoff volume entering the BMP (ft<sup>3</sup>/year)

$D_{annual}$ : Average annual precipitation (inches/year)

A: Tributary Area (ft<sup>2</sup>)

C: Runoff factor (unitless)

**Part 4)** Determine the annual sediment load delivered to the BMP. This is a function of the average annual runoff volume and the average sediment concentration in stormwater from all tributary land uses as shown below.

$$L_{annual} = TSS_{BMP} \times V_{annual} \times 0.0000624$$

Where:

$L_{annual}$ : Annual sediment load delivered to the BMP (lbs/year)

$TSS_{BMP}$ : Average sediment concentration in runoff entering the BMP (mg/L)

$V_{annual}$ : Average annual runoff volume entering the BMP (ft<sup>3</sup>)

## Appendix B: Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

### BMP Sediment Capacity

The BMP sediment capacity is the weight of sediment (lbs) that can be stored within the BMP before significant clogging impacts begin to occur. The BMP sediment capacity can be determined as follows.

**Part 1)** Determine the appropriate load to clog value by referencing Table B.4-2 below and identifying the BMP configuration that best characterizes the proposed BMP design.

**Table B.4-2: Guidance for Selecting Load to Clog (LC)**

BMP Configuration	Load to Clog, $L_c$ , lb/sq-ft
<b>Default Load to Clog Value</b>	2
Greater than or equal to 75 percent vegetative cover	3
Greater than or equal to 20 to 30 in/hr media permeability and outlet flow control	3
Greater than or equal to 75 percent vegetative cover, greater than or equal to 30 in/hr media permeability and outlet flow control	4

**Part 2)** Determine the BMP Sediment Capacity (lbs) by multiplying the BMP Load to Clog by the BMP surface area.

$$C_{BMP} = B \times L_c$$

Where:

$C_{BMP}$ : BMP sediment capacity (lbs)

B: BMP Surface Area (ft<sup>2</sup>)

$L_c$ : BMP load to clog value (lbs/ft<sup>2</sup>)

### Major Maintenance Frequency

The major maintenance frequency can be calculated by dividing the BMP sediment capacity by the annual sediment load delivered to the BMP as shown below.

$$M_{BMP} = C_{BMP}/L_{annual}$$

Where:

$M_{BMP}$ : Major maintenance frequency for BMP (years)

$C_{BMP}$ : BMP sediment capacity (lbs)

$L_{annual}$ : Annual sediment load delivered to the BMP (lbs/yr)

The calculated major maintenance frequency must be 10 years or greater. If the calculated major sediment capacity and/or reduce the annual sediment load delivered to the BMP. In limited

## Appendix B: Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

circumstances, frequencies of less than 10 years may be acceptable if supported to the satisfaction of the City plan reviewer.

### **B.4.2 Capture and Use Evaluation**

If the proposed project includes habitable structures over 9 stories in height, the applicant must perform a capture and use evaluation as outlined herein.

The capture and use evaluation should be performed at the project-scale, and not be limited to a single DMA. This evaluation must identify the potential demand for using stormwater for indoor toilets and outdoor irrigation use and determine if this demand is sufficient to drawdown the DCV within a 36 hour time period.

#### **Toilet and Urinal Flushing Demand Calculations\***

The following guidelines should be followed for computing harvested water demand from toilet and urinal flushing:

- If reclaimed water is planned for use for toilet and urinal flushing, then the demand for harvested storm water is equivalent to the total demand minus the reclaimed water supplied, and should be reduced by the amount of reclaimed water that is available during the wet season.
- Demand calculations for toilet and urinal flushing should be based on the average rate of use during the wet season for a typical year.
- Demand calculations should include changes in occupancy over weekends and around holidays and changes in attendance/enrollment over school vacation periods.
- For facilities with generally high demand, but periodic shut downs (e.g., for vacations, maintenance, or other reasons), a project specific analysis should be conducted to determine whether the long term storm water capture performance of the system can be maintained despite shut downs.
- Such an analysis should consider the statistical distributions of precipitation and demand, most importantly the relationship of demand to the wet seasons of the year.

Table B.4-3 provides planning level demand estimates for toilet and urinal flushing per resident, or employee, for a variety of project types. The per capita use per day is based on daily employee or resident usage. For non-residential types of development, the “visitor factor” and “student factor” (for schools) should be multiplied by the employee use to account for toilet and urinal usage for non-employees using facilities.

## Appendix B: Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

**Table B.4-3. Toilet and Urinal Water Usage per Resident or Employee**

Land Use Type	Toilet User Unit of Normalization	Per Capita Use per Day		Visitor Factor <sup>4</sup>	Water Efficiency Factor	Total Use per Resident or Employee
		Toilet Flushing <sup>1, 2</sup>	Urinals <sup>3</sup>			
Residential	Resident	18.5	NA	NA	0.5	9.3
Office	Employee (non-visitor)	9.0	2.27	1.1	0.5	7 (avg)
Retail	Employee (non-visitor)	9.0	2.11	1.4	0.5	
Schools	Employee (non-student)	6.7	3.5	6.4	0.5	33
Various Industrial Uses (excludes process water)	Employee (non-visitor)	9.0	2	1	0.5	5.5

1 - Based on American Waterworks Association Research Foundation, 1999. Residential End Uses of Water. Denver, CO: AWWARF

2 - Based on use of 3.45 gallons per flush and average number of per employee flushes per subsector, Table D-1 for MWD (Pacific Institute, 2003)

3 - Based on use of 1.6 gallons per flush, Table D-4 and average number of per employee flushes per subsector, Appendix D (Pacific Institute, 2003)

4 - Multiplied by the demand for toilet and urinal flushing for the project to account for visitors. Based on proportion of annual use allocated to visitors and others (includes students for schools; about 5 students per employee) for each subsector in Table D-1 and D-4 (Pacific Institute, 2003)

5 - Accounts for requirements to use ultra low flush toilets in new development projects; assumed that requirements will reduce toilet and urinal flushing demand by half on average compared to literature estimates. Ultra low flush toilets are required in all new construction in California as of January 1, 1992. Ultra low flush toilets must use no more than 1.6 gallons per flush and Ultra low flush urinals must use no more than 1 gallon per flush. Note: If zero flush urinals are being used, adjust accordingly.

### Planning Level Irrigation Demands

To simplify the planning process, the method described above has been used to develop daily average wet season demands for a one-acre irrigated area based on the plant/landscape type. These demand estimates can be used to calculate the drawdown of harvest and use systems for the purpose of LID BMP sizing calculations.

**Table B.4-4. Planning Level Irrigation Demand by Plant Factor and Landscape Type**

General Landscape Type	36-Hour Planning Level Irrigation Demand (gallons per irrigated acre per 36 hour period)
Hydrozone – Low Plant Water Use	390
Hydrozone – Moderate Plant Water Use	1,470
Hydrozone – High Plant Water Use	2,640
Special Landscape Area	2,640

### B.4.3 BMPs Downstream of a Storage Unit

Incorporation of upstream storage units (cisterns, vaults, etc) into a project's design can regulate flows to downstream biofiltration BMPs and potentially optimize the required BMP footprints. Use of this approach is not supported by County automated worksheets, but compliance with stormwater pollutant control requirements can be demonstrated through the following steps.

**Step 1)** Determine the flow rate from the upstream storage unit

- Use the orifice equation to determine outflow from the storage unit when it is filled to the depth associated with the DCV.

**Step 2)** Demonstrate that the proposed BMP can accommodate flows from the storage unit

- Multiply the BMP surface area (ft<sup>2</sup>) by the filtration rate of the biofiltration soil media (in/hr) and divide by 43,200 to convert the units into CFS. For proprietary BMPs, this rate should correspond with the rates from certified testing the manufacturer has performed.

**Step 3)** Demonstrate that the proposed BMP biofilters 92% of the annual runoff volume

- If continuous simulation modeling has been performed, provide output reports from SWMM or SDHM modeling.
- If continuous simulation modeling has not been performed, reference the percent capture nomographs in Figure B.3-1 to determine the percentage of annual runoff that is biofiltered. To use the nomographs, applicants must represent the BMP storage capacity as a fraction of the DCV along the x-axis, trace a line vertically to the colored line representing the drawdown time of the system, and then determine the percentage of annual runoff biofiltered by tracing horizontally to the y-axis.

**Step 4)** If the downstream biofiltration BMP is <3% of the effective tributary area, provide information supporting use of compact biofiltration as generally outlined below.

- Retention Requirements: Demonstrate that minimum retention requirements from Section B.2 are satisfied.
- Maintenance Requirements: Demonstrate that the BMP design is expected to last 10 years before major maintenance is anticipated per Appendix B.4.1.
- Proprietary Requirements (if applicable): Provide proprietary information demonstrating that the device meets biofiltration criteria outlined in Appendices F.1-F.2.

### **B.4.4 Onsite Alternative Compliance**

If desired, a PDP applicant may generate stormwater pollutant control and/or hydromodification flow control benefits by managing stormwater flows from “excess areas” that are conveyed to the site. Management of flows from these excess areas may be used to offset flows from “required areas” that lack management.

Required areas are the areas of a project for which the Permit mandates pollutant control and/or HMP flow control requirements. Excess areas are the areas of a project for which the Permit does not mandate pollutant control and/or HMP flow control requirements. Areas of offsite run-on to the PDP site may always be considered excess areas. Additionally, for redevelopment projects falling under the 50% redevelopment threshold, onsite areas that are not being redeveloped may also be considered excess areas.

Compliance with stormwater pollutant control requirements using this onsite alternative compliance approach can be demonstrated as outlined below.

**Step 1)** Determine the untreated DCV from the required area

**Step 2)** Determine the treated DCV from the excess area

- If required areas and excess areas contain different land uses, a land use factor must be applied to account for variations in pollutant concentrations. In most cases, this factor results in a lower treatment volume being credited. Refer to the Water Quality Equivalency (WQE) document for guidance on determining a land use factor and note that the WQE terms “ACP tributary” and “reference tributary” correlate with “excess areas” and “required areas” respectively.

**Step 3)** Demonstrate compliance

- Show that the treated DCV from the excess area is greater than or equal to the untreated DCV from the required area ( $\text{Step 2} \geq \text{Step 1}$ ).
- Use of this onsite alternative compliance approach does not mandate flow-thru treatment of untreated flows from required areas; however, applicants are encouraged to do so where feasible.

### **B.4.5 Offline BMPs**

Diversion flow rates for offline BMPs must be sized to convey the maximum flow rate of runoff produced from a rainfall intensity of 0.2 inch of rainfall per hour, for each hour of every storm event. The following hydrologic method must be used to calculate the diversion flow rate for off-line BMPs:

## Appendix B: Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

$$Q = C \times i \times A$$

Where:

Q = Diversion flow rate in (ft<sup>3</sup>)

C = Runoff factor, area weighted estimate using Table B.1-1

i = Rainfall intensity of 0.2 in/hr

A = Tributary area (ac)

## B.5 Supporting Information for Pollutant Control Standards

This sections presents backup information describing the rationale for the following elements relating to pollutant control: establishment of the pollutant control performance standard, establishment of retention requirements, establishment of 85th percentile rainfall depths, backup information on tree well retention values, and backup information on BMP major maintenance frequency calculations.

### B.5.1 Pollutant Control Performance Standard

Storm water BMPs can be conceptualized as having a storage volume and a treatment rate, in various proportions. Both are important in the long-term performance of the BMP under a range of actual storm patterns, depths, and inter-event times. Long-term performance is measured by the operation of a BMP over the course of multiple years, and provides a more complete metric than the performance of a BMP during a single event, which does not take into account antecedent conditions, including multiple storms arriving in short timeframes. A BMP that draws down more quickly would be expected to capture a greater fraction of overall runoff (i.e., long-term runoff) than an identically sized BMP that draws down more slowly. This is because storage is made available more quickly, so subsequent storms are more likely to be captured by the BMP. In contrast a BMP with a long drawdown time would stay mostly full, after initial filling, during periods of sequential storms. The volume in the BMP that draws down more quickly is more “valuable” in terms of long term performance than the volume in the one that draws down more slowly. The MS4 permit definition of the DCV does not specify a drawdown time, therefore the definition is not a complete indicator of a BMP's level of performance. An accompanying performance-based expression of the BMP sizing standard is essential to ensure uniformity of performance across a broad range of BMPs and helps prevents BMP designs from being used that would not be effective.

An evaluation of the relationships between BMP design parameters and expected long term capture efficiency has been conducted to address the needs identified above. Relationships have been developed through a simplified continuous simulation analysis of precipitation, runoff, and routing, that relate BMP design volume and storage recovery rate (i.e., drawdown time) to an estimated long

## Appendix B: Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

term level of performance using United States Environmental Protection Agency (USEPA) SWMM and parameters listed in Appendix G for Lake Wohlford, Lindbergh, and Oceanside rain gages. Comparison of the relationships developed using the three gages indicated that the differences in relative capture estimates are within the uncertainties in factors used to develop the relationships. For example, the estimated average annual capture for the BMP sized for the DCV and 36 hour drawdown using Lake Wohlford, Lindbergh, and Oceanside are 80%, 76% and 83% respectively. In an effort to reduce the number of curves that are made available, relationships developed using Lake Wohlford are included in this manual for use in the whole San Diego County region.

Figure B.3-1 demonstrated that a BMP sized for the runoff volume from the 85th percentile, 24-hour storm event (i.e., the DCV), which draws down in 36 hours is capable of managing approximately 80 percent of the average annual. There is long precedent for 80 percent capture of average annual runoff as approximately the point at which larger BMPs provide decreasing capture efficiency benefit (also known as the “knee of the curve”) for BMP sizing. The characteristic shape of the plot of capture efficiency versus storage volume in Figure B.3-1 illustrates this concept.

As such, this equivalency (between DCV draw down in 36-hours and 80 percent capture) has been utilized to provide a common currency between volume-based BMPs with a wide range of drawdown rates. This approach allows flexibility in the design of BMPs while ensuring consistent performance.

### B.5.2 Retention Requirement

In May 2016, the RWQCB provided clarification on the 2013 MS4 Permit requirement for the BMPDM to “...provide guidance for hydraulic loading rates and other biofiltration design criteria necessary to maximize the storm water retention and pollutant removal of treatment control BMPs.” Through coordination with the RWQCB, a quantifiable minimum retention requirement for treatment control BMPs was established based on the assumption that BMPs would be sized at 3% of the effective tributary area and be unlined where feasible.

The retention curves presented in Figure B.2-1 were developed using Version 1.4 automated pollutant control worksheets assuming various rainfall depths (0.60 to 1.20 inches) and design infiltration rates (0.000 to 0.500 in/hr). BMPs were sized at 3% of the effective impervious tributary area, provided 18” soil media depth, 3” of gravel above the underdrain, 6” underdrains with no hydromodification management orifices, 3” of gravel beneath the underdrain, and varied surface ponding depths as needed to fully satisfy pollutant removal standards.

### B.5.3 Rainfall Depth

The method of calculating the 85th percentile is to produce a list of values, order them from smallest to largest, and then pick the value that is 85 percent of the way through the list. Only values that are capable of producing run off are of interest for this purpose. Lacking a legislative definition of rainfall

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values capable of producing runoff, Flood Control staff in San Diego County have observed that the point at which significant runoff begins is rather subjective, and is affected by land use type and soil moisture. In highly-urbanized areas, the soil has a high impermeability and runoff can begin with as little as 0.02" of rainfall. In rural areas, soil impermeability is significantly lower and even 0.30" of rain on dry soil will frequently not produce significant runoff. For this reason, San Diego County has chosen to use the more objective method of including all non-zero 24-hour rainfall totals when calculating the 85th percentile. To produce a statistically significant number, only stations with 30 years or greater of daily rainfall records are used.

A collection of 56 precipitation gage points was developed with 85th percentile precipitation values based on multiple years of gage data. A raster surface (grid of cells with values) was interpolated from that set of points. The surface initially did not cover the County's entire jurisdiction. A total of 13 dummy points were added. Most of those were just outside the County boundary to enable the software to generate a surface that covered the entire County. A handful of points were added to enforce a plausible surface. In particular, one point was added in the desert east of Julian, to enforce a gradient from high precipitation in the mountains to low precipitation in the desert. Three points were added near the northern boundary of the County to adjust the surface to reflect the effect of elevation in areas lacking sufficient operating gages.

Several methods of interpolation were considered. The method chosen is named by Environmental Systems Research Institute as the Natural Neighbor technique. This method produces a surface that is highly empirical, with the value of the surface being a product of the values of the data points nearest each cell. It does not produce peaks or valleys of surface based on larger area trends, and is free of artifacts that appeared with other methods.

### B.5.4 Tree Wells

Tree Well credit volume is estimated based on typical characteristics of Tree Wells as follows:

It is assumed that each tree is considered a single BMP, with calculations based on the soil media reservoir volume and/or the individual tree within the tree BMP as appropriate. Tree Well credit volume is calculated as:

$$TWCV = TIV + TCIV + TETV$$

Where:

- TWCV = Tree Well credit volume (ft<sup>3</sup>)
- TIV = Total infiltration volume of all storage layers within tree BMPs (ft<sup>3</sup>)

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- TCIV = Total canopy interception volume of tree BMPs (ft<sup>3</sup>)
- TETV = Total evapotranspiration volume, sums the media evapotranspiration storage within each tree BMP (ft<sup>3</sup>)

Total infiltration volume is calculated as the total volume stored within the tree BMP soil media reservoir. Infiltration volume was assumed to be 20% of the total BMP soil media reservoir volume, the available pore space in the soil media reservoir (porosity – field capacity).

Total canopy interception volume was calculated as the average interception capacity for the entire mature tree canopy projection area. Interception capacity was determined to be 0.04 inches per square foot for all tree sizes, an average from the findings published by Breuer et al (2003) for coniferous and deciduous trees.

Total evapotranspiration volume is the available evapotranspiration storage volume (field capacity – wilting point) within the BMP storage layer media. TEVT is assumed to be 10% of the minimum soil volume. The minimum soil volume as required by SD-A fact sheet of 2 cubic feet per unit canopy projection area was assumed for estimating reduction in DCV.

There may be rain events that generate more runoff than the tree well can handle. Installing an overflow above the design storm water retention level of the reservoir can prevent system failure during extreme weather events. Placement of the overflow should be determined based on the infiltration rate of the subsoil. If infiltration is not adequate to remove water from the rooting zone (the top 18 to 24 inches of soil media reservoir) within 48 hours, the depth of the soil media reservoir may be increased, and the overflow should be placed such that if water rises to the level of the rooting zone it will drain in less than 48 hours.

### **B.5.5 Sediment Clogging**

Under the 2011 Model SUSMP, a sizing factor of 4 percent was used for sizing biofiltration BMPs. This value was derived based on the goal of treating the runoff from a 0.2 inch per hour uniform precipitation intensity at a constant media flow rate of 5 inches per hour. While this method was simple, it was considered to be conservative as it did not account for significant transient storage present in biofiltration BMPs (i.e., volume in surface storage and subsurface storage that would need to fill before overflow occurred). Under this manual, biofiltration BMPs will typically provide subsurface storage to promote infiltration losses; therefore typical BMP profiles will tend to be somewhat deeper than those provided under the 2011 Model SUSMP. A deeper profile will tend to provide more transient storage and allow smaller footprint sizing factors while still providing similar or better treatment capacity and pollutant removal. Therefore a reduction in the minimum sizing factor from the factor used in the 2011 Model SUSMP is supportable. However, as footprint decreases, issues related to potential performance, operations, and/or maintenance can increase for a number of

## Appendix B: Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

reasons:

1. As the surface area of the media bed decreases, the sediment loading per unit area increases, increasing the risk of clogging. While vigorous plant growth can help maintain permeability of soil, there is a conceptual limit above which plants may not be able to mitigate for the sediment loading. Scientific knowledge is not conclusive in this area.
2. With smaller surface areas and greater potential for clogging, water may be more likely to bypass the system via overflow before filling up the profile of the BMP.
3. As the footprint of the system decreases, the amount of water that can be infiltrated from subsurface storage layers and evapotranspire from plants and soils tends to decrease.
4. With smaller sizing factors, the hydraulic loading per unit area increases, potentially reducing the average contact time of water in the soil media and diminishing treatment performance.

The MS4 Permit requires that volume and pollutant retention be maximized. Therefore, a minimum sizing factor was determined to be needed. This minimum sizing factor does not replace the need to conduct sizing calculations as described in this manual; rather it establishes a lower limit on required size of biofiltration BMPs as the last step in these calculations. Additionally, it does not apply to alternative biofiltration designs that utilize the checklist in Appendix F (Biofiltration Standard and Checklist). Acceptable alternative designs (such as proprietary systems meeting Appendix F criteria) typically include design features intended to allow acceptable performance with a smaller footprint and have undergone field scale testing to evaluate performance and required O&M frequency.

### Sediment Clogging Calculations

As sediment accumulates in a filter, the permeability of the filter tends to decline. The lifespan of the filter bed can be estimated by determining the rate of sediment loading per unit area of the filter bed. To determine the media bed surface area sizing factor needed to provide a target lifespan, simple sediment loading calculations were conducted based on typical urban conditions. The inputs and results of this calculation are summarized in Table B.5-1.

**Table B.5-1: Inputs and Results of Clogging Calculation**

Parameter	Value	Source
Representative TSS Event Mean Concentration, mg/L	100	Approximate average of San Diego Land Use Event Mean Concentrations from San Diego River and San Luis Rey River WQIP
Runoff Coefficient of Impervious Surface	0.90	Table B.1-1
Runoff Coefficient of Pervious Surface	0.10	Table B.1-1 for landscape areas

## Appendix B: Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

Parameter	Value	Source
Imperviousness	40% to 90%	Planning level assumption, covers typical range of single family to commercial land uses
Average Annual Precipitation, inches	11 to 13	Typical range for much of urbanized San Diego County
Load to Initial Maintenance, kg/m <sup>2</sup>	10	Pitt, R. and S. Clark, 2010. Evaluation of Biofiltration Media for Engineered Natural Treatment Systems.
Allowable period to initial clogging, yr	10	Planning-level assumption
Estimated BMP Footprint Needed for 10-Year Design Life	2.8 to 3.3%	Calculated

This analysis suggests that a 3 percent sizing factor, coupled with sediment source controls and careful system design, should provide reasonable protection against premature clogging. However, there is substantial uncertainty in sediment loading and the actual load to clog that will be observed under field conditions in the San Diego climate. Additionally this analysis did not account for the effect of plants on maintaining soil permeability. Therefore this line of evidence should be considered provisional, subject to refinement based on field scale experience. As field scale experience is gained about the lifespan of biofiltration BMPs in San Diego and the mitigating effects of plants on long term clogging, it may be possible to justify lower factors of safety and therefore smaller design sizes in some cases. If a longer lifespan is desired and/or greater sediment load is expected, then a larger sizing factor may be justified.

Generally, the purpose of a minimum sizing factor is to help improve the performance and reliability of standard biofiltration systems and limit the use of sizing methods and assumptions that may lead to designs that are less consistent with the intent of the MS4 Permit.

Ultimately, this factor is a surrogate for a variety of design considerations, including clogging and associated hydraulic capacity, volume reduction potential, and treatment contact time. A prudent design approach should consider each of these factors on a project-specific basis and identify whether site conditions warrant a larger or smaller factor. For example a system treating only rooftop runoff in an area without any allowable infiltration may have negligible clogging risk and negligible volume reduction potential – a smaller sizing factor may not substantially reduce performance in either of these areas. Alternatively, for a site with high sediment load and limited pre-treatment potential, a larger sizing factor may be warranted to help mitigate potential clogging risks. County staff has discretion to accept alternative sizing factor(s) based on project-specific or jurisdiction-specific considerations. Additionally, the recommended minimum sizing factor may change over time as more experience with biofiltration is obtained.



**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

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**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

## **Geotechnical Engineer Analysis**

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- D.1. Infiltration Restrictions
- D.2. Determination of Design Infiltration Rates
- D.3. Geotechnical Reporting Requirements

# Appendix D Geotechnical Engineer Analysis

## D.1 Infiltration Restrictions

This section is only applicable if the analysis of infiltration restrictions is performed by a licensed engineer practicing in geotechnical engineering. The SWQMP Preparer and Geotechnical Engineer must work collaboratively to identify any infiltration restrictions identified in Form 4 on the next page. Upon completion of this section, the Geotechnical Engineer must characterize each DMA as Restricted or Unrestricted for infiltration and provide adequate support/discussion in the geotechnical report. A DMA is considered restricted when one or more restrictions exist which cannot be reasonably resolved through site design changes.

Form 4 is divided into Mandatory Considerations and Optional Considerations. Mandatory Considerations include elements that may pose a significant risk to human health and safety and must always be evaluated. Optional Considerations include elements that are not necessarily associated with human health and safety, so analysis is not mandated through this guidance document. All elements presented in this table are subject to the discretion of the Geotechnical Engineer if adequate supporting information is provided.

**Appendix D: Approved Infiltration Rate Assessment Methods**

Infiltration Restrictions		Form 4	
Retention is required at the project site to the maximum extent practicable. Complete this form to summarize applicable infiltration restrictions. Supporting documentation must be provided in the Attachments.			
Restriction Element		Applicable?	
<b>Mandatory Considerations</b>	BMP is within 100 feet of contaminated soils	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within 100 feet of industrial activities lacking source control	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within 100 feet of well/groundwater basin	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within 50 feet of septic tanks/leach fields	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within 10 feet of structures/tanks/walls	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within 10 feet of sewer utilities	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within 10 feet of groundwater table	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within hydric soils	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within highly liquefiable soils and has connectivity to structures	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within 1.5 times the height of adjacent steep slopes ( $\geq 25\%$ )	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	City staff has assigned "Restricted" Infiltration Category	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<b>Optional Considerations</b>	BMP is within predominantly Type D soil	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within 10 feet of property line	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within fill depths of $\geq 5$ feet (existing or proposed)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within 10 feet of underground utilities	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	BMP is within 250 feet of ephemeral stream	<input type="checkbox"/> Yes	<input type="checkbox"/> No
	Other (provide detailed geotechnical support in Attachment 6)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<b>Result</b>	<b>Unrestricted</b> – No restriction elements are applicable	<input type="checkbox"/>	
	<b>Restricted</b> – One or more restriction elements are applicable	<input type="checkbox"/>	

## D.2 Determination of Design Infiltration Rates

**This section is only applicable if the determination of design infiltration rates is performed by a licensed engineer practicing in geotechnical engineering.** The guidance in this section identifies methods for identifying observed infiltration rates, corrected infiltration rates, safety factors, and design infiltration rates for use in structural BMP design. Upon completion of this section, the Geotechnical Engineer must recommend a design infiltration rate for each DMA and provide adequate support/discussion in the geotechnical report.

**Table D.2-1: Elements for Determination of Design Infiltration Rates**

Parameter	Value	Unit
Initial Infiltration Rate (Section D.2.1)		in/hr
Corrected Infiltration Rate (Section D.2.2)		in/hr
Safety Factor (Section D.2.3)		unitless
Design Infiltration Rate (Corrected Infiltration rate/Safety Factor)		in/hr

### D.2.1 Initial Infiltration Rate

For purposes of this manual, the initial infiltration rate is the infiltration rate that has been identified based on the initial testing methods. Some of the acceptable methods for determining initial infiltration rates are presented in Table D.2-2 below, though other testing methods may be acceptable as evaluated by the geotechnical engineer. The geotechnical engineer should use professional discretion when selecting a testing method as it may ultimately impact the types of BMPs that are permitted.

**Table D.2-2: Comparison of Infiltration Rate Estimation and Testing Methods**

Test	Suitability at Planning Level Screening Phase	Suitability at BMP Design Phase
NRCS Soil Survey Maps	Yes, but mapped soil types must be confirmed with site observations. Regional soil maps are known to contain inaccuracies at the scale of typical development sites.	No, unless a strong correlation is developed between soil types and infiltration rates in the direct vicinity of the site and an elevated factor of safety is used.
Grain Size Analysis	Not preferred. Should only be used if a strong correlation has been developed between grain size analysis and measured infiltration rates testing results of site soils.	No

## Appendix D: Approved Infiltration Rate Assessment Methods

Test	Suitability at Planning Level Screening Phase	Suitability at BMP Design Phase
Cone Penetrometer Testing	Not preferred. Should only be used if a strong correlation has been developed between CPT results and measured infiltration rates testing results of site soils.	No
Simple Open Pit Test	Yes	Yes, with appropriate correction for infiltration into side walls and elevated factor of safety.
Open Pit Falling Head Test	Yes	Yes, with appropriate correction for infiltration into side walls and elevated factor of safety.
Double Ring Infiltrometer Test (ASTM 3385)	Yes	Yes
Single Ring Infiltrometer Test	Yes	Yes
Large-scale Pilot Infiltration Test	Yes, but generally cost prohibitive and too water-intensive for preliminary screening of a large area.	Yes, but should consider relatively large water demand associated with this test.
Smaller-scale Pilot Infiltration Test	Yes	Yes
Well Permeameter Method (USBR 7300-89)	Yes; reliability of this test can be improved by obtaining a continuous core where tests are conducted.	Yes in areas of proposed cut where other tests are not possible; a continuous boring log should be recorded and used to interpret test; should be confirmed with a more direct measurement following excavation.
Borehole Percolation Tests (various methods)	Yes; reliability of this test can be improved by obtaining a continuous core where tests are conducted.	Yes in areas of proposed cut where other tests are not possible; a continuous boring log should be recorded and used to interpret test; should be confirmed with a more direct measurement following excavation.
Laboratory Permeability Tests (e.g., ASTM D2434)	Yes, only suitable for evaluating potential infiltration rates in proposed fill areas. For sites with proposed cut, it is preferred to do a borehole percolation test at the proposed grade instead of analyzing samples in the lab. A combination of both tests may improve reliability.	No. However, may be part of a line of evidence for estimating the design infiltration of partial infiltration BMPs constructed in future compacted fill.

## Appendix D: Approved Infiltration Rate Assessment Methods

**Table D.2-3: Role of Infiltration Testing**

Project Phase	Key Questions/Burden of Proof	General Assessment Strategies
Site Planning Phase	<ul style="list-style-type: none"> <li>• Where within the project area is infiltration potentially feasible?</li> <li>• What volume reduction approaches are potentially suitable for my project?</li> </ul>	<ul style="list-style-type: none"> <li>• Use existing data and maps to the extent possible</li> <li>• Use less expensive methods to allow a broader area to be investigated more rapidly</li> <li>• Reach tentative conclusions that are subject to confirmation/refinement at the design phase</li> </ul>
BMP Design Phase	<ul style="list-style-type: none"> <li>• What infiltration rates should be used to design infiltration and biofiltration facilities?</li> <li>• What factor of safety should be applied?</li> </ul>	<ul style="list-style-type: none"> <li>• Use more rigorous testing methods at specific BMP locations</li> <li>• Support or modify preliminary feasibility findings</li> <li>• Estimate design infiltration rates with appropriate factors of safety</li> </ul>

### **NRCS Soil Survey Maps**

NRCS Soil Survey maps can be used to establish approximate infiltration rates for use in BMP design. Under this method, default design infiltration rates may be applied based on the predominant NRCS soil type present within a proposed BMP location. Default design infiltration rates (in/hr) for each NRCS soil type are: A=0.300, B=0.200, C=0.100, D=0.025, Restricted=0.000. Use of these default design infiltration rates does not require application of any correction factors or safety factors.

### **Grain Size Analysis Testing and Correlations to Infiltration Rate**

Hydraulic conductivity can be estimated indirectly from correlations with soil grain-size distributions. While this method is approximate, correlations have been relatively well established for some soil conditions. One of the most commonly used correlations between grain size parameters and hydraulic conductivity is the Hazen (1892, 1911) empirical formula (Philips and Kitch, 2011), but a variety of others have been developed. Correlations must be developed based on testing of site-specific soils. For purposes of this manual, saturated hydraulic conductivity and infiltration rate can be assumed to be equal.

### **Cone Penetrometer Testing and Correlations to Infiltration Rate**

Hydraulic conductivity can be estimated indirectly from cone penetrometer testing (CPT). A cone penetrometer test involves advancing a small probe into the soil and measuring the relative resistance encountered by the probe as it is advanced. The signal returned from this test can be interpreted to

## **Appendix D: Approved Infiltration Rate Assessment Methods**

yield estimated soil types and the location of key transitions between soil layers. If this method is used, correlations must be developed based on testing of site-specific soils. For purposes of this manual, saturated hydraulic conductivity and infiltration rate can be assumed to be equal.

### **Simple Open Pit Test**

The Simple Open Pit Test is a falling head test in which a hole at least two feet in diameter is filled with water to a level of 6" above the bottom. Water level is checked and recorded regularly until either an hour has passed or the entire volume has infiltrated. The test is repeated two more times in succession and the rate at which the water level falls in the third test is used as the infiltration rate. This test identifies a percolation rate that should be converted to an infiltration rate using the Porchet method.

### **Open Pit Falling Head Test**

This test is similar to the Simple Open Pit Test, but covers a larger footprint, includes more specific instructions, returns more precise measurements, and generally should be overseen by a geotechnical professional. Nonetheless, it remains a relatively simple test. To perform this test, a hole is excavated at least 2 feet wide by 4 feet long (larger is preferred) and to a depth of at least 12 inches. The bottom of the hole should be approximately at the depth of the proposed infiltrating surface of the BMP. The hole is pre-soaked by filling it with water at least a foot above the soil to be tested and leaving it at least 4 hours (or overnight if clays are present). After pre-soaking, the hole is refilled to a depth of 12 inches and allow it to drain for one hour (2 hours for slower soils), measuring the rate at which the water level drops. The test is then repeated until successive trials yield a result with less than 10 percent change.

### **Double Ring Infiltrometer Test (ASTM 3385)**

The Double Ring Infiltrometer was originally developed to estimate the saturated hydraulic conductivity of low permeability materials, such as clay liners for ponds, but has seen significant use in storm water applications. The most recent revision of this method from 2009 is known as ASTM 3385-09. The testing apparatus is designed with concentric rings that form an inner ring and an annulus between the inner and outer rings. Infiltration from the annulus between the two rings is intended to saturate the soil outside of the inner ring such that infiltration from the inner ring is restricted primarily to the vertical direction.

To conduct this test, both the center ring and annulus between the rings are filled with water. There is no pre-wetting of the soil in this test. However, a constant head of 1 to 6 inches is maintained for 6 hours, or until a constant flow rate is established. Both the inner flow rate and annular flow rate are recorded, but if they are different, the inner flow rate should be used. There are a variety of approaches that are used to maintain a constant head on the system, including use of a Mariotte tube, constant level float valves, or manual observation and filling. This test must be conducted at the elevation of

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the proposed infiltrating surface; therefore application of this test is limited in cases where the infiltration surface is a significant distance below existing grade at the time of testing.

This test is generally considered to provide a direct estimate of vertical infiltration rate for the specific point tested and is highly replicable. However, given the small diameter of the inner ring (standard diameter is 12 inches, but it can be larger), this test only measures infiltration rate in a small area. Additionally, given the small quantity of water used in this test compared to larger scale tests, this test may be biased high in cases where the long term infiltration rate is governed by groundwater mounding and the rate at which mounding dissipates (i.e., the capacity of the infiltration receptor). Finally, the added effort and cost of isolating vertical infiltration rate may not necessarily be warranted considering that BMPs typically have a lateral component of infiltration as well. Therefore, while this method has the advantages of being technical rigorous and well standardized, it should not necessarily be assumed to be the most representative test for estimating full-scale infiltration rates. Source: American Society for Testing and Materials (ASTM) International (2009)

### Single Ring Infiltrometer Test

The single ring infiltrometer test is not a standardized ASTM test, however it is a relatively well-controlled test and shares many similarities with the ASTM standard double ring infiltrometer test (ASTM 3385-09). This test is a constant head test using a large ring (preferably greater than 40 inches in diameter) usually driven 12 inches into the soil. Water is ponded above the surface. The rate of water addition is recorded and infiltration rate is determined after the flow rate has stabilized. Water can be added either manually or automatically.

The single ring used in this test tends to be larger than the inner ring used in the double ring test. Driving the ring into the ground limits lateral infiltration; however some lateral infiltration is generally considered to occur. Experience in Riverside County (CA) has shown that this test gives results that are close to full-scale infiltration facilities. The primary advantages of this test are that it is relatively simple to conduct and has a larger footprint (compared to the double-ring method) and restricts horizontal infiltration and is more standardized (compared to open pit methods). However, it is still a relatively small scale test and can only be reasonably conducted near the existing ground surface.

### Large-scale Pilot Infiltration Test

As its name implies, this test is closer in scale to a full-scale infiltration facility. This test was developed by Washington State Department of Ecology specifically for storm water applications.

To perform this test, a test pit is excavated with a horizontal surface area of roughly 100 square feet to a depth that allows 3 to 4 feet of ponding above the expected bottom of the infiltration facility. Water is continually pumped into the system to maintain a constant water level (between 3 and 4 feet about the bottom of the pit, but not more than the estimated water depth in the proposed facility) and the flow rate is recorded. The test is continued until the flow rate stabilizes. Infiltration rate is

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calculated by dividing the flow rate by the surface area of the pit. Similar to other open pit test, this test is known to result in a slight bias high because infiltration also moves laterally through the walls of the pit during the test. Washington State Department of Ecology requires a correction factor of 0.75 (factor of safety of 1.33) be applied to results.

This test has the advantage of being more resistant to bias from localized soil variability and being more similar to the dimensionality and scale of full scale BMPs. It is also more likely to detect long term decline in infiltration rates associated with groundwater mounding. As such, it remains the preferred test for establishing design infiltration rates in Western Washington (Washington State Department of Ecology, 2012). In a comparative evaluation of test methods, this method was found to provide a more reliable estimate of full-scale infiltration rate than double ring infiltrometer and borehole percolation tests (Philips and Kitch 2011).

The difficulty encountered in this method is that it requires a larger area be excavated than the other methods, and this in turn requires larger equipment for excavation and a greater supply of water. However, this method should be strongly considered when less information is known about spatial variability of soils and/or a higher degree of certainty in estimated infiltration rates is desired.

### Smaller-scale Pilot Infiltration Test

The smaller-scale PIT is conducted similarly to the large-scale PIT but involves a smaller excavation, ranging from 20 to 32 square feet instead of 100 square feet for the large-scale PIT, with similar depths. The primary advantage of this test compared to the full-scale PIT is that it requires less excavation volume and less water. It may be more suitable for small-scale distributed infiltration controls where the need to conduct a greater number of tests outweighs the accuracy that must be obtained in each test, and where groundwater mounding is not as likely to be an issue.

### Well Permeameter Method (USBR 7300-89)

Well permeameter methods were originally developed for purposes of assessing aquifer permeability and associated yield of drinking water wells. This family of tests is most applicable in situations in which infiltration facilities will be placed substantially below existing grade, which limits the use of surface testing methods.

In general, this test involves drilling a 6 inch to 8 inch test well to the depth of interest and maintaining a constant head until a constant flow rate has been achieved. Water level is maintained with down-hole floats. The Porchet method or the nomographs provided in the USBR Drainage Manual (United States Department of the Interior, Bureau of Reclamation, 1993) are used to convert the measured rate of percolation to an estimate of vertical hydraulic conductivity. A smaller diameter boring may be adequate, however this then requires a different correction factor to account for the increased variability expected.

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While these tests have applicability in screening level analysis, considerable uncertainty is introduced in the step of converting direct percolation measurements to estimates of vertical infiltration. Additionally, this testing method is prone to yielding erroneous results cases where the vertical horizon of the test intersects with minor lenses of sandy soils that allow water to dissipate laterally at a much greater rate than would be expected in a full-scale facility. To improve the interpretation of this test method, a continuous bore log should be inspected to determine whether thin lenses of material may be biasing results at the strata where testing is conducted. Consult USBR procedure 7300-89 for more details.

Source: (United States Department of the Interior, Bureau of Reclamation, 1990, 1993)

### **Borehole Percolation Tests (various methods)**

Borehole percolation tests were originally developed as empirical tests to estimate the capacity of onsite sewage disposal systems (septic system leach fields), but have more recently been adopted into use for evaluating storm water infiltration. Similar to the well permeameter method, borehole percolation methods primarily measure lateral infiltration into the walls of the boring and are designed for situations in which infiltration facilities will be placed well below current grade. The percolation rate obtained in this test should be converted to an infiltration rate using a technique such as the Porchet method.

This test is generally implemented similarly to the USBR Well Permeameter Method. Per the Riverside County Borehole Percolation method, a hole is bored to a depth at least 5 times the borehole radius. The hole is presoaked for 24 hours (or at least 2 hours if sandy soils with no clay). The hole is filled to approximately the anticipated top of the proposed infiltration basin. Rates of fall are measured for six hours, refilling each half hour (or 10 minutes for sand). Tests are generally repeated until consistent results are obtained.

The same limitations described for the well permeameter method apply to borehole percolation tests, and their applicability is generally limited to initial screening. To improve the interpretation of this test method, a continuous soil core can be extracted from the hole and below the test depth, following testing, to determine whether thin lenses of material may be biasing results at the strata where testing is conducted.

Sources: Riverside County Percolation Test (2011), California Test 750 (Caltrans, 1986), San Bernardino County Percolation Test (1992); USEPA Falling Head Test (USEPA, 1980).

### **D.2.2 Corrected Infiltration Rate**

For purposes of this manual, the corrected infiltration rate is the initial infiltration rate as modified by appropriate correction factors needed to convert from percolation to infiltration or to correct for

## Appendix D: Approved Infiltration Rate Assessment Methods

effects of water temperature. The sections below present discussion on correction factors that should be considered by the Geotechnical Engineer.

### **D.2.2.1 Percolation Rate Correction Factor**

A common misunderstanding is that the “percolation rate” obtained from a percolation test is equivalent to the “infiltration rate” obtained from tests such as a single or double ring infiltrometer test which is equivalent to the “saturated hydraulic conductivity”. In fact, these terms have different meanings. Saturated hydraulic conductivity is an intrinsic property of a specific soil sample under a given density. It is a coefficient in Darcy’s equation (Darcy 1856) that characterizes the flux of water that will occur under a given gradient. The measurement of saturated hydraulic conductivity in a laboratory test is typically referred to as “permeability”, which is a function of the density, structure, stratification, fines, and discontinuities of a given sample under given controlled conditions. In contrast, infiltration is the downward entry of water into the soil. The velocity at which water enters the soil is infiltration rate. Infiltration rate is typically expressed in inches per hour. For the purposes of this manual, saturated hydraulic conductivity and infiltration rate can be assumed to be equal. Similarly, to permeability, infiltration rate can be limited by a number of factors including the layering of soil, density, discontinuities, and initial moisture content. These factors control how quickly water can move through a soil. However, infiltration rate can also be influenced by mounding of groundwater, and the rate at which water dissipates horizontally below a BMP – both of which describe the “capacity” of the “infiltration receptor” to accept this water over an extended period. For this reason, an infiltration test should ideally be conducted for a relatively long duration resembling a series of storm events so that the capacity of the infiltration receptor is evaluated as well as the rate at which water can enter the system. Infiltration rates are generally tested with larger diameter holes, pits, or apparatuses intended to enforce a primarily vertical direction of flux.

In contrast, percolation is tested with small diameter holes, and it is mostly a lateral phenomenon. The direct measurement yielded by a percolation test tends to overestimate the infiltration rate, except perhaps in cases in which a BMP has similar dimensionality to the borehole, such as a dry well. Adjustment of percolation rates may be made to an infiltration rate using a technique such as the Porchet Method. For drywell BMPs this adjustment may be determined per other methods, (i.e. USBR 7300-89), or may be omitted entirely at the discretion of the geotechnical engineer.

### **D.2.2.2 Temperature Correction Factor**

The rate of infiltration through soil is affected by the viscosity of water, which in turn is affected by the temperature of water. As such, infiltration rate is strongly dependent on the temperature of the infiltrating water (Cedergren, 1997). For example, Emerson (2008) found that wintertime infiltration rates below a BMP in Pennsylvania were approximately half their peak summertime rates. As such, it is important to consider the effects of temperature when planning tests and interpreting results.

## Appendix D: Approved Infiltration Rate Assessment Methods

If possible, testing should be conducted at a temperature that approximates the typical runoff temperatures for the site during the times when rainfall occurs. If this is not possible, then the results of infiltration tests should be adjusted to account for the difference between the temperature at the time of testing and the typical temperature of runoff when rainfall occurs. The measured infiltration can be adjusted by the ratio of the viscosity at the test temperature versus the typical temperature when rainfall occurs (Cedergren, 1997), per the following formula:

$$K_{\text{Typical}} = K_{\text{Test}} \times \left( \frac{\mu_{\text{Test}}}{\mu_{\text{Typical}}} \right)$$

Where:

$K_{\text{Typical}}$  = the typical infiltration rate expected at typical temperatures when rainfall occurs

$K_{\text{Test}}$  = the infiltration rate measured or estimated under the conditions of the test

$\mu_{\text{Typical}}$  = the viscosity of water at the typical temperature expected when rainfall occurs

$\mu_{\text{Test}}$  = the viscosity of water at the temperature at which the test was conducted

### D.2.3 Safety Factors

**A safety factor between 2.0 and 9.0 must be applied to the infiltration rates determined above.**

Application of a safety factor reduces initial or corrected infiltration rates in order to account for various considerations that can impact infiltration rates measured rates over time. In order to minimize safety factor impacts, applicants should consider performing rigorous site investigation, incorporating pretreatment and resiliency into the site design, and taking steps to reduce incidental compaction within BMP footprints.

If the proposed BMP utilizes an underdrain, a default safety factor of 2.0 may be applied or a more detailed safety factor may be determined per Table D.2-4. If the proposed BMP does not utilize an underdrain, then the safety factor must be determined through completion of Table D.2-4.

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**Table D.2-4: Factor of Safety and Design Infiltration Rate Worksheet**

Factor of Safety and Design Infiltration Rate Worksheet		Worksheet D.5-1			
Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) $p = w \times v$
A	Suitability Assessment	Soil assessment methods	0.25	Refer to Table D.2-5	
		Predominant soil texture	0.25		
		Site soil variability	0.25		
		Depth to groundwater / impervious layer	0.25		
	Suitability Assessment Safety Factor, $S_A = \Sigma p$				
B	Design	Level of pretreatment/ expected sediment loads	0.5	Refer to Table D.2-5	
		Redundancy/resiliency	0.25		
		Compaction during construction	0.25		
	Design Safety Factor, $S_B = \Sigma p$				
Safety Factor, $S_{total} = S_A \times S_B$					

## Appendix D: Approved Infiltration Rate Assessment Methods

**Table D.2-5: Design Related Considerations for Infiltration Facility Safety Factors**

Consideration	High Concern – 3 points	Medium Concern – 2 points	Low Concern – 1 point
Infiltration Testing Method	Any	At least 2 tests of any kind within 50ft of BMP	At least 4 tests within BMP footprint, OR Large/Small Scale Pilot Infiltration Testing over at least 5% of BMP footprint
Soil Texture Class	Unknown, Silty, or Clayey	Loamy	Granular/Slightly Loamy
Soil Variability	Unknown or High	Moderately Homogenous	Slightly Homogenous
Depth to Groundwater/ Obstruction	<5 ft below BMP	5-15 ft below BMP	>15 below BMP
Pretreatment	None/Minimal	Provides good pretreatment OR does not receive significant runoff from unpaved areas	Provides excellent pretreatment OR only receives runoff from rooftops and road surfaces
Resiliency	None/Minimal	Includes underdrain/backup drainage that ensures ponding draws down in <96 hours	Includes underdrain/backup drainage AND supports easy restoration of impacted infiltration rates
Compaction	Moderate Likelihood	Low Likelihood	Very Low Likelihood

## D.3 Geotechnical Reporting Requirements

This section is only applicable if a licensed engineer practicing in geotechnical engineering has performed the determination of infiltration restrictions and/or design infiltration rates. The geotechnical report must document the following items in the geotechnical report.

- Date of site analysis
- Scope and results of testing
- Public health and safety requirements that affect infiltration locations
  - Must address Mandatory Considerations presented in Appendix D.1
- Conclusions
  - Characterize DMAs as Restricted or Unrestricted for Infiltration
  - Identify Design Infiltration Rates for DMAs
- Correspondence between County Staff and Geotechnical Engineer (if applicable)
  - Development status of site prior to the project application (i.e. new development with raw ungraded land, or redevelopment with existing graded conditions)
  - The history of design discussions for the site proposed project
  - Site design alternatives considered to achieve infiltration or partial infiltration on site
  - Physical impairments and public safety concerns (i.e. fire road egress, sewer lines, etc)
  - The extent low impact development BMP requirements were included in the project design

It is ultimately the responsibility of the SWQMP Preparer (not the geotechnical engineer) to interpret the conclusions made in the geotechnical report and ensure they are appropriately supported/reflected in associated SWQMP submittal materials such as checklists, narratives, calculations, exhibits, and supplemental reports.



**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

# **BMP Design Fact Sheets**

# Appendix E BMP Design Fact Sheets

The following fact sheets were developed to assist the project applicants with designing BMPs to meet the storm water obligations:

MS4 Category	Manual Category	Design Fact Sheet
Source Control	Source Control	SC: Source Control BMP Requirements
Site Design	Site Design	SD-1: Street Trees SD-5: Impervious Area Dispersion SD-6A: Green Roofs SD-6B: Permeable Pavement (Site Design BMP) SD-8: Rain Barrels
Retention	Harvest and Use	HU-1: Cistern
	Infiltration	INF-1: Infiltration Basins INF-2: Bioretention INF-3: Permeable Pavement (Pollutant Control)
	Partial Retention	PR-1: Biofiltration with Partial Retention
Biofiltration	Biofiltration	BF-1: Biofiltration BF-2: Nutrient Sensitive Media Design BF-3: Proprietary Biofiltration
Flow-thru Treatment Control	Flow-thru Treatment Control with Alternative Compliance	FT-1: Vegetated Swales FT-2: Media Filters FT-3: Sand Filters FT-4: Dry Extended Detention Basin FT-5: Proprietary Flow-thru Treatment Control
		PL: Plant List

## E.1 Source Control BMP Requirements

### Worksheet E.1-1: Source Control BMP Requirements

How to comply: Projects shall comply with this requirement by implementing all source control BMPs listed in this section that are applicable to their project. Applicability shall be determined through consideration of the development project's features and anticipated pollutant sources. Appendix E.1 provides guidance for identifying source control BMPs applicable to a project. Checklist I.4 in Appendix I shall be used to document compliance with source control BMP requirements.

**How to use this worksheet:**

1. Review Column 1 and identify which of these potential sources of storm water pollutants apply to your site. Check each box that applies.
2. Review Column 2 and incorporate all of the corresponding applicable BMPs in your project site plan.
3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in a table in your project-specific storm water management report. Describe your specific BMPs in an accompanying narrative, and explain any special conditions or situations that required omitting BMPs or substituting alternatives.

If These Sources Will Be on the Project Site ...	... Then Your SWQMP Shall Consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<ul style="list-style-type: none"> <li><input type="checkbox"/> A. Onsite storm drain inlets</li>   <li><input type="checkbox"/> Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Locations of inlets.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Mark all inlets with the words “No Dumping! Flows to Bay” or similar.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Maintain and periodically repaint or replace inlet markings.</li> <li><input type="checkbox"/> Provide storm water pollution prevention information to new site owners, lessees, or operators.</li> <li><input type="checkbox"/> See applicable operational BMPs in Fact Sheet SC-44, “Drainage System Maintenance,” in the CASQA Stormwater Quality Handbooks at <a href="http://www.cabmphandbooks.com">www.cabmphandbooks.com</a>.</li> <li><input type="checkbox"/> Include the following in lease agreements: “Tenant shall not allow anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains.”</li> </ul>

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<input type="checkbox"/> <b>B.</b> Interior floor drains and elevator shaft sump pumps <input type="checkbox"/> Not Applicable		<input type="checkbox"/> State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.	<input type="checkbox"/> Inspect and maintain drains to prevent blockages and overflow.
<input type="checkbox"/> <b>C.</b> Interior parking garages <input type="checkbox"/> Not Applicable		<input type="checkbox"/> State that parking garage floor drains will be plumbed to the sanitary sewer.	<input type="checkbox"/> Inspect and maintain drains to prevent blockages and overflow.
<input type="checkbox"/> <b>D1.</b> Need for future indoor & structural pest control <input type="checkbox"/> Not Applicable		<input type="checkbox"/> Note building design features that discourage entry of pests.	<input type="checkbox"/> Provide Integrated Pest Management information to owners, lessees, and operators.

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<ul style="list-style-type: none"> <li><input type="checkbox"/> D2. Landscape/ Outdoor Pesticide Use</li> <li><input type="checkbox"/> Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Show locations of existing trees or areas of shrubs and ground cover to be undisturbed and retained.</li> <li><input type="checkbox"/> Show self-retaining landscape areas, if any.</li> <li><input type="checkbox"/> Show storm water treatment facilities.</li> </ul>	<p>State that final landscape plans will accomplish all of the following.</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Preserve existing drought tolerant trees, shrubs, and ground cover to the maximum extent possible.</li> <li><input type="checkbox"/> Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to storm water pollution.</li> <li><input type="checkbox"/> Where landscaped areas are used to retain or detain storm water, specify plants that are tolerant of periodic saturated soil conditions.</li> <li><input type="checkbox"/> Consider using pest-resistant plants, especially adjacent to hardscape.</li> <li><input type="checkbox"/> To ensure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Maintain landscaping using minimum or no pesticides.</li> <li><input type="checkbox"/> See applicable operational BMPs in Fact Sheet SC-41, “Building and Grounds Maintenance,” in the CASQA Stormwater Quality Handbooks at <a href="http://www.cabmphandbooks.com">www.cabmphandbooks.com</a>.</li> <li><input type="checkbox"/> Provide IPM information to new owners, lessees and operators.</li> </ul>

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<ul style="list-style-type: none"> <li><input type="checkbox"/> E. Pools, spas, ponds, decorative fountains, and other water features.</li> <li><input type="checkbox"/> Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Show location of water feature and a sanitary sewer cleanout in an accessible area within 10 feet.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> If the City requires pools to be plumbed to the sanitary sewer, place a note on the plans and state in the narrative that this connection will be made according to City requirements.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> See applicable operational BMPs in Fact Sheet SC-72, “Fountain and Pool Maintenance,” in the CASQA Stormwater Quality Handbooks at <a href="http://www.cabmphandbooks.com">www.cabmphandbooks.com</a>.</li> </ul>
<ul style="list-style-type: none"> <li><input type="checkbox"/> F. Food service</li> <li><input type="checkbox"/> Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment.</li> <li><input type="checkbox"/> On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Describe the location and features of the designated cleaning area.</li> <li><input type="checkbox"/> Describe the items to be cleaned in this facility and how it has been sized to ensure that the largest items can be accommodated.</li> </ul>	

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<ul style="list-style-type: none"> <li><input type="checkbox"/> G. Refuse areas</li> <li><input type="checkbox"/> Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Show where site refuse and recycled materials will be handled and stored for pickup. See City requirements for sizes and other details of refuse areas.</li> <li><input type="checkbox"/> If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run- on and show locations of berms to prevent runoff from the area. Also show how the designated area will be protected from wind dispersal.</li> <li><input type="checkbox"/> Any drains from dumpsters, compactors, and tallow bin areas shall be connected to a grease removal device before discharge to sanitary sewer.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> State how site refuse will be handled and provide supporting detail to what is shown on plans.</li> <li><input type="checkbox"/> State that signs will be posted on or near dumpsters with the words “Do not dump hazardous materials here” or similar.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> State how the following will be implemented: Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post “no hazardous materials” signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on- site. See Fact Sheet SC-34, “Waste Handling and Disposal” in the CASQA Stormwater Quality Handbooks at <a href="http://www.cabmphandbooks.com">www.cabmphandbooks.com</a>.</li> </ul>

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative Table and Narrative
<input type="checkbox"/> <b>H.</b> Industrial processes. <input type="checkbox"/> Not Applicable	<input type="checkbox"/> Show process area.	<input type="checkbox"/> If industrial processes are to be located onsite, state: “All process activities to be performed indoors. No processes to drain to exterior or to storm drain system.”	<input type="checkbox"/> See Fact Sheet SC-10, “Non-Stormwater Discharges” in the CASQA Stormwater Quality Handbooks at <a href="http://www.cabmphandbooks.com">www.cabmphandbooks.com</a> .
<input type="checkbox"/> <b>I.</b> Outdoor storage of equipment or materials. (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.) <input type="checkbox"/> Not Applicable	<input type="checkbox"/> Show any outdoor storage areas, including how materials will be covered. Show how areas will be graded and bermed to prevent run-on or runoff from area and protected from wind dispersal. <input type="checkbox"/> Storage of non-hazardous liquids shall be covered by a roof and/or drain to the sanitary sewer system, and be contained by berms, dikes, liners, or vaults. <input type="checkbox"/> Storage of hazardous materials and wastes must be in compliance with the local hazardous materials ordinance and a Hazardous Materials Management Plan for the site.	<input type="checkbox"/> Include a detailed description of materials to be stored, storage areas, and structural features to prevent pollutants from entering storm drains. Where appropriate, reference documentation of compliance with the requirements of local Hazardous Materials Programs for: <ul style="list-style-type: none"> <li>▪ Hazardous Waste Generation</li> <li>▪ Hazardous Materials Release Response and Inventory</li> <li>▪ California Accidental Release Prevention Program</li> <li>▪ Aboveground Storage Tank</li> <li>▪ Uniform Fire Code Article 80 Section 103(b) &amp; (c) 1991</li> <li>▪ Underground Storage Tank</li> </ul>	<input type="checkbox"/> See the Fact Sheets SC-31, “Outdoor Liquid Container Storage” and SC-33, “Outdoor Storage of Raw Materials” in the CASQA Stormwater Quality Handbooks at <a href="http://www.cabmphandbooks.com">www.cabmphandbooks.com</a> .

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<ul style="list-style-type: none"> <li><input type="checkbox"/> J. Vehicle and Equipment Cleaning</li> <li><input type="checkbox"/> Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Show on drawings as appropriate:               <ul style="list-style-type: none"> <li>(1) Commercial/industrial facilities having vehicle /equipment cleaning needs shall either provide a covered, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses.</li> <li>(2) Multi-dwelling complexes shall have a paved, bermed, and covered car wash area (unless car washing is prohibited onsite and hoses are provided with an automatic shut-off to discourage such use).</li> <li>(3) Washing areas for cars, vehicles, and equipment shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer.</li> <li>(4) Commercial car wash facilities shall be designed such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility shall discharge to the sanitary sewer, or a wastewater reclamation system shall be installed.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> If a car wash area is not provided, describe measures taken to discourage onsite car washing and explain how these will be enforced.</li> </ul>	<p>Describe operational measures to implement the following (if applicable):</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Washwater from vehicle and equipment washing operations shall not be discharged to the storm drain system.</li> <li><input type="checkbox"/> Car dealerships and similar may rinse cars with water only.</li> <li><input type="checkbox"/> See Fact Sheet SC-21, “Vehicle and Equipment Cleaning,” in the CASQA Stormwater Quality Handbooks at <a href="http://www.cabmphandbooks.com">www.cabmphandbooks.com</a></li> </ul>

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>K.</b> Vehicle/Equipment Repair and Maintenance</li> <li><input type="checkbox"/> Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Accommodate all vehicle equipment repair and maintenance indoors. Or designate an outdoor work area and design the area to protect from rainfall, run-on runoff, and wind dispersal.</li> <li><input type="checkbox"/> Show secondary containment for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas.</li> <li><input type="checkbox"/> Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer and an industrial waste discharge permit will be obtained.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> State that no vehicle repair or maintenance will be done outdoors, or else describe the required features of the outdoor work area.</li> <li><input type="checkbox"/> State that there are no floor drains or if there are floor drains, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency’s requirements.</li> <li><input type="checkbox"/> State that there are no tanks, containers or sinks to be used for parts cleaning or rinsing or, if there are, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency’s requirements.</li> </ul>	<p>In the report, note that all of the following restrictions apply to use the site:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> No person shall dispose of, nor permit the disposal, directly or indirectly of vehicle fluids, hazardous materials, or rinsewater from parts cleaning into storm drains.</li> <li><input type="checkbox"/> No vehicle fluid removal shall be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids shall be contained or drained from the vehicle immediately.</li> <li><input type="checkbox"/> No person shall leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment.</li> </ul>

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<ul style="list-style-type: none"> <li><input type="checkbox"/> L. Fuel Dispensing Areas</li> <li><input type="checkbox"/> Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Fueling areas<sup>1</sup> shall have impermeable floors (i.e., portland cement concrete or equivalent smooth impervious surface) that are (1) graded at the minimum slope necessary to prevent ponding; and (2) separated from the rest of the site by a grade break that prevents run-on of storm water to the MEP.</li> <li><input type="checkbox"/> Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover’s minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area<sup>1</sup>.] The canopy [or cover] shall not drain onto the fueling area.</li> </ul>		<ul style="list-style-type: none"> <li><input type="checkbox"/> The property owner shall dry sweep the fueling area routinely.</li> <li><input type="checkbox"/> See the Business Guide Sheet, “Automotive Service—Service Stations” in the CASQA Stormwater Quality Handbooks at <a href="http://www.cabmphandbooks.com">www.cabmphandbooks.com</a>.</li> </ul>

1. The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<p><b>M. Loading Docks</b></p> <p><input type="checkbox"/> Not Applicable</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks shall be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts shall be positioned to direct storm water away from the loading area. Water from loading dock areas should be drained to the sanitary sewer where feasible. Direct connections to storm drains from depressed loading docks are prohibited.</li> <li><input type="checkbox"/> Loading dock areas draining directly to the sanitary sewer shall be equipped with a spill control valve or equivalent device, which shall be kept closed during periods of operation.</li> <li><input type="checkbox"/> Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.</li> </ul>		<ul style="list-style-type: none"> <li><input type="checkbox"/> Move loaded and unloaded items indoors as soon as possible.</li> <li><input type="checkbox"/> See Fact Sheet SC-30, “Outdoor Loading and Unloading,” in the CASQA Stormwater Quality Handbooks at <a href="http://www.cabmphandbooks.com">www.cabmphandbooks.com</a>.</li> </ul>

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<ul style="list-style-type: none"> <li><input type="checkbox"/> N. Fire Sprinkler Test Water</li> <li><input type="checkbox"/> Not Applicable</li> </ul>		<ul style="list-style-type: none"> <li><input type="checkbox"/> Provide a means to drain fire sprinkler test water to the sanitary sewer.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> See the note in Fact Sheet SC-41, “Building and Grounds Maintenance,” in the CASQA Stormwater Quality Handbooks at <a href="http://www.cabmphandbooks.com">www.cabmphandbooks.com</a>.</li> </ul>
<ul style="list-style-type: none"> <li><input type="checkbox"/> O. Miscellaneous Drain or Wash Water               <ul style="list-style-type: none"> <li><input type="checkbox"/> Boiler drain lines</li> <li><input type="checkbox"/> Condensate drain lines</li> <li><input type="checkbox"/> Rooftop equipment</li> <li><input type="checkbox"/> Drainage sumps</li> <li><input type="checkbox"/> Roofing, gutters, and trim</li> </ul> </li> <li><input type="checkbox"/> Not Applicable</li> </ul>		<ul style="list-style-type: none"> <li><input type="checkbox"/> Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system.</li> <li><input type="checkbox"/> Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system.</li> <li><input type="checkbox"/> Rooftop mounted equipment with potential to produce pollutants shall be roofed and/or have secondary containment.</li> <li><input type="checkbox"/> Any drainage sumps onsite shall feature a sediment sump to reduce the quantity of sediment in pumped water.</li> <li><input type="checkbox"/> Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff.</li> </ul>	

If These Sources Will Be on the Project Site ...	... Then Your SWQMP shall consider These Source Control BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Drawings	3 Permanent Controls—List in Table and Narrative	4 Operational BMPs—Include in Table and Narrative
<input type="checkbox"/> P. Plazas, sidewalks, and parking lots. <input type="checkbox"/> Not Applicable			<input type="checkbox"/> Plazas, sidewalks, and parking lots shall be swept regularly to prevent the accumulation of litter and debris.  Debris from pressure washing shall be collected to prevent entry into the storm drain system. Washwater containing any cleaning agent or degreaser shall be collected and discharged to the sanitary sewer and not discharged to a storm drain.

## E.2 SD-1 Street Trees



*Street Trees (Source: County of San Diego LID Manual – EOA, Inc.)*

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### MS4 Permit Category

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Site Design

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### Manual Category

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Site Design

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### Applicable Performance Standard

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Site Design

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### Primary Benefits

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Volume Reduction

### Description

Trees planted to intercept rainfall and runoff can be used as storm water management measures that provide additional benefits beyond those typically associated with trees, including energy conservation, air quality improvement, and aesthetic enhancement. Typical storm water management benefits associated with trees include:

- **Interception of rainfall** – tree surfaces (roots, foliage, bark, and branches) intercept, evaporate, store, or convey precipitation to the soil before it reaches surrounding impervious surfaces
- **Reduced erosion** – trees protect denuded area by intercepting or reducing the velocity of rain drops as they fall through the tree canopy
- **Increased infiltration** – soil conditions created by roots and fallen leaves promote infiltration
- **Treatment of storm water** – trees provide treatment through uptake of nutrients and other storm water pollutants (phytoremediation) and support of other biological processes that break down pollutants

Typical street tree system components include:

- Trees of the appropriate species for site conditions and constraints
- Available growing space based on tree species, soil type, water availability, surrounding land uses, and project goals

- Optional suspended pavement design to provide structural support for adjacent pavement without requiring compaction of underlying layers
- Optional root barrier devices as needed; a root barrier is a device installed in the ground, between a tree and the sidewalk, intended to guide roots down and away from the sidewalk in order to prevent sidewalk lifting from tree roots.
- Optional tree grates; to be considered to maximize available space for pedestrian circulation and to protect tree roots from compaction related to pedestrian circulation; tree grates are typically made up of porous material that will allow the runoff to soak through.
- Optional shallow surface depression for ponding of excess runoff
- Optional planter box drain

**Design Adaptations for Project Goals**

**Site design BMP to provide incidental treatment.** Street trees primarily functions as site design BMPs for incidental treatment. Benefits from street trees are accounted for by adjustment factors presented in Appendix B.2. This credit can apply to non-street trees as well (that meet the same criteria). Trees as a site design BMP are only credited up to 0.25 times the DCV from the project footprint (with a maximum single tree credit volume of 400 ft<sup>3</sup>).

**Storm water pollutant control BMP to provide treatment.** Applicants are allowed to design trees as a pollutant control BMP and obtain credit greater than 0.25 times the DCV from the project footprint (or a credit greater than 400 ft<sup>3</sup> from a single tree). For this option to be approved by the City Engineer, applicant is required to do infiltration feasibility screening (Appendix C and D) and provide calculations supporting the amount of credit claimed from implementing trees within the project footprint. The City Engineer has the discretion to request additional analysis before approving credits greater than 0.25 times the DCV from the project footprint (or a credit greater than 400 ft<sup>3</sup> from a single tree).

**Design Criteria and Considerations**

Street Trees must meet the following design criteria and considerations. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> <b>Tree species</b> is appropriately chosen for the development (private or public). For public rights-of-ways, City planning guidelines and zoning provisions for the permissible species and placement of trees are consulted. A list of trees appropriate for site design that can be	Proper tree placement and species selection minimizes problems such as pavement damage by surface roots and poor growth.

<i>Siting and Design</i>	<i>Intent/Rationale</i>															
<p>used by all county municipalities are provided in Appendix E.20</p>																
<p><b>Location of trees</b> planted along public streets follows City requirements and guidelines. Vehicle and pedestrian line of sight are considered in tree selection and placement.</p> <p>Unless exemption is granted by the City Engineer the following minimum tree separation distance is followed</p>																
<input type="checkbox"/>	<table border="1"> <thead> <tr> <th>Improvement</th> <th>Minimum distance to Street Tree</th> </tr> </thead> <tbody> <tr> <td>Traffic Signal, Stop sign</td> <td>20 feet</td> </tr> <tr> <td>Underground Utility lines (except sewer)</td> <td>5 feet</td> </tr> <tr> <td>Sewer Lines</td> <td>10 feet</td> </tr> <tr> <td>Above ground utility structures (Transformers, Hydrants, Utility poles, etc.)</td> <td>10 feet</td> </tr> <tr> <td>Driveways</td> <td>10 feet</td> </tr> <tr> <td>Intersections (intersecting curb lines of two streets)</td> <td>25 feet</td> </tr> </tbody> </table>	Improvement	Minimum distance to Street Tree	Traffic Signal, Stop sign	20 feet	Underground Utility lines (except sewer)	5 feet	Sewer Lines	10 feet	Above ground utility structures (Transformers, Hydrants, Utility poles, etc.)	10 feet	Driveways	10 feet	Intersections (intersecting curb lines of two streets)	25 feet	<p>Roadway safety for both vehicular and pedestrian traffic is a key consideration for placement along public streets.</p>
Improvement	Minimum distance to Street Tree															
Traffic Signal, Stop sign	20 feet															
Underground Utility lines (except sewer)	5 feet															
Sewer Lines	10 feet															
Above ground utility structures (Transformers, Hydrants, Utility poles, etc.)	10 feet															
Driveways	10 feet															
Intersections (intersecting curb lines of two streets)	25 feet															
<input type="checkbox"/>	<p><b>Underground utilities and overhead wires</b> are considered in the design and avoided or circumvented. Underground utilities are routed around or through the planter in suspended pavement applications. All underground utilities are protected from water and root penetration.</p>	<p>Tree growth can damage utilities and overhead wires resulting in service interruptions. Protecting utilities routed through the planter prevents damage and service interruptions.</p>														

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<p><input type="checkbox"/> <b>Suspended pavement</b> design was developed where appropriate to minimize soil compaction and improve infiltration and filtration capabilities.</p> <p>Suspended pavement was constructed with an approved structural cell.</p>	<p>Suspended pavement designs provide structural support without compaction of the underlying layers, thereby promoting tree growth.</p> <p>Recommended structural cells include poured in place concrete columns, Silva Cells manufactured by Deeproot Green Infrastructures and Stratacell and Stratavault systems manufactured by Citygreen Systems.</p>
<p><input type="checkbox"/> A minimum soil volume of 2 cubic feet per square foot of canopy projection volume is provided for each tree. Canopy projection area is the ground area beneath the tree, measured at the drip line.</p>	<p>The minimum soil volume ensures that there is adequate storage volume to allow for unrestricted evapotranspiration.</p> <p>A lower amount of soil volume may be allowed at the discretion of the City Engineer if certified by a landscape architect or agronomist. The retention credit from the tree is directly proportional to the soil volume provided for the tree.</p>
<p><input type="checkbox"/> DCV from the tributary area draining to the tree is equal to or greater than the tree credit volume</p>	<p>The minimum tributary area ensures that the tree receives enough runoff to fully utilize the infiltration and evapotranspiration potential provided. In cases where the minimum tributary area is not provided, the tree credit volume must be reduced proportionately to the actual tributary area.</p>
<p><input type="checkbox"/> Inlet opening to the tree that is at least 18 inches wide.</p> <p>A minimum 2 inch drop in grade from the inlet to the finish grade of the tree.</p>	<p>Design requirement to ensure that the runoff from the tributary area is not bypassed.</p> <p>Different inlet openings and drops in grade may be allowed at the discretion of the City Engineer if calculations are shown that the diversion flow rate (Appendix B.1.2) from the tributary area can be conveyed to the tree. In cases</p>

<i>Siting and Design</i>	<i>Intent/Rationale</i>
Grated inlets are allowed for pedestrian circulation. Grates need to be ADA compliant and have sufficient slip resistance.	where the inlet capacity is limiting the amount of runoff draining to the tree, the tree credit volume must be reduced proportionately.

**Conceptual Design and Sizing Approach for Site Design**

1. Determine the areas where street trees can be used in the site design to achieve incidental treatment. Street trees reduce runoff volumes from the site. Refer to Appendix B.2. Document the proposed tree locations in the SWQMP.
2. When trees are proposed as a storm water pollutant control BMP, the project proponent must submit detailed calculations for the DCV treated by trees. Document the proposed tree locations on the BMP Plan & DMA Map, and provide sizing calculations in the SWQMP Attachment following the steps in Appendix B.
3. When trees are proposed as a flow control BMP, the project proponent must submit detailed calculations for the Required Retention Volume (RRV) treated by trees. Document the proposed tree locations on the BMP Plan & DMA Map, and provide sizing calculations in the SWQMP Attachment. Tree Wells that are designed to meet flow control requirements are designated as SSD BMPs.
  - a. Determine how much volume you need. The Required Retention Volume (RRV) is the volume of rainfall that must be retained by the tree wells in the DMA to meet flow control requirements. It is calculated by multiplying the DCV by a DCV multiplier.
    - i. Determine the DCV. See Appendix B.
    - ii. Determine the DCV Multiplier. The DCV Multiplier is based on two factors: (1) The tree well soil depth and, (2) The Hydrologic Soil Group. Once you know both values, determine the DCV Multiplier using this table:
    - iii. Calculate the Required Retention Volume (DCV x DCV Multiplier). Calculate the RRV by multiplying the DCV by the DCV Multiplier. This is the volume of runoff that must be offset by the Tree Well Credit Volume. Repeat this process for each DMA.

Minimum Tree Well Soil Depth (inches)	Hydrologic Soil Group				DCV Multiplier
	A	B	C	D (Default)	
30"	1.60	2.20	2.50	2.90	
36"	1.80	2.47	2.83	3.17	
42"	2.00	2.73	3.17	3.43	
48"	2.20	3.00	3.50	3.70	

DCV Multiplier Table

## Appendix E: BMP Design Fact Sheets

Tree Well Soil Depth is the vertical distance from the top to the bottom of the soil layer in the tree well. Hydrologic Soil Group describes the native soil surrounding the tree well. Soil type affects how well water can infiltrate into the area surrounding the tree well. Group A soils provide the most infiltration and Group D the least. If your soil type is unknown, you can assume Group D. But this will result in larger DCV Multipliers, and in turn increase the size or number of tree wells needed.

Alternative Proposals: You can also propose RRV values or use methods and assumptions different than those described here. Proposals must be based on SWMM modeling or other methods acceptable to the County.

- b. Determine how much volume you have. The Tree Well Credit Volume is the volume of runoff retention in cubic feet per tree (ft<sup>3</sup>/tree) to be provided by each tree well (or group) in the DMA. Together retain a volume that is equal to or greater than the RRV for the DMA.

The volume credited for each tree well is based on the mature canopy diameter of the tree species selected. Any species listed below can be used in a tree well so long as it meets all other applicable restrictions and requirements for the project area. Native and drought tolerant species are required where feasible.

- c. Determine if you have enough volume. Compare your total Tree Well Credit Volume from Step 2 to the RRV you calculated in Step 1. Once your Credit Volume is equal to or greater than your RRV, this requirement is satisfied. If your Credit Volume is initially too low, adjust your design either to (1) increase it with more or bigger trees, or (2) decrease the RRV through DCV reductions.

Tree wells will normally be placed at the discharge point of the DMA, either individually or in groups. If some of them will retain runoff from different areas in the DMA, RRV and DCV calculations must be specific to each subarea.

If an underdrain is proposed for the Tree Well, the sizing factors shown in the DCV Multiplier Table cannot be used, and instead continuous simulation modeling should be performed. This would allow to obtain credit for soil volume underneath the underdrain.

## E.3 SD-5 Impervious Area Dispersion



*Photo Credit: Orange County Technical Guidance Document*

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### MS4 Permit Category

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Site Design

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### Manual Category

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Site Design

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### Applicable Performance Criteria

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Site Design

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### Primary Benefits

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Volume Reduction

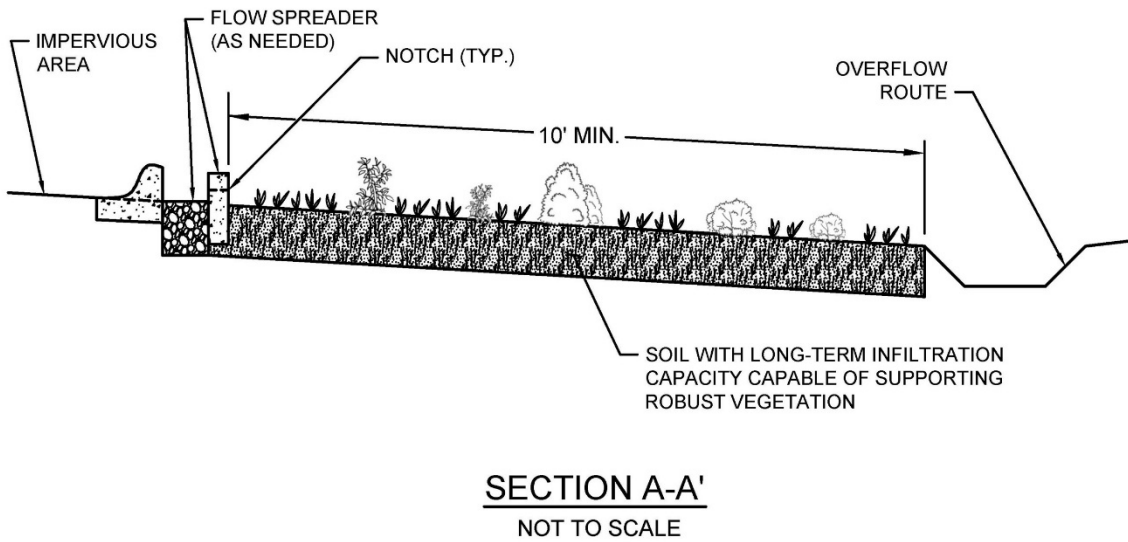
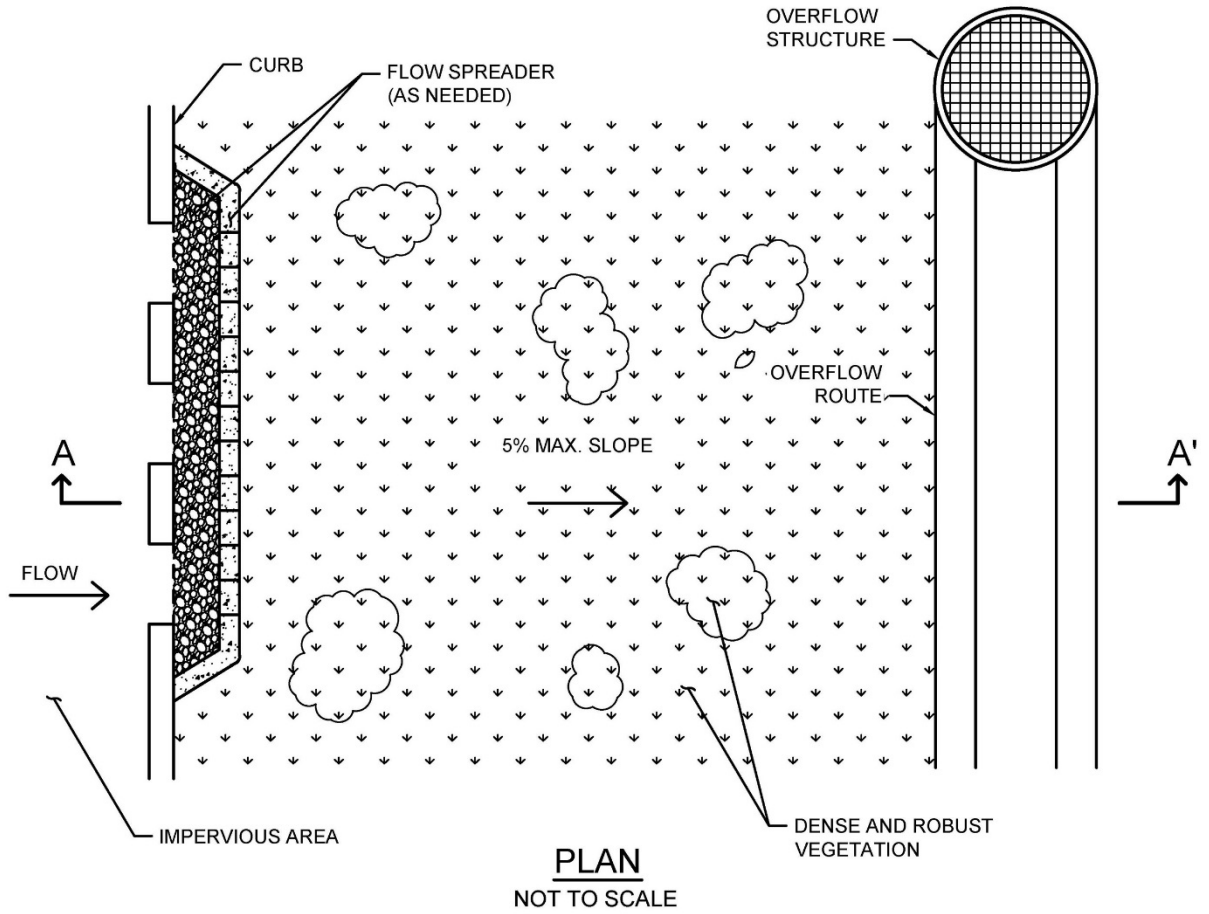
Peak Flow Attenuation

### Description

Impervious area dispersion (dispersion) refers to the practice of effectively disconnecting impervious areas from directly draining to the storm drain system by routing runoff from impervious areas such as rooftops (through downspout disconnection), walkways, and driveways onto the surface of adjacent pervious areas. The intent is to slow runoff discharges, and reduce volumes. Dispersion with partial or full infiltration results in significant volume reduction by means of infiltration and evapotranspiration.

Typical dispersion components include:

- An impervious surface from which runoff flows will be routed with minimal piping to limit concentrated inflows
- Splash blocks, flow spreaders, or other means of dispersing concentrated flows and providing energy dissipation as needed
- Dedicated pervious area, typically vegetated, with in-situ soil infiltration capacity for partial or full infiltration
- Optional soil amendments to improve vegetation support, maintain infiltration rates and enhance treatment of routed flows
- Overflow route for excess flows to be conveyed from dispersion area to the storm drain system or discharge point



Typical plan and section view of an Impervious Area Dispersion BMP

**Design Adaptations for Project Goals**

**Site design BMP to reduce impervious area and DCV.** Impervious area dispersion primarily functions as a site design BMP for reducing the effective imperviousness of a site by providing partial or full infiltration of the flows that are routed to pervious dispersion areas and otherwise slowing down excess flows that eventually reach the storm drain system. This can significantly reduce the DCV for the site.

**Design Criteria and Considerations**

**Dispersion** must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Dispersion is over areas with soil types capable of supporting or being amended (e.g., with sand or compost) to support vegetation. Media amendments must be tested to verify that they are not a source of pollutants.	Soil must have long-term infiltration capacity for partial or full infiltration and be able to support vegetation to provide runoff treatment. Amendments to improve plant growth must not have negative impact on water quality.
<input type="checkbox"/> Dispersion has vegetated sheet flow over a relatively large distance (minimum 10 feet) from inflow to overflow route.	Full or partial infiltration requires relatively large areas to be effective depending on the permeability of the underlying soils.
<input type="checkbox"/> Pervious areas should be flat (with less than 5% slopes) and vegetated.	Flat slopes facilitate sheet flows and minimize velocities, thereby improving treatment and reducing the likelihood of erosion.
<i>Inflow velocities</i>	
<input type="checkbox"/> Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
<i>Dedication</i>	
<input type="checkbox"/> Dispersion areas must be owned by the project owner and be dedicated for the purposes of dispersion to the exclusion of other future uses that might reduce the effectiveness of the dispersion area.	Dedicated dispersion areas prevent future conversion to alternate uses and facilitate continued full and partial infiltration benefits.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<i>Vegetation</i>	
<input type="checkbox"/> Dispersion typically requires dense and robust vegetation for proper function. Drought tolerant species should be selected to minimize irrigation needs. A plant list to aid in selection can be found in Appendix E.20.	Vegetation improves resistance to erosion and aids in runoff treatment.

**Conceptual Design and Sizing Approach for Site Design**

1. Determine the areas where dispersion can be used in the site design to reduce the DCV for pollutant control sizing.
2. Calculate the DCV for storm water pollutant control per Appendix B.2, taking into account reduced runoff from dispersion.
3. Determine if a DMA is considered “Self-retaining” if the impervious to pervious ratio is:
  - a. 2:1 when the pervious area is composed of Hydrologic Soil Group A
  - b. 1:1 when the pervious area is composed of Hydrologic Soil Group B

## E.4 SD-6A: Green Roofs



*Location: County of San Diego Operations Center, San Diego, California*

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### MS4 Permit Category

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Site Design

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### Manual Category

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Site Design

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### Applicable Performance Standard

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Site Design

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### Primary Benefits

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Volume Reduction  
Peak Flow Attenuation

### Description

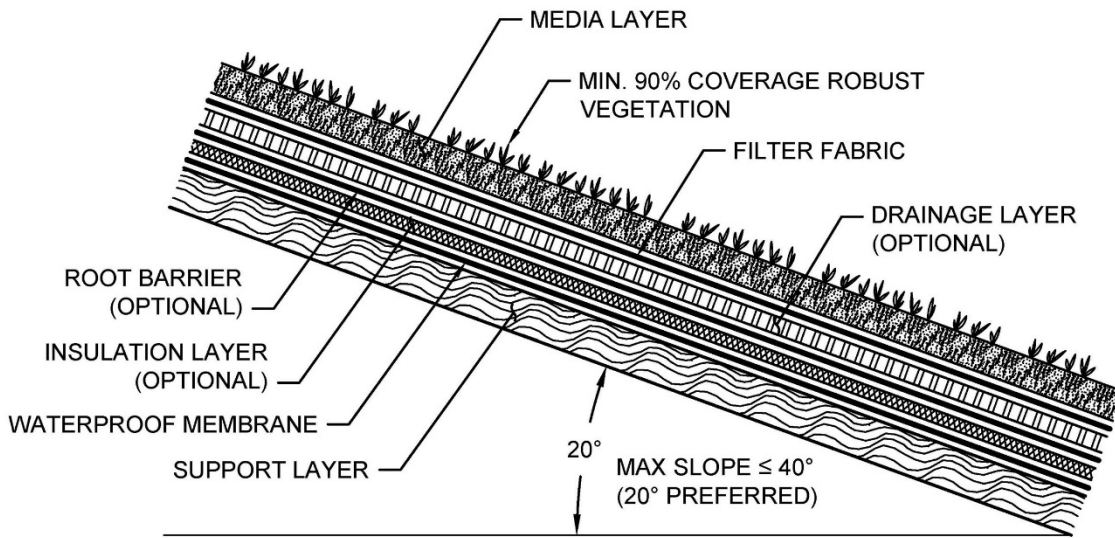
Green roofs are vegetated rooftop systems that reduce runoff volumes and rates, treat storm water pollutants through filtration and plant uptake, provide additional landscape amenity, and create wildlife habitat. Additionally, green roofs reduce the heat island effect and provide acoustical control, air filtration and oxygen production. In terms of building design, they can protect against ultraviolet rays and extend the roof lifetime, as well as increase the building insulation, thereby decreasing heating and cooling costs. There are two primary types of green roofs:

- **Extensive** – lightweight, low maintenance system with low-profile, drought tolerant type groundcover in shallow growing medium (6 inches or less)
- **Intensive** – heavyweight, high maintenance system with a more garden-like configuration and diverse plantings that may include shrubs or trees in a thicker growing medium (greater than 6 inches)

Typical green roof components include, from top to bottom:

- Vegetation that is appropriate to the type of green roof system, climate, and watering conditions
- Media layer (planting mix or engineered media) capable of supporting vegetation growth
- Filter fabric to prevent migration of fines (soils) into the drainage layer

- Optional drainage layer to convey excess runoff
- Optional root barrier
- Optional insulation layer
- Waterproof membrane
- Structural roof support capable of withstanding the additional weight of a green roof



**PROFILE**  
NOT TO SCALE

### Typical profile of a Green Roof BMP

#### ***Design Adaptations for Project Goals***

**Site design BMP to provide incidental treatment.** Green roofs can be used as a site design feature to reduce the impervious area of the site through replacing conventional roofing. This can reduce the DCV and flow control requirements for the site.

#### ***Design Criteria and Considerations***

Green roofs must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Roof slope is $\leq 40\%$ (Roofs that are $\leq 20\%$ are preferred).	Steep roof slopes increases project complexity and requires supplemental anchoring.
<input type="checkbox"/> Structural roof capacity design supports the calculated additional load (lbs/sq. ft) of the vegetation growing medium and additional drainage and barrier layers.	Inadequate structural capacity increases the risk for roof failure and harm to the building and occupants.
<input type="checkbox"/> Design and construction is planned to be completed by an experienced green roof specialist.	A green roof specialist will minimize complications in implementation and potential structural issues that are critical to green roof success.
<input type="checkbox"/> Green roof location and extent must meet fire safety provisions.	Green roof design must not negatively impact fire safety.
<input type="checkbox"/> Maintenance access is included in the green roof design.	Maintenance will facilitate proper functioning of drainage and irrigation components and allow for removal of undesirable vegetation and soil testing, as needed.
<b><i>Vegetation</i></b>	
<input type="checkbox"/> Vegetation is suitable for the green roof type, climate and expected watering conditions. Perennial, self-sowing plants that are drought-tolerant (e.g., sedums, succulents) and require little to no fertilizer, pesticides or herbicides are recommended. Vegetation pre-grown at grade may allow plants to establish prior to facing harsh roof conditions.	Plants suited to the design and expected growing environment are more likely to survive.
<input type="checkbox"/> Vegetation is capable of covering $\geq 90\%$ the roof surface.	Benefits of green roofs are greater with more surface vegetation.
<input type="checkbox"/> Vegetation is robust and erosion-resistant in order to withstand the anticipated rooftop environment (e.g., heat, cold, high winds).	Weak plants will not survive in extreme rooftop environments.
<input type="checkbox"/> Vegetation is fire resistant.	Vegetation that will not burn easily decreases the chance for fire and harm to the building and occupants.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Vegetation considers roof sun exposure and shaded areas based on roof slope and location.	The amount of sunlight the vegetation receives can inhibit growth therefore the beneficial effects of a vegetated roof.
<input type="checkbox"/> An irrigation system (e.g., drip irrigation system) is included as necessary to maintain vegetation.	Proper watering will increase plant survival, especially for new plantings.
<input type="checkbox"/> Media is well-drained and is the appropriate depth required for the green roof type and vegetation supported.	Unnecessary water retention increases structural loading. An adequate media depth increases plant survival.
<input type="checkbox"/> A filter fabric is used to prevent migration of media fines through the system.	Migration of media can cause clogging of the drainage layer.
<input type="checkbox"/> A drainage layer is provided if needed to convey runoff safely from the roof. The drainage layer can be comprised of gravel, perforated sheeting, or other drainage materials.	Inadequate drainage increases structural loading and the risk of harm to the building and occupants.
<input type="checkbox"/> A root barrier comprised of dense material to inhibit root penetration is used if the waterproof membrane will not provide root penetration protection.	Root penetration can decrease the integrity of the underlying structural roof components and increase the risk of harm to the building and occupants.
<input type="checkbox"/> An insulation layer is included as needed to protect against the water in the drainage layer from extracting building heat in the winter and cool air in the summer.	Regulating thermal impacts of green roofs will aid in controlling building heating and cooling costs.
<input type="checkbox"/> A waterproof membrane is used to prevent the roof runoff from vertically migrating and damaging the roofing material. A root barrier may be required to prevent roots from compromising the integrity of the membrane.	Water-damaged roof materials increase the risk of harm to the building and occupants.

**Conceptual Design and Sizing Approach for Site Design**

1. Determine the areas where green roofs can be used in the site design to replace conventional roofing to reduce the DCV. These green roof areas can be credited toward reducing runoff generated through representation in storm water calculations as pervious, not impervious, areas but are not credited for storm water pollutant control.

2. Calculate the DCV per Appendix B.2.

## E.5 SD-6B Permeable Pavement (Site Design BMP)



Photo Credit: San Diego Low Impact Development Design Manual

### Description

Permeable pavement is pavement that allows for percolation through void spaces in the pavement surface into subsurface layers. Permeable pavements reduce runoff volumes and rates and can provide pollutant control via infiltration, filtration, sorption, sedimentation, and biodegradation processes. When used as a site design BMP, the subsurface layers are designed to provide storage of storm water runoff so that outflow rates can be controlled via infiltration into subgrade soils. Varying levels of storm water treatment and

flow control can be provided depending on the size of the permeable pavement system relative to its drainage area and the underlying infiltration rates. As a site design BMP permeable pavement areas are designed to be self-retaining and are designed primarily for direct rainfall. Self-retaining permeable pavement areas have a ratio of total drainage area (including permeable pavement) to area of permeable pavement of 1.5:1 or less. Permeable pavement surfaces can be constructed from modular paver units or paver blocks, pervious concrete, porous asphalt, and turf pavers. Sites designed with permeable pavements can significantly reduce the impervious area of the project. Reduction in impervious surfaces decreases the DCV and can reduce the footprint of treatment control and flow control BMPs.

### Design Adaptations for Project Goals

#### Site design BMP to reduce impervious area and DCV.

Permeable pavement without an underdrain can be used as a site design feature to reduce the impervious area of the site by replacing traditional pavements, including roadways, parking lots, emergency access lanes, sidewalks, trails and driveways.

Typical Permeable Pavement Components (Top to Bottom)
Permeable surface layer
Bedding layer for permeable surface
Aggregate storage layer with optional underdrain(s)
Optional final filter course layer over uncompacted existing subgrade

### Conceptual Design and Sizing Approach for Site Design

1. Determine the areas where permeable pavements can be used in the site design to replace conventional pavements to reduce the DCV. These areas can be credited toward reducing runoff generated through representation in storm water calculations as pervious, not impervious, areas but are not credited for storm water pollutant control.
2. Calculate the DCV per Appendix B.2, taking into account reduced runoff from permeable pavement areas.

## E.6 SD-8 Rain Barrels



Photo Credit: San Diego Low Impact Development Design Manual

### Description

Rain barrels are containers that can capture rooftop runoff and store it for future use. With controlled timing and volume release, the captured rainwater can be used for irrigation or alternative grey water between storm events, thereby reducing runoff volumes and associated pollutants to downstream waterbodies. Rain barrels tend to be smaller systems, less than 100 gallons. Treatment can be achieved when rain barrels are used as part of a treatment train along with other BMPs that use captured flows in applications that do not result in discharges into the storm drain system. Rooftops are the ideal tributary areas for rain barrels.

### Design Adaptations for Project Goals

**Site design BMP to reduce effective impervious area and DCV.** Barrels can be used as a site design feature to reduce the effective impervious area of the site by removing roof runoff from the site discharge. This can reduce the DCV and flow control requirements for the site.

### Important Considerations

**Maintenance:** Rain barrels require regular monitoring and cleaning to ensure that they do not become clogged with leaves or other debris.

**Economics:** Rain barrels have low installation costs.

**Limitations:** Due to San Diego’s arid climate, some rain barrels may fill only a few times each year.

Typical Rain Barrel Components
Storage container, barrel or tank for holding captured flows
Inlet and associated valves and piping
Outlet and associated valves and piping
Overflow outlet
Optional pump
Optional first flush diverters
Optional roof, supports, foundation, level indicator, and other accessories

### Conceptual Design and Sizing Approach for Site Design

1. Determine the areas where rain barrels can be used in the site design to capture roof runoff to reduce the DCV. Rain barrels reduce the effective impervious area of the site by removing roof runoff from the site discharge.
2. Calculate the DCV per Appendix B.2, taking into account reduced runoff from permeable pavement areas.

## E.7 HU-1 Cistern



*Photo Credit: Water Environment Research Foundation: WERF.org*

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### MS4 Permit Category

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Retention

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### Manual Category

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Harvest and Use

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### Applicable Performance Standards

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Pollutant Control

Flow Control

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### Primary Benefits

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Volume Reduction

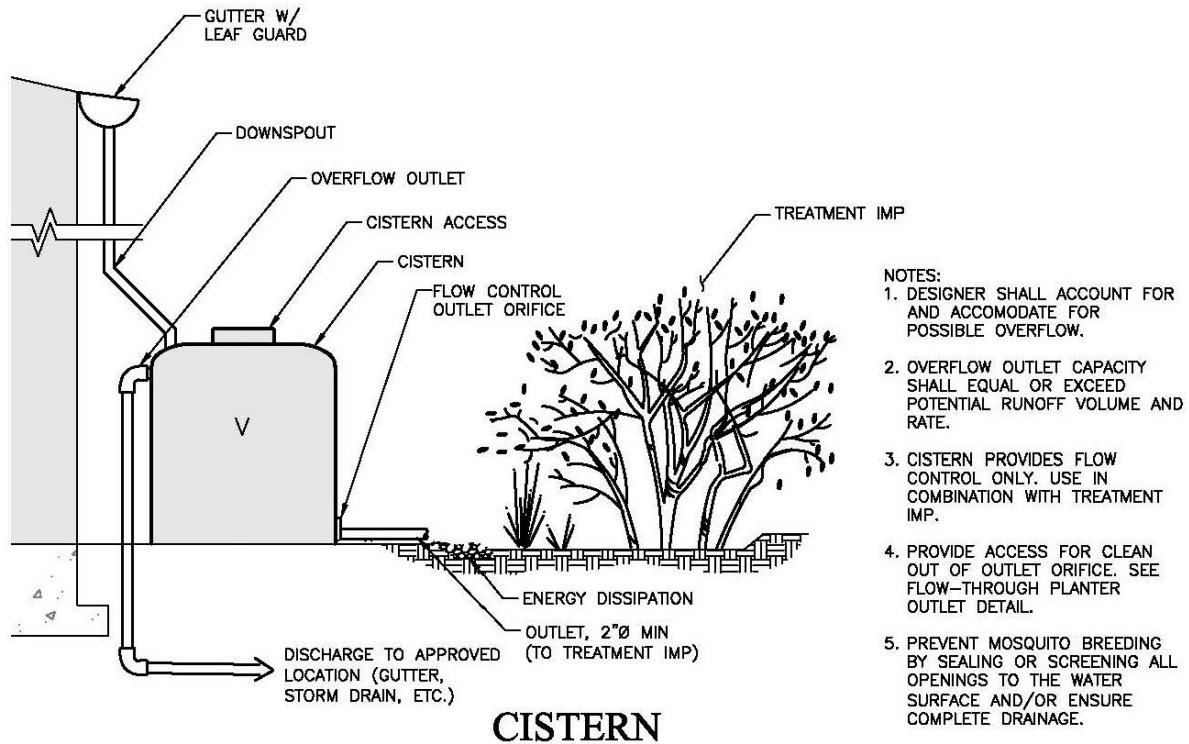
Peak Flow Attenuation

### Description

Cisterns are containers that can capture rooftop runoff and store it for future use. With controlled timing and volume release, the captured rainwater can be used for irrigation or alternative grey water between storm events, thereby reducing runoff volumes and associated pollutants to downstream water bodies. Cisterns are larger systems (generally >100 gallons) that can be self-contained aboveground or below ground systems. Treatment can be achieved when cisterns are used as part of a treatment train along with other BMPs that use captured flows in applications that do not result in discharges into the storm drain system. Rooftops are the ideal tributary areas for cisterns.

Typical cistern components include:

- Storage container, barrel or tank for holding captured flows
- Inlet and associated valves and piping
- Outlet and associated valves and piping
- Overflow outlet
- Optional pump
- Optional first flush diverters
- Optional roof, supports, foundation, level indicator, and other accessories



Source: City of San Diego Storm Water Standards

**Design Adaptations for Project Goals**

**Site design BMP to reduce effective impervious area and DCV.** Cisterns can be used as a site design feature to reduce the effective impervious area of the site by removing roof runoff from the site discharge. This can reduce the DCV and flow control requirements for the site.

**Harvest and use for storm water pollutant control.** Typical uses for captured flows include irrigation, toilet flushing, cooling system makeup, and vehicle and equipment washing.

**Integrated storm water flow control and pollutant control configuration.** Cisterns provide flow control in the form of volume reduction and/or peak flow attenuation and storm water treatment through elimination of discharges of pollutants. Additional flow control can be achieved by sizing the cistern to include additional detention storage and/or real-time automated flow release controls.

**Design Criteria and Considerations**

Cisterns must meet the following design criteria. Deviations from the below criteria may be approved

at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Cisterns are sized to detain the full DCV of contributing area and empty within 36 hours.	<p>Draining the cistern makes the storage volume available to capture the next storm.</p> <p>The applicant has an option to use a different drawdown time up to 96 hours if the volume of the facility is adjusted using the percent capture method in Appendix B.4.2.</p>
<input type="checkbox"/> Cisterns are fitted with a flow control device such as an orifice or a valve to limit outflow in accordance with drawdown time requirements.	<p>Flow control provides flow attenuation benefits and limits cistern discharge to downstream facilities during storm events.</p>
<input type="checkbox"/> Cisterns are designed to drain completely, leaving no standing water, and all entry points are fitted with traps or screens, or sealed.	<p>Complete drainage and restricted entry prevents mosquito habitat.</p>
<input type="checkbox"/> Leaf guards and/or screens are provided to prevent debris from accumulating in the cistern.	<p>Leaves and organic debris can clog the outlet of the cistern.</p>
<input type="checkbox"/> Access is provided for maintenance and the cistern outlets are accessible and designed to allow easy cleaning.	<p>Properly functioning outlets are needed to maintain proper flow control in accordance with drawdown time requirements.</p>
<input type="checkbox"/> Cisterns must be designed and sited such that overflow will be conveyed safely overland to the storm drain system or discharge point.	<p>Safe overflow conveyance prevents flooding and damage of property.</p>

**Conceptual Design and Sizing Approach for Site Design and Storm Water Pollutant Control**

1. Calculate the DCV for site design per Appendix B.
2. Determine the locations on the site where cisterns can be located to capture and detain the DCV from roof areas without subsequent discharge to the storm drain system. Cisterns are best located in close proximity to building and other roofed structures to minimize piping. Cisterns can also be used as part of a treatment train upstream by increasing pollutant control through delayed runoff to infiltration BMPs such as bioretention without underdrain facilities.
3. Use the sizing worksheet in Appendix B.3 to determine if full or partial capture of the DCV

is achievable.

4. The remaining DCV to be treated should be calculated for use in sizing downstream BMP(s).

***Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable***

Control of flow rates and/or duration will typically require significant cistern volumes, and therefore the following steps should be taken prior to determination of site design and storm water pollutant control. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that cistern siting and design criteria have been met. Design for flow control can be achieved using various design configurations, shapes, and quantities of cisterns.
2. Iteratively determine the cistern storage volume required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control valve operation.
3. Verify that the cistern is drawdown within 36 hours. The drawdown time can be estimated by dividing the storage volume by the rate of use of harvested water.
4. If the cistern cannot fully provide the flow rate and duration control required by this manual, a downstream structure with additional storage volume or infiltration capacity such as a biofiltration can be used to provide remaining flow control.

## E.8 INF-1 Infiltration Basin




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### MS4 Permit Category

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Retention

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### Manual Category

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Infiltration

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### Applicable Performance Standard

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Pollutant Control

Flow Control

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### Primary Benefits

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Volume Reduction

Peak Flow Attenuation

Photo Credit: <http://www.stormwaterpartners.com/facilities/basin.html>

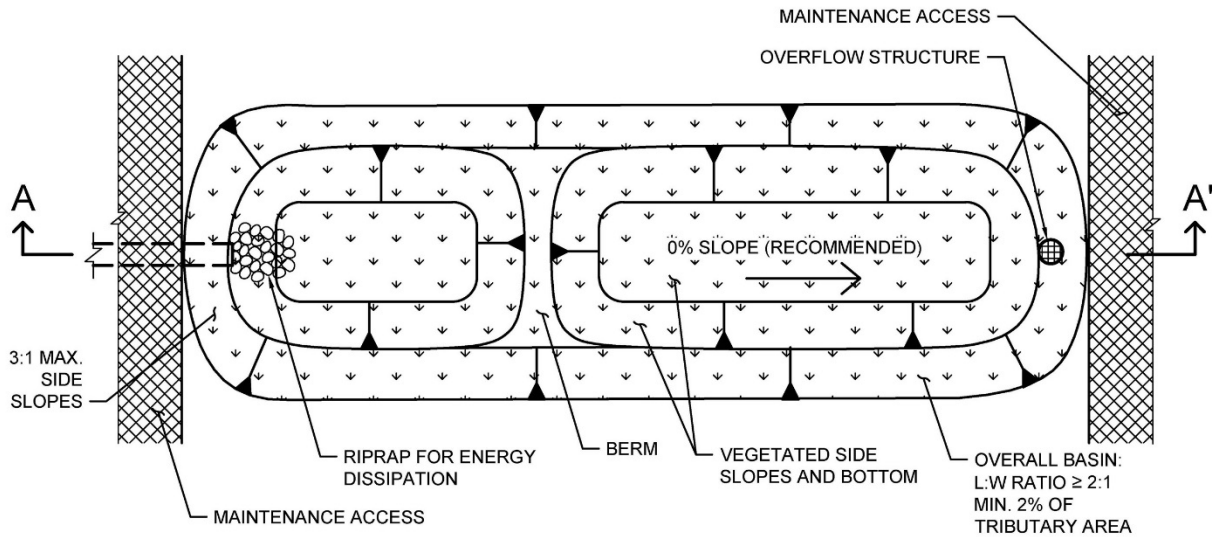
### Description

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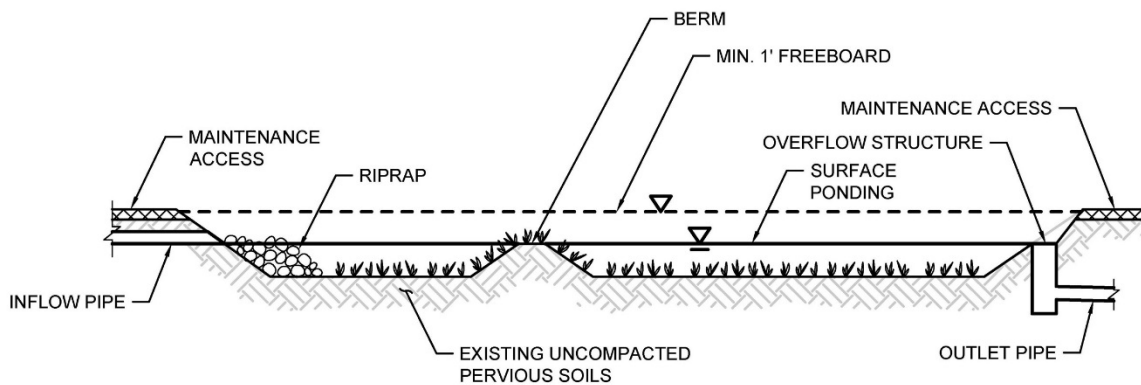
An infiltration basin typically consists of an earthen basin with a flat bottom constructed in naturally pervious soils. An infiltration basin retains storm water and allows it to evaporate and/or percolate into the underlying soils. The bottom of an infiltration basin is typically vegetated with native grasses or turf grass; however other types of vegetation can be used if they can survive periodic inundation and long inter-event dry periods. Treatment is achieved primarily through infiltration, filtration, sedimentation, biochemical processes and plant uptake. Infiltration basins can be constructed as linear **trenches** or as **underground infiltration galleries**.

Typical infiltration basin components include:

- Inflow distribution mechanisms (e.g., perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Forebay to provide pretreatment surface ponding for captured flows
- Vegetation selected based on basin use, climate, and ponding depth
- Uncompacted native soils at the bottom of the facility
- Overflow structure



**PLAN**  
NOT TO SCALE



**SECTION A-A'**  
NOT TO SCALE

**Typical plan and section view of an Infiltration BMP**

**Design Adaptations for Project Goals**

**Full infiltration BMP for storm water pollutant control.** Infiltration basins can be used as a pollutant control BMP, designed to infiltrate runoff from direct rainfall as well as runoff from adjacent areas that are tributary to the BMP. Infiltration basins must be designed with an infiltration storage volume (a function of the surface ponding volume) equal to the full DCV and able to meet drawdown time limitations.

**Integrated storm water flow control and pollutant control configuration.** Infiltration basins can

also be designed for flow rate and duration control by providing additional infiltration storage through increasing the surface ponding volume.

**Design Criteria and Considerations**

Infiltration basins must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
<input type="checkbox"/> Selection and design of basin is based on infiltration feasibility criteria and appropriate design infiltration rate (See Appendix C and D).	Must operate as a full infiltration design and must be supported by drainage area and in-situ infiltration rate feasibility findings.
<input type="checkbox"/> Finish grade of the facility is $\leq 2\%$ (0% recommended).	Flatter surfaces reduce erosion and channelization with the facility.
<input type="checkbox"/> Settling forebay has a volume $\geq 25\%$ of facility volume below the forebay overflow.	A forebay to trap sediment can decrease frequency of required maintenance.
<input type="checkbox"/> Infiltration of surface ponding is limited to a 36-hour drawdown time.	<p>Prolonged surface ponding reduce volume available to capture subsequent storms.</p> <p>The applicant has an option to use a different drawdown time up to 96 hours if the volume of the facility is adjusted using the percent capture method in Appendix B.4.2.</p>
<input type="checkbox"/> Minimum freeboard provided is $\geq 1$ foot.	Freeboard minimizes risk of uncontrolled surface discharge.
<input type="checkbox"/> Side slopes are = 3H:1V or shallower.	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
<i>Inflow and Overflow Structures</i>	

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Inflow and outflow structures are accessible by required equipment (e.g., tractor truck) for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
<input type="checkbox"/> Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
<input type="checkbox"/> Overflow is safely conveyed to a downstream storm drain system or discharge point. Size overflow structure to pass 100-year peak flow for on-line basins and water quality peak flow for off-line basins.	Planning for overflow lessens the risk of property damage due to flooding.

**Conceptual Design and Sizing Approach for Storm Water Pollutant Control**

To design infiltration basins for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement and basin area requirements, forebay volume, and maximum slopes for basin sides and bottom.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet (Appendix B.4) to determine if full infiltration of the DCV is achievable based on the infiltration storage volume calculated from the surface ponding area and depth for a maximum 36-hour drawdown time. The drawdown time can be estimated by dividing the average depth of the basin by the design infiltration rate. Appendix D provides guidance on evaluating a site’s infiltration rate.

**Conceptual Design and Sizing Approach for Storm Water Pollutant Treatment and Flow Control**

Control of flow rates and/or durations will typically require significant surface ponding volume, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and design criteria have been met, including placement and basin area requirements, forebay volume, and maximum slopes for basin sides and bottom.

## Appendix E: BMP Design Fact Sheets

2. Iteratively determine the surface ponding required to provide infiltration storage to reduce flow rates and durations to allowable limits while adhering to the maximum 36-hour drawdown time. Flow rates and durations can be controlled using flow splitters that route the appropriate inflow amounts to the infiltration basin and bypass excess flows to the downstream storm drain system or discharge point.
3. If an infiltration basin cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with appropriate storage volume such as an underground vault can be used to provide additional control.
4. After the infiltration basin has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

## E.9 INF-2 Bioretention



*Photo Credit: Ventura County Technical Guidance Document*

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### MS4 Permit Category

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Retention

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### Manual Category

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Infiltration

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### Applicable Performance Standard

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Pollutant Control  
Flow Control

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### Primary Benefits

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Volume Reduction  
Treatment  
Peak Flow Attenuation

### Description

Bioretention (bioretention without underdrain) facilities are vegetated surface water systems that filter water through vegetation and soil, or engineered media prior to infiltrating into native soils. These facilities are designed to infiltrate the full DCV. Bioretention facilities are commonly incorporated into the site within parking lot landscaping, along roadsides, and in open spaces. They can be constructed inground or partially aboveground, such as planter boxes with open bottoms (no impermeable liner at the bottom) to allow infiltration. Treatment is achieved through filtration, sedimentation, sorption, infiltration, biochemical processes and plant uptake.

Typical bioretention without underdrain components include:

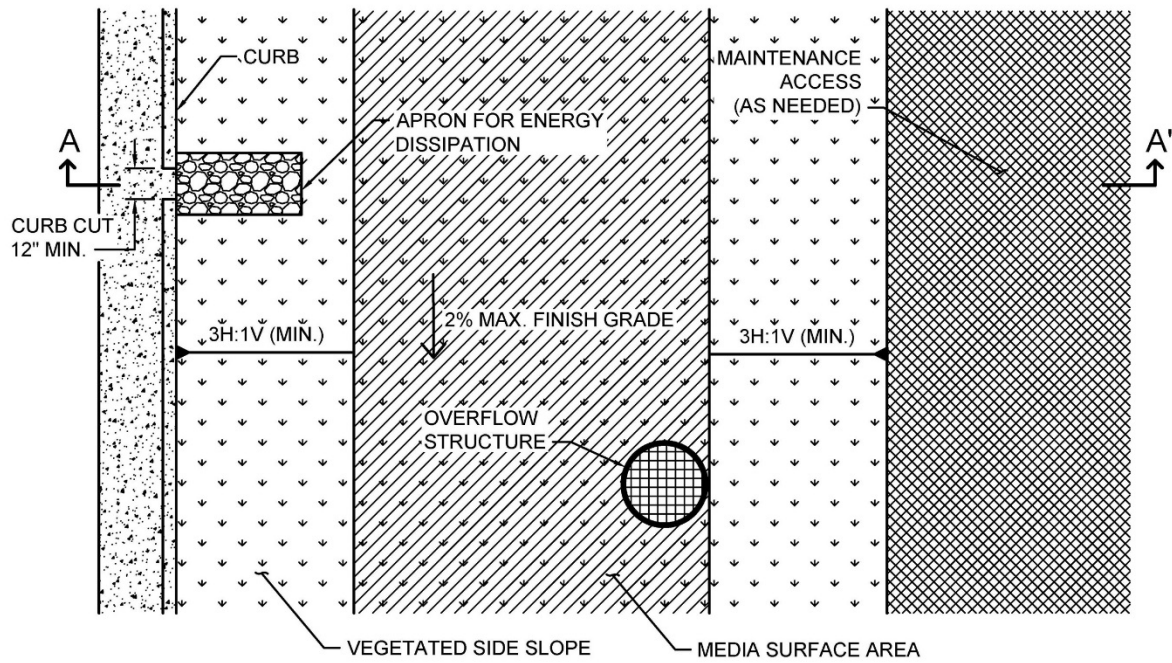
- Inflow distribution mechanisms (e.g, perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Shallow surface ponding for captured flows
- Side slope and basin bottom vegetation selected based on expected climate and ponding depth
- Non-floating mulch layer (optional)
- Media layer (planting mix or engineered media) capable of supporting vegetation growth

## Appendix E: BMP Design Fact Sheets

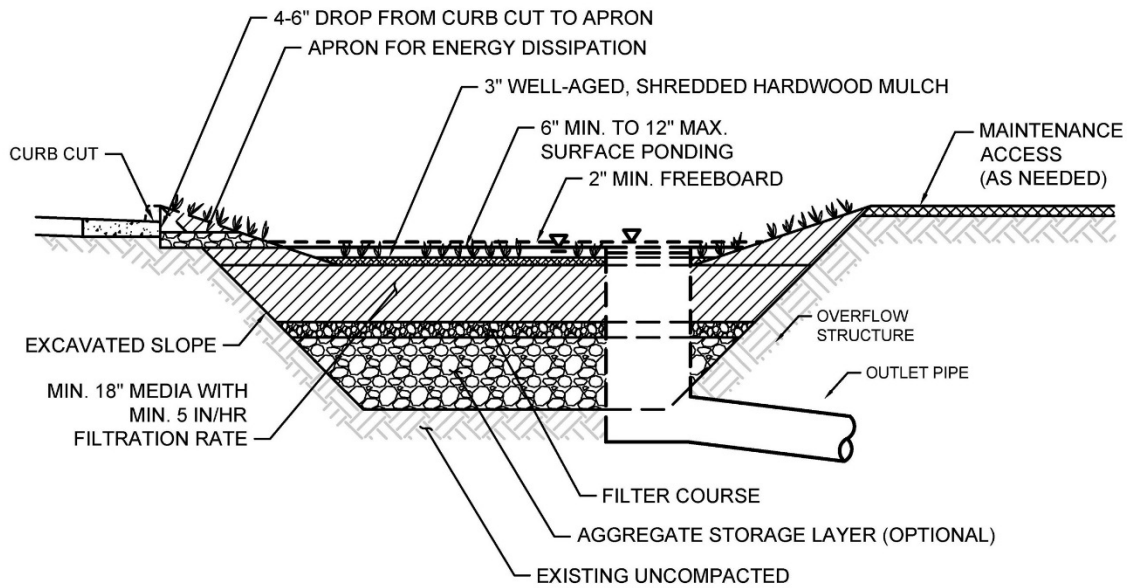
- Filter course layer consisting of aggregate to prevent the migration of fines into uncompacted native soils or the optional aggregate storage layer
- Optional aggregate storage layer for additional infiltration storage
- Uncompacted native soils at the bottom of the facility
- Overflow structure

### ***Design Adaptations for Project Goals***

- **Full infiltration BMP for storm water pollutant control.** Bioretention can be used as a pollutant control BMP designed to infiltrate runoff from direct rainfall as well as runoff from adjacent tributary areas. Bioretention facilities must be designed with an infiltration storage volume (a function of the ponding, media and aggregate storage volumes) equal to the full DCV and able to meet drawdown time limitations.
- **Integrated storm water flow control and pollutant control configuration.** Bioretention facilities can be designed to provide flow rate and duration control. This may be accomplished by providing greater infiltration storage with increased surface ponding and/or aggregate storage volume for storm water flow control.



**PLAN**  
NOT TO SCALE



**SECTION A-A'**  
NOT TO SCALE

Typical plan and section view of a Bioretention BMP

**Design Criteria and Considerations**

Bioretention must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
<input type="checkbox"/> Selection and design of BMP is based on infiltration feasibility criteria and appropriate design infiltration rate presented in Appendix C and D.	Must operate as a full infiltration design and must be supported by drainage area and in-situ infiltration rate feasibility findings.
<input type="checkbox"/> Contributing tributary area is $\leq 5$ acres ( $\leq 1$ acre preferred).	Bigger BMPs require additional design features for proper performance.  Contributing tributary area greater than 5 acres may be allowed at the discretion of the City Engineer if the following conditions are met: 1) incorporate design features (e.g. flow spreaders) to minimizing short circuiting of flows in the BMP and 2) incorporate additional design features requested by the City Engineer for proper performance of the regional BMP.
<input type="checkbox"/> Finish grade of the facility is $\leq 2\%$ . In long bioretention facilities where the potential for internal erosion and channelization exists, the use of check dams is required.	Flatter surfaces reduce erosion and channelization within the facility. Internal check dams reduce velocity and dissipate energy.
<b>Surface Ponding</b>	
<input type="checkbox"/> Surface ponding is limited to a 24-hour drawdown time.	24-hour drawdown time is recommended for plant health.  Surface ponding drawdown time greater than 24-hours but less than 96 hours may be allowed at the discretion of the City Engineer if certified by a landscape architect or agronomist.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Surface ponding depth is $\geq 6$ and $\leq 12$ inches.	<p>Surface ponding capacity lowers subsurface storage requirements. Deep surface ponding raises safety concerns.</p> <p>Surface ponding depth greater than 12 inches (for additional pollutant control or surface outlet structures or flow-control orifices) may be allowed at the discretion of the City Engineer if the following conditions are met: 1) surface ponding depth drawdown time is less than 24 hours; and 2) safety issues and fencing requirements are considered (typically ponding greater than 18” will require a fence and/or flatter side slopes) and 3) potential for elevated clogging risk is considered.</p>
<input type="checkbox"/> A minimum of 12 inches of freeboard is provided.	<p>Freeboard provides room for head over overflow structures and minimizes risk of uncontrolled surface discharge.</p>
<input type="checkbox"/> Side slopes are stabilized with vegetation and are $\geq 3H: 1V$ .	<p>Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.</p>
<b><i>Vegetation</i></b>	
<input type="checkbox"/> Plantings are suitable for the climate and expected ponding depth. A plant list to aid in selection can be found in Appendix E.20.	<p>Plants suited to the climate and ponding depth are more likely to survive.</p>
<input type="checkbox"/> An irrigation system with a connection to water supply is provided as needed.	<p>Seasonal irrigation might be needed to keep plants healthy.</p>
<b><i>Mulch</i></b>	
<input type="checkbox"/> A minimum of 3 inches of well-aged, shredded hardwood mulch that has been stockpiled or stored for at least 12 months is provided. <input type="checkbox"/> Mulch must be non-floating to avoid clogging of overflow structure.	<p>Mulch will suppress weeds and maintain moisture for plant growth. Aging mulch kills pathogens and weed seeds and allows beneficial microbes to multiply.</p>

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<b>Media Layer</b>	
<input type="checkbox"/> Media maintains a minimum filtration rate of 5 in/hr over lifetime of facility. A minimum initial filtration rate of 10 in/hr is recommended.	<p>A high filtration rate through the soil mix minimizes clogging potential and allows flows to quickly enter the aggregate storage layer, thereby minimizing bypass.</p>
<input type="checkbox"/> Media is a minimum 18 inches deep, meeting either of these two media specifications: City of San Diego Storm Water Standards, Appendix F.3 (May 2021, unless superseded by more recent edition) <b>or</b> County of San Diego BMP Design Manual: Appendix F.2 Biofiltration Soil Media Composition, Testing,(September 2020, unless superseded by more recent edition).	<p>A deep media layer provides additional filtration and supports plants with deeper roots.</p> <p>Standard specifications shall be followed.</p>
<input type="checkbox"/> Alternatively, for proprietary designs and custom media mixes not meeting the media specifications contained in the 2021 City of San Diego Storm Water Standards or County BMP Design Manual, the media meets the pollutant treatment performance criteria in Section F.1.	<p>For non-standard or proprietary designs, compliance with F.1 ensures that adequate treatment performance will be provided.</p>
<input type="checkbox"/> Media surface area is 3% of contributing area times adjusted runoff factor or greater. Unless demonstrated that the BMP surface area can be smaller than 3%	<p>Greater surface area to tributary area ratios decrease loading rates per square foot and therefore increase longevity.</p> <p>Adjusted runoff factor is to account for site design BMPs implemented upstream of the BMP (such as rain barrels, impervious area dispersion, etc.). Refer to Appendix B.2 guidance.</p> <p>Use Worksheet B.5-1 Line 26 to estimate the minimum surface area required per this criteria.</p>
<b>Filter Course Layer (Optional)</b>	
<input type="checkbox"/> A filter course is used to prevent migration of fines through layers of the facility. Filter fabric is not used.	<p>Migration of media can cause clogging of the aggregate storage layer void spaces or</p>

<i>Siting and Design</i>	<i>Intent/Rationale</i>
	subgrade. Filter fabric is more likely to clog.
<input type="checkbox"/> Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog the facility and impede infiltration.
<input type="checkbox"/> Filter course calculations assessing suitability for particle migration prevention have been completed.	Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.
<b><i>Aggregate Storage Layer (Optional)</i></b>	
<input type="checkbox"/> Class 2 Permeable per Caltrans specification 68-1.025 is recommended for the storage layer. Washed, open-graded crushed rock may be used, however a 4-6 inch washed pea gravel filter course layer at the top of the crushed rock is required.	Washing aggregate will help eliminate fines that could clog the aggregate storage layer void spaces or subgrade.
<input type="checkbox"/> Maximum aggregate storage layer depth is determined based on the infiltration storage volume that will infiltrate within a 36-hour drawdown time.	A maximum drawdown time to facilitate provision of adequate storm water storage for the next storm event.
<b><i>Inflow and Overflow Structures</i></b>	
<input type="checkbox"/> Inflow and overflow structures are accessible for inspection and maintenance. Overflow structures must be connected to downstream storm drain system or appropriate discharge point.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
<input type="checkbox"/> Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
<input type="checkbox"/> Curb cut inlets are at least 12 inches wide, have a 4-6 inch reveal (drop) and an apron and energy dissipation as needed.	Inlets must not restrict flow and apron prevents blockage from vegetation as it grows in. Energy dissipation prevents erosion.
<input type="checkbox"/> Overflow is safely conveyed to a downstream storm drain system or discharge point. Size overflow structure to pass 100-year peak flow	Planning for overflow lessens the risk of property damage due to flooding.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
for on-line basins and water quality peak flow for off-line basins.	

**Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only**

To design bioretention for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement and basin area requirements, maximum side and finish grade slope, and the recommended media surface area tributary ratio.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet to determine if full infiltration of the DCV is achievable based on the available infiltration storage volume calculated from the bioretention without underdrain footprint area, effective depths for surface ponding, media and aggregate storage layers, and in-situ soil design infiltration rate for a maximum 36-hour drawdown time for the aggregate storage layer, with surface ponding no greater than a maximum 24-hour drawdown. The drawdown time can be estimated by dividing the average depth of the basin by the design infiltration rate of the underlying soil. Appendix D provides guidance on evaluating a site's infiltration rate. A generic sizing worksheet is provided in Appendix B.4.
4. Where the DCV cannot be fully infiltrated based on the site or bioretention constraints, an underdrain can be added to the design (use biofiltration with partial retention factsheet).

**Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable**

Control of flow rates and/or durations will typically require significant surface ponding and/or aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations shall be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and design criteria have been met, including placement requirements, maximum side and finish grade slopes, and the recommended media surface area tributary area ratio. Design for flow control can be achieved using various design configurations.
2. Iteratively determine the facility footprint area, surface ponding and/or aggregate storage layer depth required to provide infiltration storage to reduce flow rates and durations to allowable limits while adhering to the maximum drawdown times for surface ponding and aggregate storage. Flow rates and durations can be controlled using flow splitters that route the appropriate inflow amounts to the bioretention facility and bypass excess flows to the downstream storm drain system or discharge point.
3. If bioretention without underdrain facility cannot fully provide the flow rate and duration

## Appendix E: BMP Design Fact Sheets

control required by the MS4 permit, an upstream or downstream structure with appropriate storage volume such as an underground vault can be used to provide additional control.

4. After bioretention without underdrain BMPs have been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

## E.10 INF-3 Permeable Pavement (Pollutant Control)



*Location: Kellogg Park, San Diego, California*

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### MS4 Permit Category

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Retention  
Flow-thru Treatment  
Control

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### Manual Category

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Infiltration  
Flow-thru Treatment  
Control

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### Applicable Performance Standard

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Pollutant Control  
Flow Control

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### Primary Benefits

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Volume Reduction  
Peak Flow Attenuation

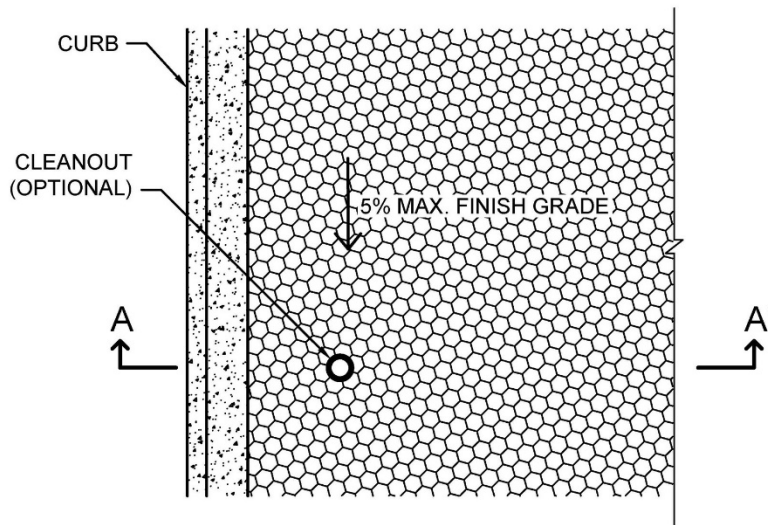
### Description

Permeable pavement is pavement that allows for percolation through void spaces in the pavement surface into subsurface layers. The subsurface layers are designed to provide storage of storm water runoff so that outflows, primarily via infiltration into subgrade soils or release to the downstream conveyance system, can be at controlled rates. Varying levels of storm water treatment and flow control can be provided depending on the size of the permeable pavement system relative to its drainage area, the underlying infiltration rates, and the configuration of outflow controls. Pollutant control permeable pavement is designed to receive runoff from a larger tributary area than site design permeable pavement (see SD-6B). Pollutant control is provided via infiltration, filtration, sorption, sedimentation, and biodegradation processes.

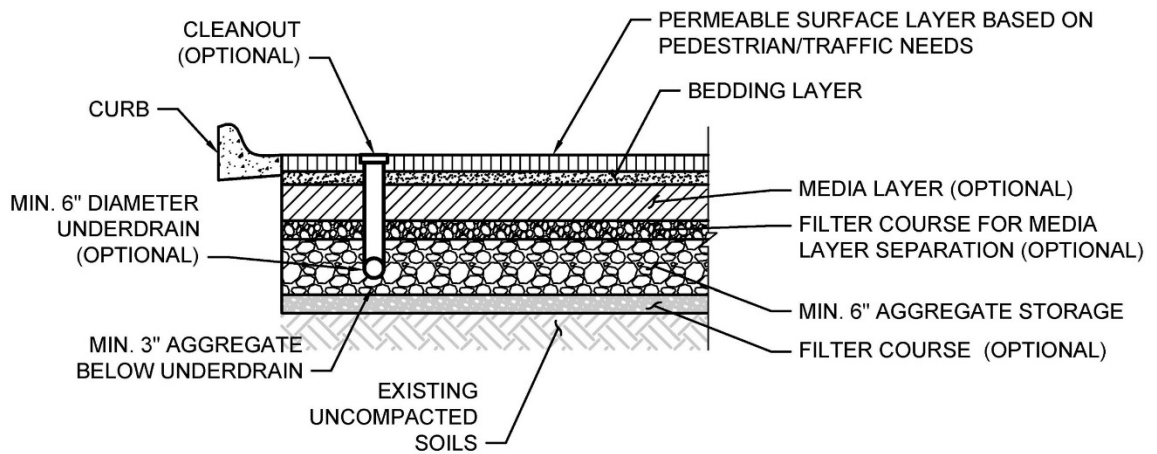
Typical permeable pavement components include, from top to bottom:

- Permeable surface layer
- Bedding layer for permeable surface
- Aggregate storage layer with optional underdrain(s)

- Optional final filter course layer over uncompacted existing subgrade



**PLAN**  
NOT TO SCALE



**SECTION A-A'**  
NOT TO SCALE

Typical plan and Section view of a Permeable Pavement BMP

Subcategories of permeable pavement include modular paver units or paver blocks, pervious concrete, porous asphalt, and turf pavers. These subcategory variations differ in the material used for the permeable surface layer but have similar functions and characteristics below this layer.

### ***Design Adaptations for Project Goals***

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**Site design BMP to reduce impervious area and DCV.** See site design option SD-6B.

**Full infiltration BMP for storm water pollutant control.** Permeable pavement without an underdrain and without impermeable liners can be used as a pollutant control BMP, designed to infiltrate runoff from direct rainfall as well as runoff from adjacent areas that are tributary to the pavement. The system must be designed with an infiltration storage volume (a function of the aggregate storage volume) equal to the full DCV and able to meet drawdown time limitations.

**Partial infiltration BMP with flow-thru treatment for storm water pollutant control.** Permeable pavement can be designed so that a portion of the DCV is infiltrated by providing an underdrain with infiltration storage below the underdrain invert. The infiltration storage depth should be determined by the volume that can be reliably infiltrated within drawdown time limitations. Water discharged through the underdrain is considered flow-thru treatment and is not considered biofiltration treatment. Storage provided above the underdrain invert is included in the flow-thru treatment volume.

**Flow-thru treatment BMP for storm water pollutant control.** The system may be lined and/or installed over impermeable native soils with an underdrain provided at the bottom to carry away filtered runoff. Water quality treatment is provided via unit treatment processes other than infiltration. This configuration is considered to provide flow-thru treatment, not biofiltration treatment. Significant aggregate storage provided above the underdrain invert can provide detention storage, which can be controlled via inclusion of an orifice in an outlet structure at the downstream end of the underdrain. **PDPs have the option to add saturated storage to the flow-thru configuration in order to reduce the DCV that the BMP is required to treat.** Saturated storage can be added to this design by including an upturned elbow installed at the downstream end of the underdrain or via an internal weir structure designed to maintain a specific water level elevation. The DCV can be reduced by the amount of saturated storage provided.

**Integrated storm water flow control and pollutant control configuration.** With any of the above configurations, the system can be designed to provide flow rate and duration control. This may include having a deeper aggregate storage layer that allows for significant detention storage above the underdrain, which can be further controlled via inclusion of an outlet structure at the downstream end of the underdrain.

**Design Criteria and Considerations**

Permeable pavements must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
<input type="checkbox"/> Selection must be based on infiltration feasibility criteria.	Full or partial infiltration designs must be supported by drainage area feasibility findings.
<input type="checkbox"/> An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
<input type="checkbox"/> Permeable pavement is not placed in an area with significant overhanging trees or other vegetation.	Leaves and organic debris can clog the pavement surface.
<input type="checkbox"/> For pollutant control permeable pavement, the ratio of the total drainage area (including the permeable pavement) to the permeable pavement should not exceed 4:1.	Higher ratios increase the potential for clogging but may be acceptable for relatively clean tributary areas.
<input type="checkbox"/> Finish grade of the permeable pavement has a slope $\leq 5\%$ .	Flatter surfaces facilitate increased runoff capture.
<input type="checkbox"/> Minimum depth to groundwater and bedrock $\geq 10$ ft.	A minimum separation facilitates infiltration and lessens the risk of negative groundwater impacts.
<input type="checkbox"/> Contributing tributary area includes effective sediment source control and/or pretreatment measures such as raised curbed or grass filter strips.	Sediment can clog the pavement surface.
<input type="checkbox"/> Direct discharges to permeable pavement are only from downspouts carrying “clean” roof	Roof runoff typically carries less sediment than runoff from other

<i>Siting and Design</i>	<i>Intent/Rationale</i>
runoff that are equipped with filters to remove gross solids.	impervious surfaces and is less likely to clog the pavement surface.
<b><i>Permeable Surface Layer</i></b>	
<input type="checkbox"/> Permeable surface layer type is appropriately chosen based on pavement use and expected vehicular loading.	Pavement may wear more quickly if not durable for expected loads or frequencies.
<input type="checkbox"/> Permeable surface layer type is appropriate for expected pedestrian traffic.	Expected demographic and accessibility needs (e.g., adults, children, seniors, runners, high-heeled shoes, wheelchairs, strollers, bikes) requires selection of appropriate surface layer type that will not impede pedestrian needs.
<b><i>Bedding Layer for Permeable Surface</i></b>	
<input type="checkbox"/> Bedding thickness and material is appropriate for the chosen permeable surface layer type.	<p>Porous asphalt requires a 2- to 4-inch layer of asphalt and a 1- to 2-inch layer of choker course (single-sized crushed aggregate, one-half inch) to stabilize the surface.</p> <p>Pervious concrete also requires an aggregate course of clean gravel or crushed stone with a minimum amount of fines.</p> <p>Permeable Interlocking Concrete Paver requires 1 or 2 inches of sand or No. 8 aggregate to allow for leveling of the paver blocks.</p> <p>Similar to Permeable Interlocking Concrete Paver, plastic grid systems also require a 1- to 2-inch bedding course of either gravel or sand.</p> <p>For Permeable Interlocking Concrete Paver and plastic grid systems, if sand is used, a geotextile should be used between the sand course and the reservoir media to prevent the sand from migrating into the stone media.</p>

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Aggregate used for bedding layer is washed prior to placement.	Washing aggregate will help eliminate fines that could clog the permeable pavement system aggregate storage layer void spaces or underdrain.
<i>Media Layer (Optional) –used between bedding layer and aggregate storage layer to provide pollutant treatment control</i>	
<input type="checkbox"/> The pollutant removal performance of the media layer is documented by the applicant.	Media used for BMP design should be shown via research or testing to be appropriate for expected pollutants of concern and flow rates.
<input type="checkbox"/> A filter course is provided to separate the media layer from the aggregate storage layer.	Migration of media can cause clogging of the aggregate storage layer void spaces or underdrain.
<input type="checkbox"/> If a filter course is used, calculations assessing suitability for particle migration prevention have been completed.	Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.
<input type="checkbox"/> Consult permeable pavement manufacturer to verify that media layer provides required structural support.	Media must not compromise the structural integrity or intended uses of the permeable pavement surface.
<i>Aggregate Storage Layer</i>	
<input type="checkbox"/> Aggregate used for the aggregate storage layer is washed and free of fines.	Washing aggregate will help eliminate fines that could clog aggregate storage layer void spaces or underdrain.
<input type="checkbox"/> Minimum layer depth is 6 inches and for infiltration designs, the maximum depth is determined based on the infiltration storage volume that will infiltrate within a 36-hour drawdown time.	A minimum depth of aggregate provides structural stability for expected pavement loads.
<i>Underdrain and Outflow Structures</i>	
<input type="checkbox"/> Underdrains and outflow structures, if used, are accessible for inspection and maintenance.	Maintenance will improve the performance and extend the life of the permeable pavement system.

<i>Siting and Design</i>		<i>Intent/Rationale</i>
<input type="checkbox"/>	Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
<input type="checkbox"/>	Minimum underdrain diameter is 6 inches.	Smaller diameter underdrains are prone to clogging.
<input type="checkbox"/>	Underdrains are made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
<i>Filter Course (Optional)</i>		
<input type="checkbox"/>	Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog subgrade and impede infiltration.

**Conceptual Design and Sizing Approach for Site Design**

1. Determine the areas where permeable pavement can be used in the site design to replace traditional pavement to reduce the impervious area and DCV. These permeable pavement areas can be credited toward reducing runoff generated through representation in storm water calculations as pervious, not impervious, areas but are not credited for storm water pollutant control. These permeable pavement areas should be designed as self-retaining with the appropriate tributary area ratio identified in the design criteria.
2. Calculate the DCV per Appendix B, taking into account reduced runoff from self-retaining permeable pavement areas.

**Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only**

To design permeable pavement for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement requirements, maximum finish grade slope, and the recommended tributary area ratio for non-self-retaining permeable pavement. If infiltration is infeasible, the permeable pavement can be designed as flow-thru treatment per the sizing worksheet. If infiltration is feasible, calculations should follow the remaining design steps.

2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet to determine if full or partial infiltration of the DCV is achievable based on the available infiltration storage volume calculated from the permeable pavement footprint, aggregate storage layer depth, and in-situ soil design infiltration rate for a maximum 36-hour drawdown time. The applicant has an option to use a different drawdown time up to 96 hours if the volume of the facility is adjusted using the percent capture method in Appendix B.4.2.
4. Where the DCV cannot be fully infiltrated based on the site or permeable pavement constraints, an underdrain must be incorporated above the infiltration storage to carry away runoff that exceeds the infiltration storage capacity.
5. The remaining DCV to be treated should be calculated for use in sizing downstream BMP(s).

***Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable***

Control of flow rates and/or durations will typically require significant aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and design criteria have been met, including placement requirements, maximum finish grade slope, and the recommended tributary area ratio for non-self-retaining permeable pavement. Design for flow control can be achieved using various design configurations, but a flow-thru treatment design will typically require a greater aggregate storage layer volume than designs which allow for full or partial infiltration of the DCV.
2. Iteratively determine the area and aggregate storage layer depth required to provide infiltration and/or detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If the permeable pavement system cannot fully provide the flow rate and duration control required by this manual, a downstream structure with sufficient storage volume such as an underground vault can be used to provide remaining controls.
4. After permeable pavement has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

## E.11 PR-1 Biofiltration with Partial Retention



*Location: 805 and Bonita Road, Chula vista, CA.*

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### MS4 Permit Category

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NA

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### Manual Category

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Partial Retention

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### Applicable Performance Standard

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Pollutant Control

Flow Control

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### Primary Benefits

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Volume Reduction

Treatment

Peak Flow Attenuation

### Description

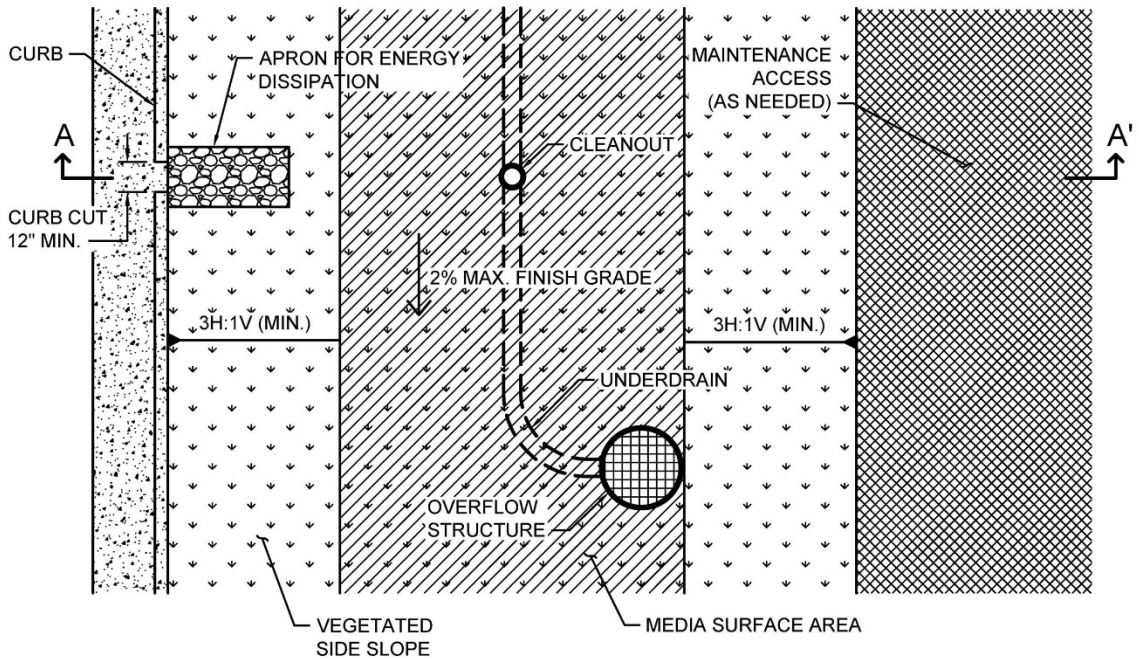
Biofiltration with partial retention (partial infiltration and biofiltration) facilities are vegetated surface water systems that filter water through vegetation, and soil or engineered media prior to infiltrating into native soils, discharge via underdrain, or overflow to the downstream conveyance system. Where feasible, these BMPs have an elevated underdrain discharge point that creates storage capacity in the aggregate storage layer. Biofiltration with partial retention facilities are commonly incorporated into the site within parking lot landscaping, along roadsides, and in open spaces. They can be constructed in ground or partially aboveground, such as planter boxes with open bottoms to allow infiltration. Treatment is achieved through filtration, sedimentation, sorption, infiltration, biochemical processes and plant uptake.

Typical biofiltration with partial retention components include:

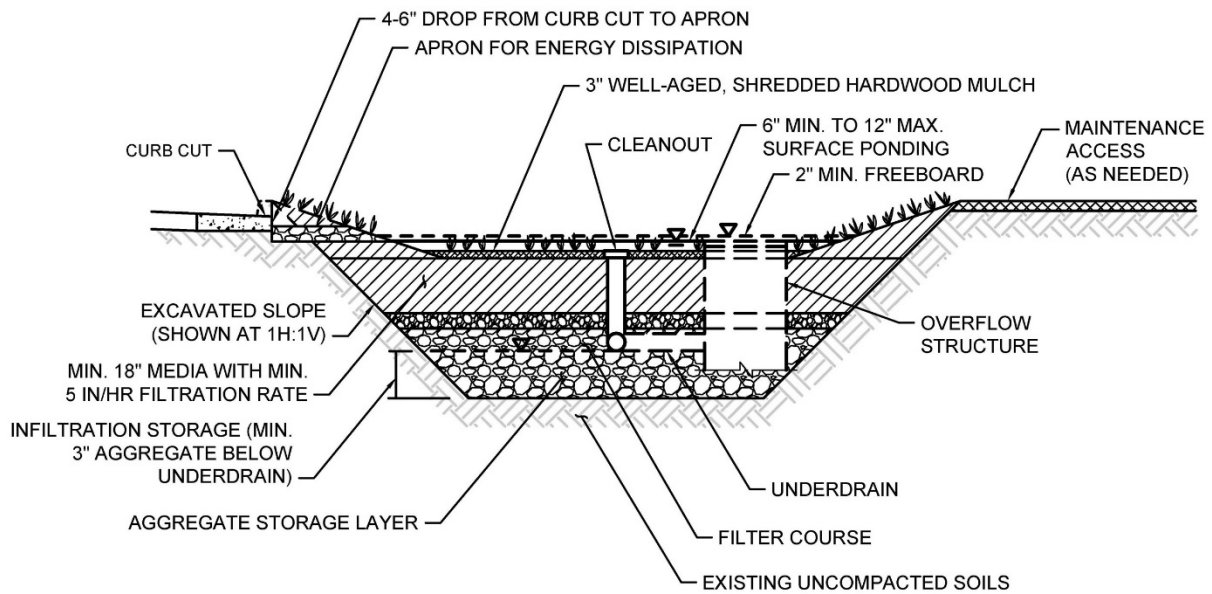
- Inflow distribution mechanisms (e.g, perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Shallow surface ponding for captured flows
- Side Slope and basin bottom vegetation selected based on climate and ponding depth
- Non-floating mulch layer
- Media layer (planting mix or engineered media) capable of supporting vegetation growth
- Filter course layer consisting of aggregate to prevent the migration of fines into uncompacted native soils or the optional aggregate storage layer
- Aggregate storage layer with underdrain(s)

## Appendix E: BMP Design Fact Sheets

- Uncompacted native soils at the bottom of the facility
- Overflow structure



**PLAN**  
NOT TO SCALE



**SECTION A-A'**  
NOT TO SCALE

Typical plan and Section view of a Biofiltration with Partial Retention BMP

**Design Adaptations for Project Goals**

**Partial infiltration BMP with biofiltration treatment for storm water pollutant control.** Biofiltration with partial retention can be designed so that a portion of the DCV is infiltrated by providing infiltration storage below the underdrain invert. The infiltration storage depth should be determined by the volume that can be reliably infiltrated within drawdown time limitations. Water discharged through the underdrain is considered biofiltration treatment. Storage provided above the underdrain within surface ponding, media, and aggregate storage is included in the biofiltration treatment volume.

**Integrated storm water flow control and pollutant control configuration.** The system can be designed to provide flow rate and duration control by primarily providing increased surface ponding and/or having a deeper aggregate storage layer. This will allow for significant detention storage, which can be controlled via inclusion of an orifice in an outlet structure at the downstream end of the underdrain.

**Design Criteria and Considerations**

Biofiltration with partial retention must meet the following design criteria and considerations. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
<input type="checkbox"/> Selection and design of basin is based on infiltration feasibility criteria and appropriate design infiltration rate (See Appendix C and D).	Must operate as a partial infiltration design and must be supported by drainage area and in-situ infiltration rate feasibility findings.
<input type="checkbox"/> Contributing tributary area shall be $\leq 5$ acres ( $\leq 1$ acre preferred).	Bigger BMPs require additional design features for proper performance.  Contributing tributary area greater than 5 acres may be allowed at the discretion of the City Engineer if the following conditions are met: 1) incorporate design features (e.g. flow spreaders) to

<i>Siting and Design</i>	<i>Intent/Rationale</i>
	minimizing short circuiting of flows in the BMP and 2) incorporate additional design features requested by the City Engineer for proper performance of the regional BMP.
<input type="checkbox"/> Finish grade of the facility is $\leq 2\%$ .	Flatter surfaces reduce erosion and channelization within the facility.
<i>Surface Ponding</i>	
<input type="checkbox"/> Surface ponding is limited to a 24-hour drawdown time.	Surface ponding limited to 24 hours for plant health. Surface ponding drawdown time greater than 24-hours but less than 96 hours may be allowed at the discretion of the City Engineer if certified by a landscape architect or agronomist.
<input type="checkbox"/> Surface ponding depth is $\geq 6$ and $\leq 12$ inches.	<p>Surface ponding capacity lowers subsurface storage requirements. Deep surface ponding raises safety concerns.</p> <p>Surface ponding depth greater than 12 inches (for additional pollutant control or surface outlet structures or flow-control orifices) may be allowed at the discretion of the City Engineer if the following conditions are met: 1) surface ponding depth drawdown time is less than 24 hours; and 2) safety issues and fencing requirements are considered (typically ponding greater than 18" will require a fence and/or flatter side slopes) and 3) potential for elevated clogging risk is considered.</p>
<input type="checkbox"/> A minimum of 12 inches of freeboard is provided.	Freeboard provides room for head over overflow structures and minimizes risk of uncontrolled surface discharge.
<input type="checkbox"/> Side slopes are stabilized with vegetation and are = 3H:1V or shallower.	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<i>Vegetation</i>	
<input type="checkbox"/> Plantings are suitable for the climate and expected ponding depth. A plant list to aid in selection can be found in Appendix E.20	Plants suited to the climate and ponding depth are more likely to survive.
<input type="checkbox"/> An irrigation system with a connection to water supply should be provided as needed.	Seasonal irrigation might be needed to keep plants healthy.
<i>Mulch</i>	
<input type="checkbox"/> A minimum of 3 inches of well-aged, shredded hardwood mulch that has been stockpiled or stored for at least 12 months is provided. Mulch must be non-floating to avoid clogging of overflow structure.	Mulch will suppress weeds and maintain moisture for plant growth. Aging mulch kills pathogens and weed seeds and allows the beneficial microbes to multiply.
<i>Media Layer</i>	
<input type="checkbox"/> Media maintains a minimum filtration rate of 5 in/hr over lifetime of facility. An initial filtration rate of 8 to 12 in/hr is recommended to allow for clogging over time; the initial filtration rate should not exceed 12 inches per hour.	A filtration rate of at least 5 inches per hour allows soil to drain between events, and allows flows to relatively quickly enter the aggregate storage layer, thereby minimizing bypass. The initial rate should be higher than long term target rate to account for clogging over time. However an excessively high initial rate can have a negative impact on treatment performance, therefore an upper limit is needed.
<input type="checkbox"/> Media is a minimum 18 inches deep, meeting either of these two media specifications:  City of San Diego Storm Water Standards Appendix F.3 (May 2021, unless superseded by more recent edition) <b>or</b> County of San Diego BMP Design Manual: Appendix F.2 Biofiltration Soil Media Composition, Testing,(September 2020, unless superseded by more recent edition).	A deep media layer provides additional filtration and supports plants with deeper roots.
Alternatively, for proprietary designs and	Standard specifications shall be followed.  For non-standard or proprietary designs, compliance with Appendix F.1 ensures that adequate treatment performance will be provided.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<p>custom media mixes not meeting the media specifications contained in the 2021 City of San Diego Storm Water Standards or County BMP Design Manual, the media meets the pollutant treatment performance criteria in Section F.1.</p>	<p>Greater surface area to tributary area ratios: a) maximizes volume retention as required by the MS4 Permit and b) decrease loading rates per square foot and therefore increase longevity.</p>
<p><input type="checkbox"/> Media surface area is 3% of contributing area times adjusted runoff factor or greater. Unless demonstrated that the BMP surface area can be smaller than 3%.</p>	<p>Adjusted runoff factor is to account for site design BMPs implemented upstream of the BMP (such as rain barrels, impervious area dispersion, etc.). Refer to Appendix B.2 guidance.</p> <p>Use Worksheet B.5-1 Line 26 to estimate the minimum surface area required per this criteria.</p>
<p><input type="checkbox"/> Where receiving waters are impaired or have a TMDL for nutrients, the system is designed with nutrient sensitive media design (see fact sheet BF-2).</p>	<p>Potential for pollutant export is partly a function of media composition; media design must minimize potential for export of nutrients, particularly where receiving waters are impaired for nutrients.</p>
<b><i>Filter Course Layer</i></b>	
<p><input type="checkbox"/> A filter course is used to prevent migration of fines through layers of the facility. Filter fabric is not used.</p>	<p>Migration of media can cause clogging of the aggregate storage layer void spaces or subgrade. Filter fabric is more likely to clog.</p>
<p><input type="checkbox"/> Filter course is washed and free of fines.</p>	<p>Washing aggregate will help eliminate fines that could clog the facility</p>
<p><input type="checkbox"/> Filter course calculations assessing suitability for particle migration prevention have been completed.</p>	<p>Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.</p>

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<b><i>Aggregate Storage Layer</i></b>	
<input type="checkbox"/> Class 2 Permeable per Caltrans specification 68-1.025 is recommended for the storage layer. Washed, open-graded crushed rock may be used, however a 4-6 inch washed pea gravel filter course layer at the top of the crushed rock is required.	Washing aggregate will help eliminate fines that could clog the aggregate storage layer void spaces or subgrade.
<input type="checkbox"/> Maximum aggregate storage layer depth below the underdrain invert is determined based on the infiltration storage volume that will infiltrate within a 36-hour drawdown time.	A maximum drawdown time is needed for vector control and to facilitate providing storm water storage for the next storm event.
<b><i>Inflow, Underdrain, and Outflow Structures</i></b>	
<input type="checkbox"/> Inflow, underdrains and outflow structures are accessible for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
<input type="checkbox"/> Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods. (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
<input type="checkbox"/> Curb cut inlets are at least 12 inches wide, have a 4-6 inch reveal (drop) and an apron and energy dissipation as needed.	Inlets must not restrict flow and apron prevents blockage from vegetation as it grows in. Energy dissipation prevents erosion.
<input type="checkbox"/> Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
<input type="checkbox"/> Minimum underdrain diameter is 6 inches.	Smaller diameter underdrains are prone to clogging.
<input type="checkbox"/> Underdrains are made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
<input type="checkbox"/> An underdrain cleanout with a minimum 6-inch diameter and lockable cap is placed every	Properly spaced cleanouts will facilitate underdrain maintenance.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
250 to 300 feet as required based on underdrain length.	
<input type="checkbox"/> Overflow is safely conveyed to a downstream storm drain system or discharge point. Size overflow structure to pass 100-year peak flow for on-line infiltration basins and water quality peak flow for off-line basins.	Planning for overflow lessens the risk of property damage due to flooding.

**Nutrient Sensitive Media Design**

To design biofiltration with partial retention with underdrain for storm water pollutant control only (no flow control required), the following steps should be taken:

**Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only**

To design biofiltration with partial retention and an underdrain for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Generalized sizing procedure is presented in Appendix B.5. The surface ponding should be verified to have a maximum 24-hour drawdown time.

**Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable**

Control of flow rates and/or durations will typically require significant surface ponding and/or aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Iteratively determine the facility footprint area, surface ponding and/or aggregate storage layer depth required to provide detention and/or infiltration storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If biofiltration with partial retention cannot fully provide the flow rate and duration control

## Appendix E: BMP Design Fact Sheets

required by this manual, an upstream or downstream structure with significant storage volume such as an underground vault can be used to provide remaining controls.

4. After biofiltration with partial retention has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

## E.12 BF-1 Biofiltration



*Location: 43<sup>rd</sup> Street and Logan Avenue, San Diego, California*

### Description

Biofiltration (Bioretention with underdrain) facilities are vegetated surface water systems that filter water through vegetation, and soil or engineered media prior to discharge via underdrain or overflow to the downstream conveyance system. Bioretention with underdrain facilities are commonly incorporated into the site within parking lot landscaping, along roadsides, and in open spaces. Because these types of facilities have limited or no infiltration, they are typically designed to provide enough hydraulic head to move flows through the underdrain connection to the storm drain system. Treatment is achieved through filtration, sedimentation, sorption, biochemical processes and plant uptake.

Typical bioretention with underdrain components include:

- Inflow distribution mechanisms (e.g, perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Shallow surface ponding for captured flows
- Side slope and basin bottom vegetation selected based on expected climate and ponding depth
- Non-floating mulch layer (Optional)
- Media layer (planting mix or engineered media) capable of supporting vegetation growth
- Filter course layer consisting of aggregate to prevent the migration of fines into uncompacted native soils or the aggregate storage layer
- Aggregate storage layer with underdrain(s)
- Impermeable liner or uncompacted native soils at the bottom of the facility
- Overflow structure

### MS4 Permit Category

Biofiltration

### Manual Category

Biofiltration

### Applicable Performance Standard

Pollutant Control

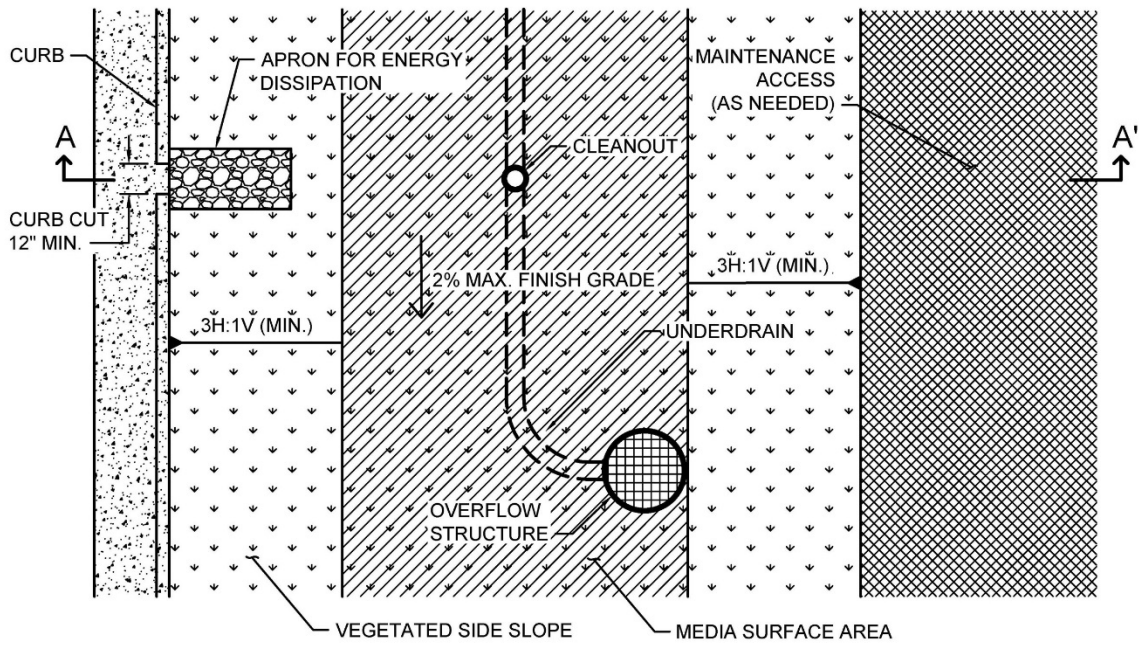
Flow Control

### Primary Benefits

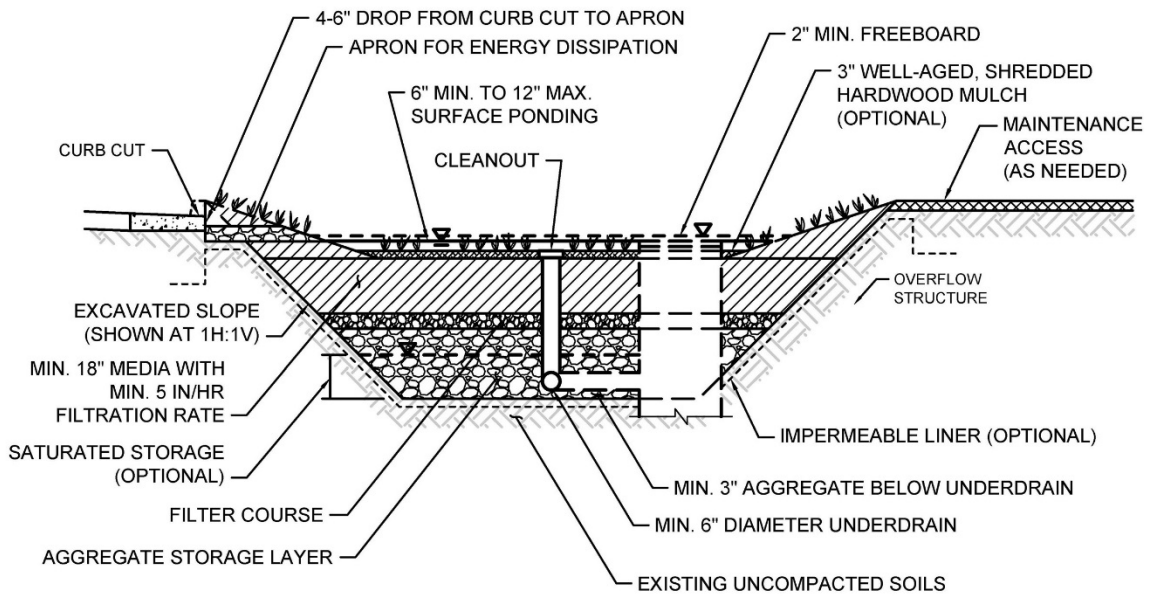
Treatment

Volume Reduction (Incidental)

Peak Flow Attenuation (Optional)



**PLAN**  
NOT TO SCALE



**SECTION A-A'**  
NOT TO SCALE

**Typical plan and Section view of a Biofiltration BMP**

**Design Adaptations for Project Goals**

**Biofiltration Treatment BMP for storm water pollutant control.** The system is lined or un-lined to provide incidental infiltration, and an underdrain is provided at the bottom to carry away filtered runoff. This configuration is considered to provide biofiltration treatment via flow through the media layer. Storage provided above the underdrain within surface ponding, media, and aggregate storage is considered included in the biofiltration treatment volume. Saturated storage within the aggregate storage layer can be added to this design by raising the underdrain above the bottom of the aggregate storage layer or via an internal weir structure designed to maintain a specific water level elevation.

**Integrated storm water flow control and pollutant control configuration.** The system can be designed to provide flow rate and duration control by primarily providing increased surface ponding and/or having a deeper aggregate storage layer above the underdrain. This will allow for significant detention storage, which can be controlled via inclusion of an outlet structure at the downstream end of the underdrain.

**Design Criteria and Considerations**

Bioretention with underdrain must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
<input type="checkbox"/> An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration or lateral flows should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
<input type="checkbox"/> Contributing tributary area shall be $\leq 5$ acres ( $\leq 1$ acre preferred).	Bigger BMPs require additional design features for proper performance. Contributing tributary area greater than 5 acres may be allowed at the discretion of the City Engineer if the following conditions are met: 1) incorporate design features (e.g. flow spreaders) to minimizing short circuiting of flows in

<i>Siting and Design</i>	<i>Intent/Rationale</i>
	the BMP and 2) incorporate additional design features requested by the City Engineer for proper performance of the regional BMP.
<input type="checkbox"/> Finish grade of the facility is $\leq 2\%$ .	Flatter surfaces reduce erosion and channelization within the facility.
<i>Surface Ponding</i>	
<input type="checkbox"/> Surface ponding is limited to a 24-hour drawdown time.	Surface ponding limited to 24 hours for plant health. Surface ponding drawdown time greater than 24-hours but less than 96 hours may be allowed at the discretion of the City Engineer if certified by a landscape architect or agronomist.
<input type="checkbox"/> Surface ponding depth is $\geq 6$ and $\leq 12$ inches.	Surface ponding capacity lowers subsurface storage requirements. Deep surface ponding raises safety concerns. Surface ponding depth greater than 12 inches (for additional pollutant control or surface outlet structures or flow-control orifices) may be allowed at the discretion of the City Engineer if the following conditions are met: 1) surface ponding depth drawdown time is less than 24 hours; and 2) safety issues and fencing requirements are considered (typically ponding greater than 18" will require a fence and/or flatter side slopes) and 3) potential for elevated clogging risk is considered.
<input type="checkbox"/> A minimum of 12 inches of freeboard is provided.	Freeboard provides room for head over overflow structures and minimizes risk of uncontrolled surface discharge.
<input type="checkbox"/> Side slopes are stabilized with vegetation and are = 3H:1V or shallower.	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
<i>Vegetation</i>	

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Plantings are suitable for the climate and expected ponding depth. A plant list to aid in selection can be found in Appendix E.20.	Plants suited to the climate and ponding depth are more likely to survive.
<input type="checkbox"/> An irrigation system with a connection to water supply should be provided as needed.	Seasonal irrigation might be needed to keep plants healthy.
<b><i>Mulch</i></b>	
<input type="checkbox"/> A minimum of 3 inches of well-aged, shredded hardwood mulch that has been stockpiled or stored for at least 12 months is provided.	Mulch will suppress weeds and maintain moisture for plant growth. Aging mulch kills pathogens and weed seeds and allows the beneficial microbes to multiply.
<b><i>Media Layer</i></b>	
<input type="checkbox"/> Media maintains a minimum filtration rate of 5 in/hr over lifetime of facility. An initial filtration rate of 8 to 12 in/hr is recommended to allow for clogging over time; the initial filtration rate should not exceed 12 inches per hour.	A filtration rate of at least 5 inches per hour allows soil to drain between events. The initial rate should be higher than long term target rate to account for clogging over time. However an excessively high initial rate can have a negative impact on treatment performance, therefore an upper limit is needed.
<input type="checkbox"/> Media is a minimum 18 inches deep, meeting either of these two media specifications:  City of San Diego Storm Water Standards Appendix F.3 (May 2021, unless superseded by more recent edition) <b>or</b> County of San Diego BMP Design Manual: Appendix F.2 Biofiltration Soil Media Composition, Testing,(September 2020, unless superseded by more recent edition).  Alternatively, for proprietary designs and custom media mixes not meeting the media specifications contained in the 2021 City of San Diego Storm Water Standards or County LID Manual, the media meets the pollutant treatment performance criteria in Section F.1.	A deep media layer provides additional filtration and supports plants with deeper roots.  Standard specifications shall be followed.  For non-standard or proprietary designs, compliance with F.1 ensures that adequate treatment performance will be provided.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Media surface area is 3% of contributing area times adjusted runoff factor or greater. Unless demonstrated that the BMP surface area can be smaller than 3%.	<p>Greater surface area to tributary area ratios: a) maximizes volume retention as required by the MS4 Permit and b) decrease loading rates per square foot and therefore increase longevity.</p> <p>Adjusted runoff factor is to account for site design BMPs implemented upstream of the BMP (such as rain barrels, impervious area dispersion, etc.). Refer to Appendix B.2 guidance.</p> <p>Use Worksheet B.5-1 Line 26 to estimate the minimum surface area required per this criteria.</p>
<input type="checkbox"/> Where receiving waters are impaired or have a TMDL for nutrients, the system is designed with nutrient sensitive media design (see fact sheet BF-2).	<p>Potential for pollutant export is partly a function of media composition; media design must minimize potential for export of nutrients, particularly where receiving waters are impaired for nutrients.</p>
<b><i>Filter Course Layer</i></b>	
<input type="checkbox"/> A filter course is used to prevent migration of fines through layers of the facility. Filter fabric is not used.	<p>Migration of media can cause clogging of the aggregate storage layer void spaces or subgrade. Filter fabric is more likely to clog.</p>
<input type="checkbox"/> Filter course is washed and free of fines.	<p>Washing aggregate will help eliminate fines that could clog the facility and impede infiltration.</p>
<input type="checkbox"/> Filter course calculations assessing suitability for particle migration prevention have been completed.	<p>Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.</p>
<b><i>Aggregate Storage Layer</i></b>	
<input type="checkbox"/> Class 2 Permeable per Caltrans specification 68-1.025 is recommended for the storage layer. Washed, open-graded crushed rock may be used, however a 4-6 inch washed pea gravel	<p>Washing aggregate will help eliminate fines that could clog the aggregate storage layer void spaces or subgrade.</p>

<i>Siting and Design</i>	<i>Intent/Rationale</i>
filter course layer at the top of the crushed rock is required.	Proper storage layer configuration and underdrain placement will minimize facility drawdown time.
<input type="checkbox"/> The depth of aggregate provided (12-inch typical) and storage layer configuration is adequate for providing conveyance for underdrain flows to the outlet structure.	Proper storage layer configuration and underdrain placement will minimize facility drawdown time.
<i>Inflow, Underdrain, and Outflow Structures</i>	
<input type="checkbox"/> Inflow, underdrains and outflow structures are accessible for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
<input type="checkbox"/> Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods. (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
<input type="checkbox"/> Curb cut inlets are at least 12 inches wide, have a 4-6 inch reveal (drop) and an apron and energy dissipation as needed.	Inlets must not restrict flow and apron prevents blockage from vegetation as it grows in. Energy dissipation prevents erosion.
<input type="checkbox"/> Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
<input type="checkbox"/> Minimum underdrain diameter is 6 inches.	Smaller diameter underdrains are prone to clogging.
<input type="checkbox"/> Underdrains are made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
<input type="checkbox"/> An underdrain cleanout with a minimum 6-inch diameter and lockable cap is placed every 250 to 300 feet as required based on underdrain length.	Properly spaced cleanouts will facilitate underdrain maintenance.
<input type="checkbox"/> Overflow is safely conveyed to a downstream storm drain system or discharge point Size overflow structure to pass 100-year peak flow	Planning for overflow lessens the risk of property damage due to flooding.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
for on-line infiltration basins and water quality peak flow for off-line basins.	

**Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only**

To design bioretention with underdrain for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet presented in Appendix B.5 to size biofiltration BMPs.

**Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable**

Control of flow rates and/or durations will typically require significant surface ponding and/or aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Iteratively determine the facility footprint area, surface ponding and/or aggregate storage layer depth required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If bioretention with underdrain cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with significant storage volume such as an underground vault can be used to provide remaining controls.
4. After bioretention with underdrain has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

## E.13 BF-2 Nutrient Sensitive Media Design

Some studies of bioretention with underdrains have observed export of nutrients, particularly inorganic nitrogen (nitrate and nitrite) and dissolved phosphorus. This has been observed to be a short-lived phenomenon in some studies or a long term issue in some studies. The composition of the soil media, including the chemistry of individual elements is believed to be an important factor in the potential for nutrient export. Organic amendments, often compost, have been identified as the most likely source of nutrient export. The quality and stability of organic amendments can vary widely.

The biofiltration media specifications contained in the County of San Diego BMP Design Manual: Appendix F.2 Biofiltration Soil Media Composition, Testing, (September 2020, unless superseded by more recent edition) and the City of San Diego Low Impact Development Design Manual (page B-18) (July 2011, unless superseded by more recent edition) were developed with consideration of the potential for nutrient export. These specifications include criteria for individual component characteristics and quality in order to control the overall quality of the blended mixes. As of the publication of this manual, the September 2020 County of San Diego specifications provide more detail regarding mix design and quality control.

The City and County specifications noted above were developed for general purposes to meet permeability and treatment goals. In cases where the BMP discharges to receiving waters with nutrient impairments or nutrient TMDLs, the biofiltration media should be designed with the specific goal of minimizing the potential for export of nutrients from the media. Therefore, in addition to adhering to the City or County media specifications, the following guidelines should be followed:

### 1. Select plant palette to minimize plant nutrient needs

A landscape architect or agronomist should be consulted to select a plant palette that minimizes nutrient needs. Utilizing plants with low nutrient needs results in less need to enrich the biofiltration soil mix. If nutrient quantity is then tailored to plants with lower nutrient needs, these plants will generally have less competition from weeds, which typically need higher nutrient content. The following practices are recommended to minimize nutrient needs of the plant palette:

- **Utilize native, drought-tolerant plants and grasses where possible.** Native plants generally have a broader tolerance for nutrient content, and can be longer lived in leaner/lower nutrient soils.
- **Start plants from smaller starts or seed.** Younger plants are generally more tolerant of lower nutrient levels and tend to help develop soil structure as they grow. Given the lower cost of smaller plants, the project should be able to accept a plant mortality rate that is somewhat higher than starting from larger plants and providing high organic content.

### 2. Minimize excess nutrients in media mix

Once the low-nutrient plant palette is established (item 1), the landscape architect and/or agronomist should be consulted to assist in the design of a biofiltration media to balance the interests of plant establishment, water retention capacity (irrigation demand), and the potential for nutrient export. The following guidelines should be followed:

- **The mix should not exceed the nutrient needs of plants.** In conventional landscape design, the nutrient needs of plants are often exceeded intentionally in order to provide a factor of safety for plant survival. This practice must be avoided in biofiltration media as excess nutrients will increase the chance of export. The mix designer should keep in mind that nutrients can be added later (through mulching, tilling of amendments into the surface), but it is not possible to remove nutrients, once added.
- **The actual nutrient content and organic content of the selected organic amendment source should be determined when specifying mix proportions.** Nutrient content (i.e., C:N ratio; plant extractable nutrients) and organic content (i.e., % organic material) are relatively inexpensive to measure via standard agronomic methods and can provide important information about mix design. If mix design relies on approximate assumption about nutrient/organic content and this is not confirmed with testing (or the results of prior representative testing), it is possible that the mix could contain much more nutrient than intended.
- **Nutrients are better retained in soils with higher cation exchange capacity.** Cation exchange capacity can be increased through selection of organic material with naturally high cation exchange capacity, such as peat or coconut coir pith, and/or selection of inorganic material with high cation exchange capacity such as some sands or engineered minerals (e.g., low P-index sands, zeolites, rhyolites, etc). Including higher cation exchange capacity materials would tend to reduce the net export of nutrients. Natural silty materials also provide cation exchange capacity; however potential impacts to permeability need to be considered.
- **Focus on soil structure as well as nutrient content.** Soil structure is loosely defined as the ability of the soil to conduct and store water and nutrients as well as the degree of aeration of the soil. Soil structure can be more important than nutrient content in plant survival and biologic health of the system. If a good soil structure can be created with very low amounts of organic amendment, plants survivability should still be provided. While soil structure generally develops with time, biofiltration media can be designed to promote earlier development of soil structure. Soil structure is enhanced by the use of amendments with high humus content (as found in well-aged organic material). In addition, soil structure can be enhanced through the use of organic material with a distribution of particle sizes (i.e., a more heterogeneous mix).
- **Consider alternatives to compost.** Compost, by nature, is a material that is continually evolving and decaying. It can be challenging to determine whether tests previously done on a given compost stock are still representative. It can also be challenging to determine how the properties of the compost will change once placed in the media bed. More stable materials

such as aged coco coir pith, peat, biochar, shredded bark, and/or other amendments should be considered.

With these considerations, it is anticipated that less than 10 percent organic amendment by volume could be used, while still balancing plant survivability and water retention. If compost is used, designers should strongly consider utilizing less than 10 percent by volume.

### **3. Design with partial retention and/or internal water storage**

An internal water storage zone, as described in Fact Sheet PR-1 is believed to improve retention of nutrients. For lined systems, an internal water storage zone worked by providing a zone that fluctuates between aerobic and anaerobic conditions, resulting in nitrification/denitrification. In soils that will allow infiltration, a partial retention design (PR-1) allows significant volume reduction and can also promote nitrification/denitrification.

Acknowledgment: This fact sheet has been adapted from the Orange County Technical Guidance Document (May 2011). It was originally developed based on input from: Deborah Deets, City of Los Angeles Bureau of Sanitation, Drew Ready, Center for Watershed Health, Rick Fisher, ASLA, City of Los Angeles Bureau of Engineering, Dr. Garn Wallace, Wallace Laboratories, Glen Dake, GDML, and Jason Schmidt, Tree People. The guidance provided herein does not reflect the individual opinions of any individual listed above and should not be cited or otherwise attributed to those listed.

## E.14 BF-3 Proprietary Biofiltration Systems

The purpose of this fact sheet is to help explain the potential role of proprietary BMPs in meeting biofiltration requirements, when full retention of the DCV is not feasible. The fact sheet does not describe design criteria like the other fact sheets in this appendix because this information varies by BMP product model.

### ***Criteria for Use of a Proprietary BMP as a Biofiltration BMP***

A proprietary BMP may be acceptable as a “biofiltration BMP” under the following conditions:

- (1) The BMP meets the minimum design criteria listed in Appendix F, including the pollutant treatment performance standard in Appendix F.1;
- (2) The BMP is designed and maintained in a manner consistent with its performance certifications (See explanation in Appendix F.2); and
- (3) The BMP is acceptable at the discretion of the City Engineer. In determining the acceptability of a BMP, the City Engineer should consider, as applicable, (a) the data submitted; (b) representativeness of the data submitted; (c) consistency of the BMP performance claims with pollutant control objectives; certainty of the BMP performance claims; (d) for projects within the public right of way and/or public projects: maintenance requirements, cost of maintenance activities, relevant previous local experience with operation and maintenance of the BMP type, ability to continue to operate the system in event that the vending company is no longer operating as a business; and (e) other relevant factors. If a proposed BMP is not accepted by the City Engineer, a written explanation/reason will be provided to the applicant.

### ***Guidance for Sizing a Proprietary BMP as a Biofiltration BMP***

Proprietary biofiltration BMPs must meet the same sizing guidance as non-proprietary BMPs. Sizing is typically based on capturing and treating 1.50 times the DCV not reliably retained. Guidance for sizing biofiltration BMPs to comply with requirements of this manual is provided in Appendix F.2.

### ***City of Oceanside Specific Guidance and Criteria***

Proprietary systems being submitted for approval must have, at a minimum, a General Use Level Designation (GULD) through the Washington Dept. of Ecology’s TAPE process or certification through The Technology Acceptance Reciprocity Partnership (TARP) to treat the project’s pollutants of concern. While a GULD or TARP certification is required for consideration of

## Appendix E: BMP Design Fact Sheets

approval, it does not guarantee the system will be approved. Additional project specific factors such as project applicability and maintenance requirements will also be considered in the evaluation process.

Proprietary Devices claiming to remove or destroy bacteria must be registered pursuant to the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) prior to approval by the City of Oceanside.

## E.15 FT-1 Vegetated Swales




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### MS4 Permit Category

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Flow-thru Treatment Control

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### Manual Category

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Flow-thru Treatment Control

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### Applicable Performance Standard

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Pollutant Control

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### Primary Benefits

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Treatment  
Volume Reduction (Incidental)  
Peak Flow Attenuation

*Location: Eastlake Business Center, Chula Vista, California; Photo Credit: Eric Mosolgo*

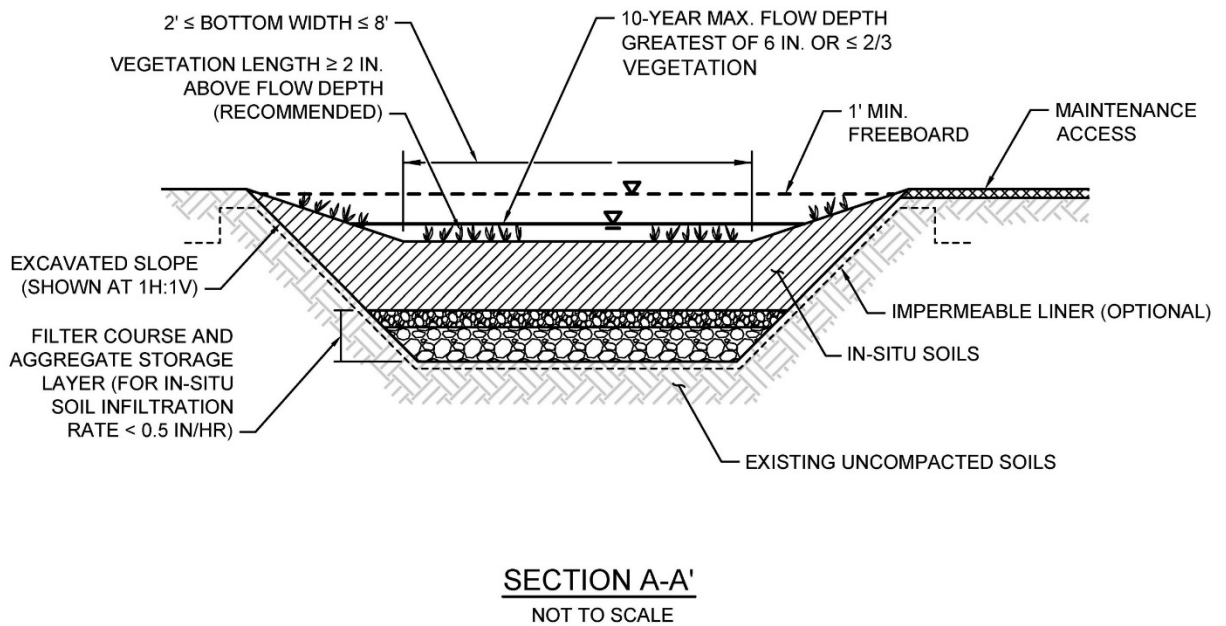
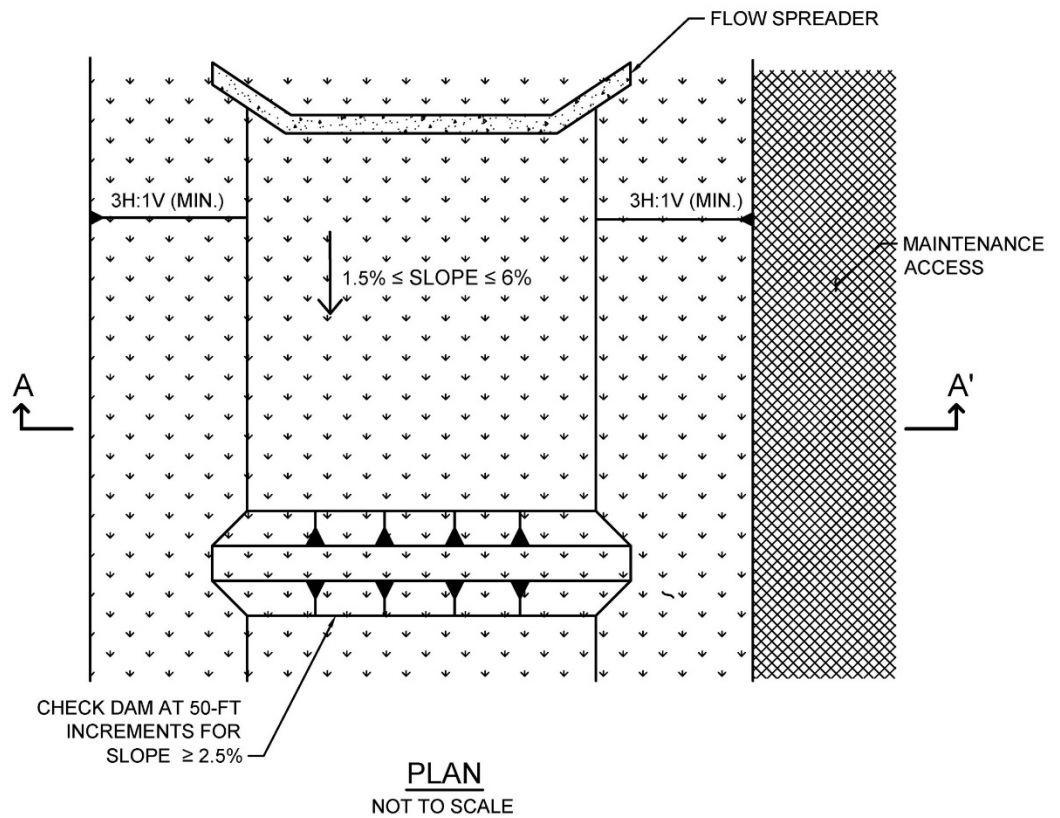
### Description

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Vegetated swales are shallow, open channels that are designed to remove storm water pollutants by physically straining/filtering runoff through vegetation in the channel. Swales can be used in place of traditional curbs and gutters and are well-suited for use in linear transportation corridors to provide both conveyance and treatment via filtration. An effectively designed vegetated swale achieves uniform sheet flow through densely vegetated areas. When soil conditions allow, infiltration and volume reduction are enhanced by adding a gravel drainage layer underneath the swale. Vegetated swales with a subsurface media layer can provide enhanced infiltration, water retention, and pollutant-removal capabilities. Pollutant removal effectiveness can also be maximized by increasing the hydraulic residence time of water in swale using weirs or check dams.

Typical vegetated swale components include:

- Inflow distribution mechanisms (e.g., flow spreader)
- Surface flow
- Vegetated surface layer
- Check dams (if required)
- Optional aggregate storage layer with underdrain(s)



Typical plan and Section view of a Vegetated Swale BMP

**Design Adaptations for Project Goals**

**Site design BMP to reduce runoff volumes and storm peaks.** Swales without underdrains are an alternative to lined channels and pipes and can provide volume reduction through infiltration. Swales can also reduce the peak runoff discharge rate by increasing the time of concentration of the site and decreasing runoff volumes and velocities.

**Flow-thru treatment BMP for storm water pollutant control.** The system is lined or un-lined to provide incidental infiltration with an underdrain and designed to provide pollutant removal through settling and filtration in the channel vegetation (usually grasses). This configuration is considered to provide flow-thru treatment via horizontal surface flow through the swale. Sizing for flow-thru treatment control is based on the surface flow rate through the swale that meets water quality treatment performance objectives.

**Design Criteria and Considerations**

Vegetated swales must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, and liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
<input type="checkbox"/> An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration or lateral flows should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
<input type="checkbox"/> Contributing tributary area $\leq 2$ acres.	Higher ratios increase the potential for clogging but may be acceptable for relatively clean tributary areas.
<input type="checkbox"/> Longitudinal slope is $\geq 1.5\%$ and $\leq 6\%$ .	Flatter swales facilitate increased water quality treatment while minimum slopes prevent ponding.
<input type="checkbox"/> For site design goal, in-situ soil infiltration rate $\geq 0.5$ in/hr (if $< 0.5$ in/hr, an underdrain is required and design goal is for pollutant control only).	Well-drained soils provide volume reduction and treatment. An underdrain should only be provided when soil

<i>Siting and Design</i>	<i>Intent/Rationale</i>
	infiltration rates are low or per geotechnical or groundwater concerns.
<b><i>Surface Flow</i></b>	
<input type="checkbox"/> Maximum flow depth is $\leq 6$ inches or $\leq \frac{2}{3}$ the vegetation length, whichever is greater. Ideally, flow depth will be $\geq 2$ inches below shortest plant species.	Flow depth must fall within the height range of the vegetation for effective water quality treatment via filtering.
<input type="checkbox"/> A minimum of 1 foot of freeboard is provided.	Freeboard minimizes risk of uncontrolled surface discharge.
<input type="checkbox"/> Cross sectional shape is trapezoidal or parabolic with side slopes $\geq 3H:1V$ .	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
<input type="checkbox"/> Bottom width is $\geq 2$ feet and $\leq 8$ feet.	A minimum of 2 feet minimizes erosion. A maximum of 8 feet prevents channel braiding.
<input type="checkbox"/> Minimum hydraulic residence time $\geq 10$ minutes.	Longer hydraulic residence time increases pollutant removal.
<input type="checkbox"/> Swale is designed to safely convey the 10-yr storm event unless a flow splitter is included to allow only the water quality event.	Planning for larger storm events lessens the risk of property damage due to flooding.
<input type="checkbox"/> Flow velocity is $\leq 1$ ft/s for water quality event. Flow velocity for 10-yr storm event is $\leq 3$ ft/s.	Lower flow velocities provide increased pollutant removal via filtration and minimize erosion.
<b><i>Vegetated Surface Layer (amendment with media is Optional)</i></b>	
<input type="checkbox"/> Soil is amended with 2 inches of media mixed into the top 6 inches of in-situ soils, as needed, to promote plant growth (optional). For enhanced pollutant control, 2 feet of media can be used in place of in-situ soils. Media meets either of these two media specifications:  City of San Diego Storm Water Standards Appendix F.3, May 2021);  Or County of San Diego Low Impact Development Handbook, September 2020:	Amended soils aid in plant establishment and growth. Media replacement for in-situ soils can improve water quality treatment and site design volume reduction.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
Appendix G -Bioretention Soil Specification.	
<input type="checkbox"/> Vegetation is appropriately selected low-growing, erosion-resistant plant species that effectively bind the soil, thrive under site-specific climatic conditions and require little or no irrigation.	Plants suited to the climate and expected flow conditions are more likely to survive.
<i>Check Dams</i>	
<input type="checkbox"/> Check dams are provided at 50-foot increments for slopes $\geq 2.5\%$ .	Check dams prevent erosion and increase the hydraulic residence time by lowering flow velocities and providing ponding opportunities.
<i>Filter Course Layer (For Underdrain Design)</i>	
<input type="checkbox"/> A filter course is used to prevent migration of fines through layers of the facility. Filter fabric is not used.	Migration of media can cause clogging of the aggregate storage layer void spaces or subgrade. Filter fabric is more likely to clog.
<input type="checkbox"/> Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog the facility and impede infiltration.
<input type="checkbox"/> Filter course calculations assessing suitability for particle migration prevention have been completed.	Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.
<i>Aggregate Storage Layer (For Underdrain Design)</i>	
<input type="checkbox"/> The depth of aggregate provided (12-inch typical) and storage layer configuration is adequate for providing conveyance for underdrain flows to the outlet structure.	Proper storage layer configuration and underdrain placement will minimize facility drawdown time.
<input type="checkbox"/> Aggregate used for the aggregate storage layer is washed and free of fines.	Washing aggregate will help eliminate fines that could clog aggregate storage layer void spaces or underdrain.
<i>Inflow and Underdrain Structures</i>	
<input type="checkbox"/> Inflow and underdrains are accessible for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
<input type="checkbox"/> Minimum underdrain diameter is 6 inches.	Smaller diameter underdrains are prone to clogging.
<input type="checkbox"/> Underdrains are made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
<input type="checkbox"/> An underdrain cleanout with a minimum 6-inch diameter and lockable cap is placed every 250 to 300 feet as required based on underdrain length.	Properly spaced cleanouts will facilitate underdrain maintenance.

**Conceptual Design and Sizing Approach for Site Design**

1. Determine the areas where vegetated swales can be used in the site design to replace traditional curb and gutter facilities and provide volume reduction through infiltration.

**Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only**

To design vegetated swales for storm water pollutant control only, the following steps should be taken:

1. Verify that siting and design criteria have been met, including bottom width and longitudinal and side slope requirements.
2. Calculate the design flow rate per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet to determine flow-thru treatment sizing of the vegetated swale and if flow velocity, flow depth, and hydraulic residence time meet required criteria. Swale configuration should be adjusted as necessary to meet design requirements.

## E.16 FT-2 Media Filters



*Photo Credit: Contech Stormwater Solutions*

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### MS4 Permit Category

Flow-thru Treatment Control

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### Manual Category

Flow-thru Treatment Control

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### Applicable Performance Standard

Pollutant Control

Flow Control

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### Primary Benefits

Treatment

Peak Flow Attenuation (Optional)

### Description

Media filters are manufactured devices that consist of a series of modular filters packed with engineered media that can be contained in a catch basin, manhole, or vault that provide treatment through filtration and sedimentation. The manhole or vault may be divided into multiple chambers where the first chamber acts as a presettling basin for removal of coarse sediment while the next chamber acts as the filter bay and houses the filter cartridges. A variety of media types are available from various manufacturers that can target pollutants of concern via primarily filtration, sorption, ion exchange, and precipitation. **Specific products must be selected to meet the flow-thru BMP selection requirements described in Appendix B.6.** Treatment effectiveness is contingent upon proper maintenance of filter units.

Typical media filter components include:

- Vault for flow storage and media housing
- Inlet and outlet
- Media filters

**Design Adaptations for Project Goals**

**Flow-thru treatment BMP for storm water pollutant control.** Water quality treatment is provided through filtration. This configuration is considered to provide flow-thru treatment, not biofiltration treatment. Storage provided within the vault restricted by an outlet is considered detention storage and is included in calculations for the flow-thru treatment volume.

**Integrated storm water flow control and pollutant control configuration.** Media filters can also be designed for flow rate and duration control via additional detention storage. The vault storage can be designed to accommodate higher volumes than the storm water pollutant control volume and can utilize multi-stage outlets to mitigate both the duration and rate of flows within a prescribed range.

**Design Criteria and Considerations**

Media filters must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, and liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
<input type="checkbox"/> Recommended for tributary areas with limited available surface area or where surface BMPs would restrict uses.	Maintenance needs may be more labor intensive for media filters than surface BMPs. Lack of surface visibility creates additional risk that maintenance needs may not be completed in a timely manner.
<input type="checkbox"/> Vault storage drawdown time $\leq 96$ hours.	Provides vector control.
<input type="checkbox"/> Vault storage drawdown time $\leq 36$ hours if the vault is used for equalization of flows for pollutant treatment.	Provides required capacity to treat back to back storms. Exception to the 36 hour drawdown criteria is allowed if additional vault storage is provided using the curves in Appendix B.4.2.
<i>Inflow and Outflow Structures</i>	
<input type="checkbox"/> Inflow and outflow structures are accessible by required equipment (e.g., vector truck) for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.

**Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only**

To design a media filter for storm water pollutant control only (no flow control required), the following steps should be taken

1. Verify that the selected BMP complies with BMP selection requirements in Appendix B.6.
2. Verify that placement and tributary area requirements have been met.
3. Calculate the required DCV and/or flow rate per Appendix B.6.3 based on expected site design runoff for tributary areas.
4. Media filter can be designed either for DCV or flow rate. To estimate the drawdown time, divide the vault storage by the treatment rate of media filters.

**Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable**

Control of flow rates and/or durations will typically require significant vault storage volume, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that placement and tributary area requirements have been met.
2. Iteratively determine the vault storage volume required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows to MS4.
3. If a media filter cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with appropriate storage volume such as an underground vault can be used to provide remaining controls.
4. After the media filter has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.
5. Verify that the vault drawdown time is 96 hours or less. To estimate the drawdown time:
  - a. Divide the vault volume by the filter surface area.
  - b. Divide the result (a) by the design filter rate.

## E.17 FT-3 Sand Filters



*Photo Credit: City of San Diego LID Manual*

### Description

Sand filters operate by filtering storm water through a constructed sand bed with an underdrain system. Runoff enters the filter and spreads over the surface. Sand filter beds can be enclosed within concrete structures or within earthen containment. As flows increase, water backs up on the surface of the filter where it is held until it can percolate through the sand. The treatment pathway is downward (vertical) through the media to an underdrain system that is connected to the downstream storm drain system. As storm water passes through the sand, pollutants are trapped on the surface of the filter, in the small pore spaces between sand grains or are adsorbed to the sand surface. The high filtration rates of sand filters, which allow a large runoff volume to pass through the media in a short amount of time, can provide efficient treatment for storm water runoff.

Typical sand filter components include:

- Forebay for pretreatment/energy dissipation
- Surface ponding for captured flows
- Sand filter bed
- Aggregate storage layer with underdrain(s)
- Overflow structure

### MS4 Permit Category

Flow-thru Treatment Control

### Manual Category

Flow-thru Treatment Control

### Applicable Performance Standard

Pollutant Control

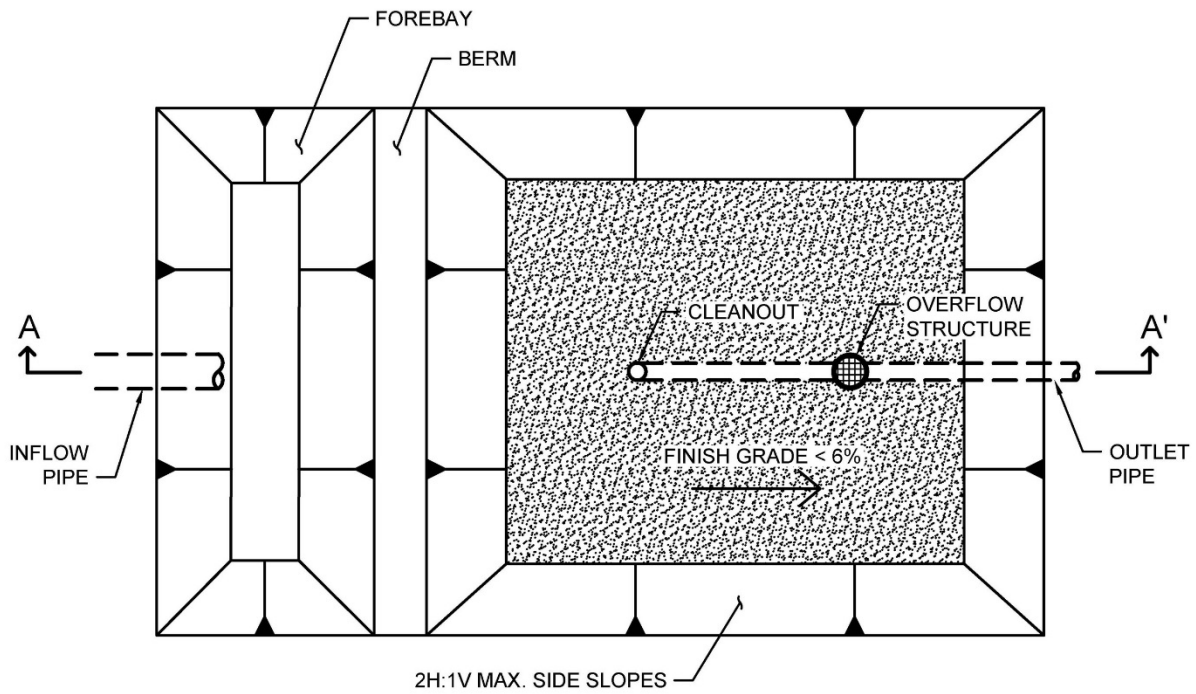
Flow Control

### Primary Benefits

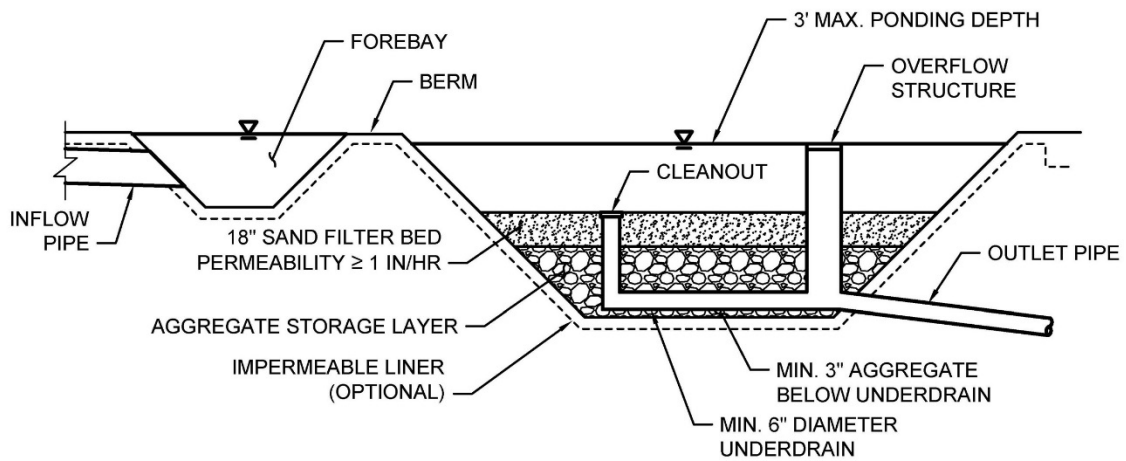
Treatment

Volume Reduction (Incidental)

Peak Flow Attenuation (Optional)



**PLAN**  
NOT TO SCALE



**SECTION A-A'**  
NOT TO SCALE

**Typical plan and Section view of a Sand Filter BMP**

**Design Adaptations for Project Goals**

**Flow-thru treatment BMP for storm water pollutant control.** The system is lined or un-lined to provide incidental infiltration, and an underdrain is provided at the bottom to carry away filtered runoff. This configuration is considered to provide flow-thru treatment via vertical flow through the sand filter bed. Storage provided above the underdrain within surface ponding, the sand filter bed, and aggregate storage is considered included in the flow-thru treatment volume. Saturated storage within the aggregate storage layer can be added to this design by including an upturned elbow installed at the downstream end of the underdrain or via an internal weir structure designed to maintain a specific water level elevation.

**Integrated storm water flow control and pollutant control configuration.** The system can be designed to provide flow rate and duration control by primarily providing increased surface ponding and/or having a deeper aggregate storage layer above the underdrain. This will allow for significant detention storage, which can be controlled via inclusion of an outlet structure at the downstream end of the underdrain.

**Design Criteria and Considerations**

Sand filters must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, and liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
<input type="checkbox"/> An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration or lateral flows should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
<input type="checkbox"/> Contributing tributary area ( $\leq 5$ acres).	Bigger BMPs require additional design features for proper performance.  Contributing tributary area greater than 5 acres may be allowed at the discretion of the City Engineer if the following conditions are met: 1) incorporate design features (e.g. flow spreaders) to minimizing short circuiting of flows in the BMP and 2) incorporate

<i>Siting and Design</i>	<i>Intent/Rationale</i>
	additional design features requested by the City Engineer for proper performance of the regional BMP.
<input type="checkbox"/> Finish grade of facility is < 6%.	Flatter surfaces reduce erosion and channelization within the facility.
<input type="checkbox"/> Earthen side slopes are $\geq 3H:1V$ .	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
<input type="checkbox"/> Surface ponding is limited to a 36-hour drawdown time.	Provides required capacity to treat back to back storms. Exception to the 36 hour drawdown criteria is allowed if additional surface storage is provided using the curves in Appendix B.4.2.
<input type="checkbox"/> Surface ponding is limited to a 96-hour drawdown time.	Prolonged surface ponding can create a vector hazard.
<input type="checkbox"/> Maximum ponding depth does not exceed 3 feet.	Surface ponding capacity lowers subsurface storage requirements and results in lower cost facilities. Deep surface ponding raises safety concerns.
<input type="checkbox"/> Sand filter bed consists of clean washed concrete or masonry sand (passing ¼ inch sieve) or sand similar to the ASTM C33 gradation.	Washing sand will help eliminate fines that could clog the void spaces of the aggregate storage layer.
<input type="checkbox"/> Sand filter bed permeability is at least 1 in/hr.	A high filtration rate through the media allows flows to quickly enter the aggregate storage layer, thereby minimizing bypass.
<input type="checkbox"/> Sand filter bed depth is at least 18 inches deep.	Different pollutants are removed in various zones of the media using several mechanisms. Some pollutants bound to sediment, such as metals, are typically removed within 18 inches of the media.
<input type="checkbox"/> Aggregate storage should be washed, bank-run gravel.	Washing aggregate will help eliminate fines that could clog the aggregate storage layer void spaces or subgrade.
<input type="checkbox"/> The depth of aggregate provided (12-inch typical) and storage layer configuration is	Proper storage layer configuration and underdrain placement will minimize facility drawdown time.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
adequate for providing conveyance for underdrain flows to the outlet structure.	
<input type="checkbox"/> Inflow, underdrains and outflow structures are accessible for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
<input type="checkbox"/> Inflow must be non-erosive sheet flow ( $\leq 3$ ft/s) unless an energy-dissipation device, flow diversion/splitter or forebay is installed.	Concentrated flow and/or excessive volumes can cause erosion in a sand filter and can be detrimental to the treatment capacity of the system.
<input type="checkbox"/> Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
<input type="checkbox"/> Minimum underdrain diameter is 6 inches.	Smaller diameter underdrains are prone to clogging.
<input type="checkbox"/> Underdrains should be made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
<input type="checkbox"/> Overflow is safely conveyed to a downstream storm drain system or discharge point.	Planning for overflow lessens the risk of property damage due to flooding.

**Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only**

To design a sand filter for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, and maximum finish grade slope.
2. Calculate the required DCV and/or flow rate per Appendix B.6.3 based on expected site design runoff for tributary areas.
3. Sand filter can be designed either for DCV or flow rate. To estimate the drawdown time, divide the average ponding depth by the permeability of the filter sand.

***Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable***

Control of flow rates and/or durations will typically require significant surface ponding and/or aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the Manual.

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, and maximum finish grade slope.
2. Iteratively determine the facility footprint area, surface ponding and/or aggregate storage layer depth required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If a sand filter cannot fully provide the flow rate and duration control required by the MS4 permit, an upstream or downstream structure with appropriate storage volume such as an underground vault can be used to provide remaining controls.
4. After the sand filter has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

## E.18 FT-4 Dry Extended Detention Basin



*Location: Rolling Hills Ranch, Chula Vista, California; Photo Credit: Eric Mosolgo*

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### MS4 Permit Category

Flow-thru Treatment Control

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### Manual Category

Flow-thru Treatment Control

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### Applicable Performance Standard

Pollutant Control

Flow Control

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### Primary Benefits

Treatment

Volume Reduction (Incidental)

Peak Flow Attenuation

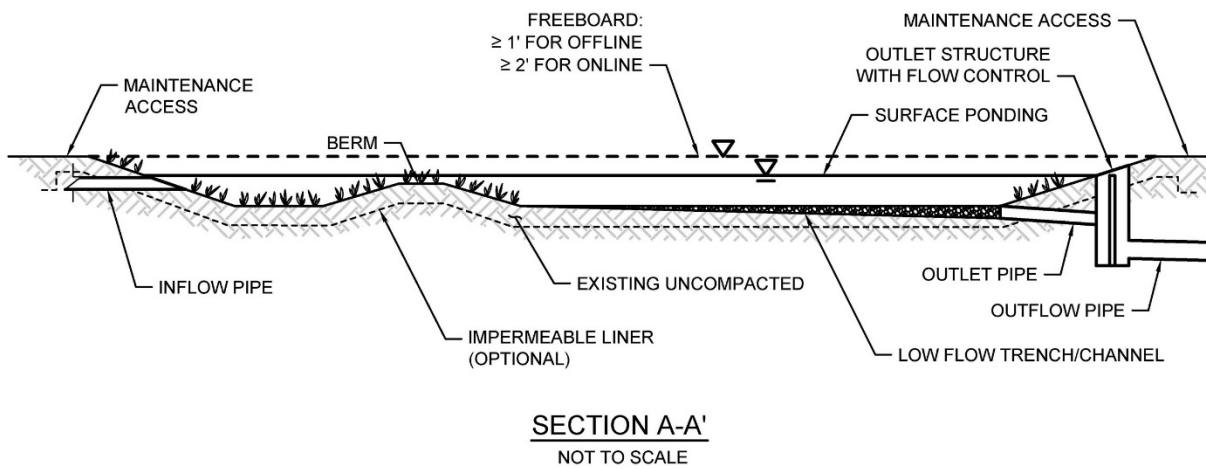
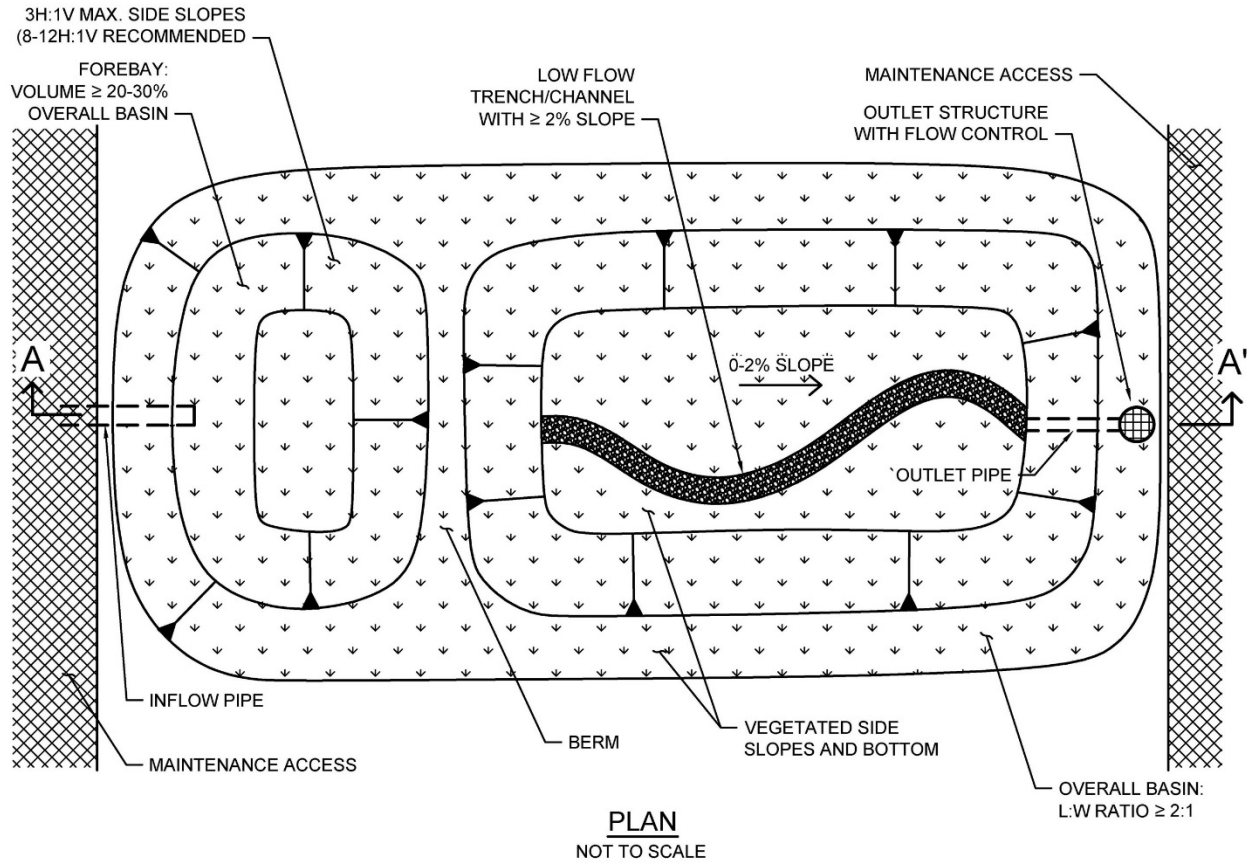
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### Description

Dry extended detention basins are basins that have been designed to detain storm water for an extended period to allow sedimentation and typically drain completely between storm events. A portion of the dissolved pollutant load may also be removed by filtration, uptake by vegetation, and/or through infiltration. The slopes, bottom, and forebay of dry extended detention basins are typically vegetated. Considerable storm water volume reduction can occur in dry extended detention basins when they are located in permeable soils and are not lined with an impermeable barrier. Dry extended detention basins are generally appropriate for developments of ten acres or larger, and have the potential for multiple uses including parks, playing fields, tennis courts, open space, and overflow parking lots. They can also be used to provide flow control by modifying the outlet control structure and providing additional detention storage.

Typical dry extended detention basins components include:

- Forebay for pretreatment
- Surface ponding for captured flows
- Vegetation selected based on basin use, climate, and ponding depth
- Low flow channel, outlet, and overflow device
- Impermeable liner or uncompacted native soils at the bottom of the facility



Typical plan and Section view of a Dry Extended Detention Basin BMP

**Design Adaptations for Project Goals**

**Flow-thru treatment BMP for storm water pollutant control.** The system is lined or un-lined to provide incidental infiltration and designed to detain storm water to allow particulates and associated pollutants to settle out. This configuration is considered to provide flow-thru treatment, not biofiltration treatment. Storage provided as surface ponding above a restricted outlet invert is considered detention storage and is included in calculations for the flow-thru treatment volume.

**Integrated storm water flow control and pollutant control configuration.** Dry extended detention basins can also be designed for flow control. The surface ponding can be designed to accommodate higher volumes than the storm water pollutant control volume and can utilize multi-stage outlets to mitigate both the duration and rate of flows within a prescribed range.

**Design Criteria and Considerations**

Dry extended detention basins must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of the City Engineer if it is determined to be appropriate:

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, and liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
<input type="checkbox"/> An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration or lateral flows should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
<input type="checkbox"/> Contributing tributary area is large (typically $\geq 10$ acres).	Dry extended detention basins require significant space and are more cost-effective for treating larger drainage areas.
<input type="checkbox"/> Longitudinal basin bottom slope is 0 - 2%.	Flatter slopes promote ponding and settling of particles.
<input type="checkbox"/> Basin length to width ratio is $\geq 2:1$ (L:W).	A larger length to width ratio provides a longer flow path to promote settling.
<input type="checkbox"/> Forebay is included that encompasses 20 - 30% of the basin volume.	A forebay to trap sediment can decrease frequency of required maintenance.

<i>Siting and Design</i>	<i>Intent/Rationale</i>
<input type="checkbox"/> Side slopes are $\geq 3H:1V$ .	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
<input type="checkbox"/> Surface ponding drawdown time is between 24 and 96 hours.	Minimum drawdown time of 24 hours allows for adequate settling time and maximizes pollutant removal. Maximum drawdown time of 96 hours provides vector control.
<input type="checkbox"/> Minimum freeboard provided is $\geq 1$ foot for offline facilities and $\geq 2$ feet for online facilities.	Freeboard provides room for head over overflow structures and minimizes risk of uncontrolled surface discharge.
<input type="checkbox"/> Inflow and outflow structures are accessible by required equipment (e.g., vector truck) for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
<input type="checkbox"/> A low flow channel or trench with a $\geq 2\%$ slope is provided. A gravel infiltration trench is provided where infiltration is allowable.	Aids in draining or infiltrating dry weather flows.
<input type="checkbox"/> Overflow is safely conveyed to a downstream storm drain system or discharge point. Size overflow structure to pass 100-year peak flow.	Planning for overflow lessens the risk of property damage due to flooding.
<input type="checkbox"/> The maximum rate at which runoff is discharged is set below the erosive threshold for the site.	Extended low flows can have erosive effects.

**Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only**

To design dry extended detention basins for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and criteria have been met, including placement requirements, contributing tributary area, forebay volume, and maximum slopes for basin sides and bottom.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet to determine flow-thru treatment sizing of the surface ponding of the dry extended detention basin, which includes calculations for a maximum 96-hour drawdown time.

***Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable***

Control of flow rates and/or durations will typically require significant surface ponding volume, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and criteria have been met, including placement requirements, tributary area, and maximum slopes for basin sides and bottom.
2. Iteratively determine the surface ponding required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If a dry extended detention basin cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with appropriate storage volume such as an additional basin or underground vault can be used to provide remaining controls.
4. After the dry extended detention basin has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

## E.19 FT-5 Proprietary Flow-Thru Treatment Control BMPs

The purpose of this fact sheet is to help explain the potential role of proprietary BMPs in meeting flow thru treatment control BMP requirements. The fact sheet does not describe design criteria like the other fact sheets in this appendix because this information varies by BMP product model.

### ***Criteria for Use of a Proprietary BMP as a Flow-Thru Treatment Control BMP***

A proprietary BMP may be acceptable as a “flow-thru treatment control BMP” under the following conditions:

- (1) The BMP is selected and sized consistent with the method and criteria described in Appendix B.6;
- (2) The BMP is designed and maintained in a manner consistent with its performance certifications (See explanation in Appendix B.6); and
- (3) The BMP is acceptable at the discretion of the City Engineer. In determining the acceptability of a BMP, the City Engineer should consider, as applicable, (a) the data submitted; (b) representativeness of the data submitted; (c) consistency of the BMP performance claims with pollutant control objectives; certainty of the BMP performance claims; (d) for projects within the public right of way and/or public projects: maintenance requirements, cost of maintenance activities, relevant previous local experience with operation and maintenance of the BMP type, ability to continue to operate the system in event that the vending company is no longer operating as a business; and (e) other relevant factors. If a proposed BMP is not accepted by the City Engineer, a written explanation/reason will be provided to the applicant..

### ***Guidance for Sizing Proprietary BMPs***

Proprietary flow-thru BMPs must meet the same sizing guidance as other flow-thru treatment control BMPs. Guidance for sizing flow-thru BMPs to comply with requirements of this manual is provided in Appendix B.6.

***City of Oceanside Specific Guidance and Criteria***

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Proprietary systems being submitted for approval must have, at a minimum, a General Use Level Designation (GULD) through the Washington Dept. of Ecology's TAPE process or certification through The Technology Acceptance Reciprocity Partnership (TARP) to treat the project's pollutants of concern. While a GULD or TARP certification is required for consideration of approval, it does not guarantee the system will be approved. Additional project specific factors such as project applicability and maintenance requirements will also be considered in the evaluation process.

## E.20 PL Plant List

Plant Name		Irrigation Requirements		Preferred Location in Basin		Applicable Bioretention Sections (Un-Lined Facilities)				Applicability to Flow-Through Planter? (Lined Facility)	
Latin Name	Common Name	Temporary Irrigation during Plant Establishment Period	Permanent Irrigation (Drip / Spray) <sup>(1)</sup>	Basin Bottom	Basin Side Slopes	Section A Treatment-Only Bioretention in Hydrologic Soil Group A or B Soils	Section B Treatment-Only Bioretention in Hydrologic Soil Group C or D soils	Section C Treatment Plus Flow Control Bioretention in Hydrologic Soil Group A or B Soils	Section D Treatment Plus Flow Control Bioretention in Hydrologic Soil Group C or D Soils	NO Applicable to Un-lined Facilities Only (Bioretention Only)	YES Can Use in Lined or Un-Lined Facility (Flow-Through Planter OR Bioretention)
<b>TREES<sup>(2)</sup></b>											
Alnus rhombifolia	White Alder	X		X	X	X	X	X	X	X	
Platanus racemosa	California Sycamore	X		X	X	X	X	X	X	X	
Salix lasiolepis	Arroyo Willow	X			X	X	X	X	X	X	
Salix lucida	Lance-Leaf Willow	X			X	X	X	X	X	X	
Sambucus mexicana	Blue Elderberry	X			X	X	X	X	X	X	
<b>SHRUBS / GROUNDCOVER</b>											
Achillea millefolium	Yarrow	X			X	X	X				X
Agrostis palens	Thingrass	X			X	X	X	X	X		X
Anemopsis californica	Yerba Manza	X			X	X	X	X	X		X
Baccharis douglasii	Marsh Baccahris	X	X	X		X	X	X	X		X
Carex praegracillis	California Field Sedge	X	X	X		X	X	X	X		X
Carex spissa	San Diego Sedge	X	X	X		X	X	X	X		X
Carex subfusca	Rusty Sedge	X	X	X	X	X	X	X	X		X
Distichlis spicata	Salt Grass	X	X	X		X	X	X	X		X
Eleocharis macrostachya	Pale Spike Rush	X	X	X		X	X	X	X		X
Festuca rubra	Red Fescue	X	X	X	X	X	X				X
Festuca californica	California Fescue	X	X		X	X	X				X
Iva hayesiana	Hayes Iva	X			X	X	X				X
Juncus Mexicana	Mexican Rush	X	X	X	X	X	X	X	X		X
Jucus patens	California Gray Rush	X	X	X	X	X	X	X	X		X
Leymus condensatus 'Canyon Prince'	Canyon Prince Wild Rye	X	X	X	X	X	X	X	X		X
Mahonia nevinii	Nevin's Barberry	X			X	X	X	X	X		X
Muhlenburgia rigens	Deergrass	X	X	X	X	X	X	X	X		X
Mimulus cardinalis	Scarlet Monkeyflower	X		X	X	X	X				X
Ribes speciosum	Fushia Flowering Goose.	X			X	X	X				X
Rosa californica	California Wild Rose	X	X		X	X	X				X
Scirpus cenusus	Low Bullrush	X	X	X		X	X	X	X		X
Sisyrinchium bellum	Blue-eyed Grass	X			X	X	X				X

1. All plants will benefit from some supplemental irrigation during hot dry summer months, particularly those on basin side slopes and further inland.
2. All trees should be planted a min. of 10' away from any drain pipes or structures.

**Appendix**

**F**

**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

# **Biofiltration Standard and Checklist**

# Appendix F Biofiltration Standard and Checklist

## Introduction

The MS4 Permit and this manual define a specific category of storm water pollutant treatment BMPs called “biofiltration BMPs.” The MS4 Permit (Section E.3.c.1) states:

**Biofiltration BMPs must be designed to have an appropriate hydraulic loading rate to maximize storm water retention and pollutant removal, as well as to prevent erosion, scour, and channeling within the BMP, and must be sized to:**

- a) **Treat 1.5 times the DCV not reliably retained onsite, OR**
- b) **Treat the DCV not reliably retained onsite with a flow-thru design that has a total volume, including pore spaces and pre-filter detention volume, sized to hold at least 0.75 times the portion of the DCV not reliably retained onsite.**

A project applicant must be able to affirmatively demonstrate that a given BMP is designed and sized in a manner consistent with this definition to be considered as a “biofiltration BMP” as part of a compliant storm water management plan. Retention is defined in the MS4 Permit as evapotranspiration, infiltration, and harvest and use of storm water vs. discharge to a surface water system.

## Contents and Intended Uses

This appendix contains a checklist of the key underlying criteria that must be met for a BMP to be considered a biofiltration BMP. The purpose of this checklist is to facilitate consistent review and approval of biofiltration BMPs that meet the “biofiltration standard” defined by the MS4 Permit.

This checklist includes specific design criteria that are essential to defining a system as a biofiltration BMP; however it does not present a complete design basis. This checklist was used to develop BMP Fact Sheets for PR-1 biofiltration with partial retention and BF-1 biofiltration, which do present a complete design basis. Therefore, biofiltration BMPs that substantially meet all aspects of the Fact sheets PR-1 or BF-1 should be able to complete this checklist without additional documentation beyond what would already be required for a project submittal.

## Appendix F: Biofiltration Standard and Checklist

Other biofiltration BMP designs<sup>1</sup> (including both non-proprietary and proprietary designs) may also meet the underlying MS4 Permit requirements to be considered biofiltration BMPs. These BMPs may be classified as biofiltration BMPs if they (1) meet the minimum design criteria listed in this appendix, including the pollutant treatment performance standard in Appendix F.1, (2) are designed and maintained in a manner consistent with their performance certifications (See explanation in Appendix F.2), if applicable, and (3) are acceptable at the discretion of the City Engineer. The applicant may be required to provide additional studies and/or required to meet additional design criteria beyond the scope of this document in order to demonstrate that these criteria are met.

### Organization

The checklist in this appendix is organized into the seven (7) main objectives associated with biofiltration BMP design. It describes the associated minimum criteria that must be met in order to qualify a biofiltration BMP as meeting the biofiltration standard. The seven main objectives are listed below. Specific design criteria and associated manual references associated with each of these objectives is provided in the checklist in the following section.

1. Biofiltration BMPs shall be allowed only as described in the BMP selection process in this manual (i.e., retention feasibility hierarchy).
2. Biofiltration BMPs must be sized using acceptable sizing methods described in this manual.
3. Biofiltration BMPs must be sited and designed to achieve maximum feasible infiltration and evapotranspiration.
4. Biofiltration BMPs must be designed with a hydraulic loading rate to maximize pollutant retention, preserve pollutant control/sequestration processes, and minimize potential for pollutant washout.
5. Biofiltration BMPs must be designed to promote appropriate biological activity to support and maintain treatment processes.
6. Biofiltration BMPs must be designed to prevent erosion, scour, and channeling within the BMP.
7. Biofiltration BMP must include operations and maintenance design features and planning

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<sup>1</sup> Defined as biofiltration designs that do not conform to the specific design criteria described in Fact Sheets PR-1 or BF-1. This category includes proprietary BMPs that are sold by a vendor as well as non-proprietary BMPs that are designed and constructed of primarily of more elementary construction materials.

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considerations to provide for continued effectiveness of pollutant and flow control functions.

## Biofiltration Criteria Checklist

The applicant shall provide documentation of compliance with each criterion in this checklist as part of the project submittal. The right column of this checklist identifies the submittal information that is recommended to document compliance with each criterion. Biofiltration BMPs that substantially meet all aspects of Fact Sheets PR-1 or BF-1 should still use this checklist; however additional documentation (beyond what is already required for project submittal) should not be required.

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**1. Biofiltration BMPs shall be allowed to be used only as described in the BMP selection process based on a documented feasibility analysis.**

Intent: This manual defines a specific prioritization of pollutant treatment BMPs, where BMPs that retain water (retained includes evapotranspired, infiltrated, and/or harvested and used) must be used before considering BMPs that have a biofiltered discharge to the MS4 or surface waters. Use of a biofiltration BMP in a manner in conflict with this prioritization (i.e., without a feasibility analysis justifying its use) is not permitted, regardless of the adequacy of the sizing and design of the system.

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|--------------------------|---|---|
| <input type="checkbox"/> | The project applicant has demonstrated that it is not technically feasible to retain the full DCV onsite. | Document feasibility analysis and findings in project submittal SWQMP per Appendix C. |
|--------------------------|---|---|

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**2. Biofiltration BMPs must be sized using acceptable sizing methods.**

Intent: The MS4 Permit and this manual defines specific sizing methods that must be used to size biofiltration BMPs. Sizing of biofiltration BMPs is a fundamental factor in the amount of storm water that can be treated and also influences volume and pollutant retention processes.

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|--------------------------|--|---|
| <input type="checkbox"/> | The project applicant has demonstrated that biofiltration BMPs are sized to meet one of the biofiltration sizing options available (Appendix B.5). | Submit sizing worksheets (Appendix B.5) or other equivalent documentation with the SWQMP. |
|--------------------------|--|---|

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**3. Biofiltration BMPs must be sited and designed to achieve maximum feasible infiltration and evapotranspiration.**

Intent: Various decisions about BMP placement and design influence how much water is retained via infiltration and evapotranspiration. The MS4 Permit requires that biofiltration BMPs achieve maximum feasible retention (evapotranspiration and infiltration) of storm water volume.

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## Appendix F: Biofiltration Standard and Checklist

<input type="checkbox"/>	The biofiltration BMP is sited to allow for maximum infiltration of runoff volume based on the feasibility factors considered in site planning efforts. It is also designed to maximize evapotranspiration through the use of amended media and plants (biofiltration designs without amended media and plants may be permissible; see Item 5).	Document site planning and feasibility analyses in SWQMP per Section 5.4.
<input type="checkbox"/>	For biofiltration BMPs categorized as “Partial Infiltration Condition” the infiltration storage depth in the biofiltration design has been selected to drain in 36 hours (+/-25%) or an alternative value shown to maximize infiltration on the site.	Included documentation of estimated infiltration rate per Appendix D; provide calculations using Appendix B.4 and B.5 to show that the infiltration storage depth meets this criterion. Note, depths that are too shallow or too deep may not be acceptable.
<input type="checkbox"/>	For biofiltration BMP locations categorized as “Partial Infiltration Condition,” the infiltration storage is over the entire bottom of the biofiltration BMP footprint.	Document on plans that the infiltration storage covers the entire bottom of the BMP (i.e., not just underdrain trenches); or an equivalent footprint elsewhere on the site.
<input type="checkbox"/>	For biofiltration BMP locations categorized as “Partial Infiltration Condition,” the sizing factor used for the infiltration storage area is not less than the minimum biofiltration BMP sizing factors calculated using Worksheet B.5.1 to achieve 40% average annual percent capture within the BMP or downstream of the BMP. .	Provide a table that compares the minimum sizing factor per Appendix B.5 to the provided sizing factor. Note: The infiltration storage area could be a separate storage feature located downstream of the biofiltration BMP, not necessarily within the same footprint.
<input type="checkbox"/>	An impermeable liner or other hydraulic restriction layer is only used when needed to avoid geotechnical and/or subsurface contamination issues in locations identified as “No Infiltration Condition.”	If using an impermeable liner or hydraulic restriction layer, provide documentation of feasibility findings per Appendix C that recommend the use of this feature.
<input type="checkbox"/>	The use of “compact” biofiltration BMP design <sup>2</sup> is permitted only in conditions identified as “No Infiltration Condition” and where site-specific documentation demonstrates that the use of larger footprint biofiltration BMPs would be infeasible.	Provide documentation of feasibility findings that recommend no infiltration is feasible. Provide site-specific information to demonstrate that a larger footprint biofiltration BMP would not be feasible.

<sup>2</sup> Compact biofiltration BMPs are defined as features with infiltration storage footprint less than the minimum sizing factors required to achieve 40% volume retention. Note that if a biofiltration BMP is accompanied by an infiltrating area downstream that has a footprint equal to at least the minimum sizing factors calculated using

**4. Biofiltration BMPs must be designed with a hydraulic loading rate to maximize pollutant retention, preserve pollutant control processes, and minimize potential for pollutant washout.**

Intent: Various decisions about biofiltration BMP design influence the degree to which pollutants are retained. The MS4 Permit requires that biofiltration BMPs achieve maximum feasible retention of storm water pollutants.

<input type="checkbox"/>	<p>Media selected for the biofiltration BMP meets minimum quality and material specifications per 2021 City of San Diego Storm Water Standards or County BMP Design Manual, including the maximum allowable design filtration rate and minimum thickness of media.</p>	<p>Provide documentation that media meets the specifications in 2021 City of San Diego Storm Water Standards or County BMP Design Manual.</p>
<p><b>OR</b></p>		
<input type="checkbox"/>	<p>Alternatively, for proprietary designs and custom media mixes not meeting the media specifications contained in the 2021 City of San Diego Storm Water Standards or County BMP Design Manual, field scale testing data are provided to demonstrate that proposed media meets the pollutant treatment performance criteria in Section F.1 below.</p>	<p>Provide documentation of performance information as described in Section F.1.</p>
<input type="checkbox"/>	<p>To the extent practicable, filtration rates are outlet controlled (e.g., via an underdrain and orifice/weir) instead of controlled by the infiltration rate of the media.</p>	<p>Include outlet control in designs or provide documentation of why outlet control is not practicable.</p>
<input type="checkbox"/>	<p>The water surface drains to at least 12 inches below the media surface within 24 hours from the end of storm event flow to preserve plant health and promote healthy soil structure.</p>	<p>Include calculations to demonstrate that drawdown rate is adequate.  Surface ponding drawdown time greater than 24-hours but less than 96 hours may be allowed at the discretion of the City Engineer if certified by a landscape architect or agronomist.</p>

Worksheet B.5.1 assuming a partial infiltration condition, then it is not considered to be a compact biofiltration BMP for the purpose of Item 4 of the checklist. For potential configurations with a higher rate biofiltration BMP upstream of an larger footprint infiltration area, the BMP would still need to comply with Item 5 of this checklist for pollutant treatment effectiveness.

## Appendix F: Biofiltration Standard and Checklist

<input type="checkbox"/>	If nutrients are a pollutant of concern, design of the biofiltration BMP follows nutrient-sensitive design criteria.	Follow specifications for nutrient sensitive design in Fact Sheet BF-2. Or provide alternative documentation that nutrient treatment is addressed and potential for nutrient release is minimized.
<input type="checkbox"/>	Media gradation calculations or geotextile selection calculations demonstrate that migration of media between layers will be prevented and permeability will be preserved.	Follow specification for choking layer or geotextile in Fact Sheet PR-1 or BF-1. Or include calculations to demonstrate that choking layer is appropriately specified.
<p><b>5. Biofiltration BMPs must be designed to promote appropriate biological activity to support and maintain treatment processes.</b></p> <p>Intent: Biological processes are an important element of biofiltration performance and longevity.</p>		
<input type="checkbox"/>	Plants have been selected to be tolerant of project climate, design ponding depths and the treatment media composition.	Provide documentation justifying plant selection. Refer to the plant list in Appendix E.20.
<input type="checkbox"/>	Plants have been selected to minimize irrigation requirements.	Provide documentation describing irrigation requirements for establishment and long term operation.
<input type="checkbox"/>	Plant location and growth will not impede expected long-term media filtration rates and will enhance long term infiltration rates to the extent possible.	Provide documentation justifying plant selection. Refer to the plant list in Appendix E.20.
<input type="checkbox"/>	If plants are not part of the biofiltration design, other biological processes are supported as needed to sustain treatment processes (e.g., biofilm in a subsurface flow wetland).	For biofiltration designs without plants, describe the biological processes that will support effective treatment and how they will be sustained.
<p><b>6. Biofiltration BMPs must be designed with a hydraulic loading rate to prevent erosion, scour, and channeling within the BMP.</b></p> <p>Intent: Erosion, scour, and/or channeling can disrupt treatment processes and reduce biofiltration effectiveness.</p>		
<input type="checkbox"/>	Scour protection has been provided for both sheet flow and pipe inflows to the BMP, where needed.	Provide documentation of scour protection as described in Fact Sheets PR-1 or BF-1 or approved equivalent.
<input type="checkbox"/>	Where scour protection has not been provided, flows into and within the BMP are kept to non-erosive velocities.	Provide documentation of design checks for erosive velocities as described in Fact Sheets PR-1 or BF-1 or approved equivalent.

## Appendix F: Biofiltration Standard and Checklist

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|--------------------------|--|---|
| <input type="checkbox"/> | For proprietary BMPs, the BMP is used in a manner consistent with manufacturer guidelines and conditions of its third-party certification <sup>3</sup> (i.e., maximum tributary area, maximum inflow velocities, etc., as applicable). | Provide copy of manufacturer recommendations and conditions of third-party certification. |
|--------------------------|--|---|
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### **7. Biofiltration BMP must include operations and maintenance design features and planning considerations for continued effectiveness of pollutant and flow control functions.**

Intent: Biofiltration BMPs require regular maintenance in order provide ongoing function as intended. Additionally, it is not possible to foresee and avoid potential issues as part of design; therefore plans must be in place to correct issues if they arise.

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|--------------------------|--|--|
| <input type="checkbox"/> | The biofiltration BMP O&M plan describes specific inspection activities, regular/periodic maintenance activities and specific corrective actions relating to scour, erosion, channeling, media clogging, vegetation health, and inflow and outflow structures. | Include O&M plan with project submittal as described in Chapter 7. |
|--------------------------|--|--|
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- |                          |   |  |
|--------------------------|---|--|
| <input type="checkbox"/> | Adequate site area and features have been provided for BMP inspection and maintenance access. | Illustrate maintenance access routes, setbacks, maintenance features as needed on project water quality plans. |
|--------------------------|---|--|
- 

- |                          |  |   |
|--------------------------|--|---|
| <input type="checkbox"/> | For proprietary biofiltration BMPs, the BMP maintenance plan is consistent with manufacturer guidelines and conditions of its third-party certification (i.e., maintenance activities, frequencies). | Provide copy of manufacturer recommendations and conditions of third-party certification. |
|--------------------------|--|---|
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<sup>3</sup> Certifications or verifications issued by the Washington Technology Acceptance Protocol-Ecology program and the New Jersey Corporation for Advanced Technology programs are typically accompanied by a set of guidelines regarding appropriate design and maintenance conditions that would be consistent with the certification/verification

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## F.1 Pollutant Treatment Performance Standard

Standard biofiltration BMPs that are designed following the criteria in Fact Sheets PR-1 and BF-1 are presumed to meet the pollutant treatment performance standard associated with biofiltration BMPs. This presumption is based on the MS4 Permit Fact Sheet which cites analyses of standard biofiltration BMPs conducted in the Ventura County Technical Guidance Manual (July 2011).

For BMPs that do not meet the biofiltration media specification and/or the range of acceptable media filtration rates described in Fact Sheet, PR-1 and BF-1, additional documentation must be provided to demonstrate that adequate pollutant treatment performance is provided to be considered a biofiltration BMP. Project applicants have three options for documenting compliance:

- 1) Project applicants may provide documentation to substantiate that the minor modifications to the design is expected to provide equal or better pollutant removal performance for the project pollutants of concern than would be provided by a biofiltration design that complies with the criteria in Fact Sheets PR-1 and BF-1. Minor modifications are design elements that deviate only slightly from standard design criteria and are expected to either not impact performance or to improve performance compared to standard biofiltration designs. The reviewing agency has the discretion to accept or reject this documentation and/or request additional documentation to substantiate equivalent or better performance to BF-1 or PR-1, as applicable. Examples of minor deviations include:
  - Different particle size distribution of aggregate, with documentation that system filtration rate will meet specifications.
  - Alternative source of organic components, with documentation of material suitability and stability from appropriate testing agency.
  - Specialized amendments to provide additional treatment mechanisms, and which have negligible potential to upset other treatment mechanisms or otherwise deteriorate performances.
- 2) For proprietary BMPs, project applicants may provide evidence that the BMP has been certified for use as part of the Washington State Technology Assessment Protocol-Ecology certification program and meets each of the following requirements:
  - a. The applicant must demonstrate (using the checklist in this Appendix) that the BMP meets all other conditions to be considered as a biofiltration BMP. For example, a cartridge media filter or hydrodynamic separator would not meet biofiltration BMP

## Appendix F: Biofiltration Standard and Checklist

design criteria regardless of Technology Acceptance Protocol-Ecology certification because they do not support effective biological processes.

- b. The applicant must select BMPs that have an active Technology Acceptance Protocol-Ecology certification, with General Use Level Designation for the appropriate project pollutants of concern as identified in Table F.1-1. The list of certified technologies is updated as new technologies are approved (link below). Technologies with Pilot Use Level Designation and Conditional Use Level Designations are not acceptable. Refer to: <http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html>.
  - c. The applicant must demonstrate that BMP is being used in a manner consistent with all conditions of the Technology Acceptance Protocol-Ecology certification while meeting the flow rate or volume design criteria that is required for biofiltration BMPs under this manual. Conditions of Technology Acceptance Protocol-Ecology certification are available by clicking on the technology name at the website listed in bullet b. Additional discussion about sizing of proprietary biofiltration BMPs to comply with applicable sizing standards is provided below in Section F.2.
  - d. For projects within the public right of way and/or public projects: the product must be acceptable to the City Engineer with respect to maintainability and long term operation of the product. In determining the acceptability of a product the [City Engineer] should consider, as applicable, maintenance requirements, cost of maintenance activities, relevant previous local experience with operation and maintenance of the BMP type, ability to continue to operate the system in event that the vending company is no longer operating as a business, and other relevant factors. If a proposed BMP is not accepted by the City Engineer, a written explanation/reason will be provided to the applicant.
- 3) For BMPs that do not fall into options 1 or 2 above, the [City Engineer] may allow the applicant to submit alternative third-party documentation that the pollutant treatment performance of the system is consistent with the performance levels associated with the necessary Technology Acceptance Protocol-Ecology certifications. Table F.1-1 describes the required levels of certification and Table F.1-2 describes the pollutant treatment performance levels associated with each level of certification. Acceptance of this approach is at the sole discretion of the City Engineer. If a proposed BMP is not accepted by the City Engineer, a written explanation/reason will be provided to the applicant. If Technology Acceptance Protocol-Ecology certifications are not available, preference shall be given to:
- a. Verified third-party, field-scale testing performance under the Technology Acceptance Reciprocity Partnership Tier II Protocol. This protocol is no longer operated, however this is considered to be a valid protocol and historic verifications are considered to be

## Appendix F: Biofiltration Standard and Checklist

representative provided that product models being proposed are consistent with those that were tested. Technology Acceptance Reciprocity Partnership verifications were conducted under New Jersey Corporation for Advance Testing and are archived at the website linked below. Note that Technology Acceptance Reciprocity Partnership verifications must be matched to pollutant treatment standards in Table F.1-2 then matched to an equivalent Technology Acceptance Protocol-Ecology certification in Table F.1-1.

- b. Verified third-party, field-scale testing performance under the New Jersey Corporation for Advance Testing protocol. Note that New Jersey Corporation for Advance Testing verifications must be matched to pollutant treatment standards in Table F.1-2 then matched to an equivalent Technology Acceptance Protocol-Ecology certification in Table F.1-1.

A list of field-scale verified technologies under Technology Acceptance Reciprocity Partnership Tier II and New Jersey Corporation for Advance Testing can be accessed at: <http://www.njcat.org/verification-process/technology-verification-database.html> (refer to field verified technologies only).

## Appendix F: Biofiltration Standard and Checklist

**Table F.1-1: Required Technology Acceptance Protocol-Ecology Certifications for Pollutants of Concern for Biofiltration Performance Standard**

Project Pollutant of Concern	Required Technology Acceptance Protocol-Ecology Certification for Biofiltration Performance Standard
Trash	Basic Treatment OR Phosphorus Treatment OR Enhanced Treatment
Sediments	Basic Treatment OR Phosphorus Treatment OR Enhanced Treatment
Oil and Grease	Basic Treatment OR Phosphorus Treatment OR Enhanced Treatment
Nutrients	Phosphorus Treatment <sup>1</sup>
Metals	Enhanced Treatment
Pesticides	Basic Treatment (including filtration) <sup>2</sup> OR Phosphorus Treatment OR Enhanced Treatment
Organics	Basic Treatment (including filtration) <sup>2</sup> OR Phosphorus Treatment OR Enhanced Treatment
Bacteria and Viruses	Basic Treatment (including bacteria removal processes) <sup>3</sup> OR Phosphorus Treatment OR Enhanced Treatment

1 – There is no Technology Acceptance Protocol-Ecology equivalent for nitrogen compounds; however systems that are designed to retain phosphorus (as well as meet basic treatment designation), generally also provide treatment of nitrogen compounds. Where nitrogen is a pollutant of concern, relative performance of available certified systems for nitrogen removal should be considered in BMP selection.

2 – Pesticides, organics, and oxygen demanding substances are typically addressed by particle filtration consistent with the level of treatment required to achieve Basic treatment certification; if a system with Basic treatment certification does not provide filtration, it is not acceptable for pesticides, organics or oxygen demanding substances.

3 – There is no Technology Acceptance Protocol-Ecology equivalent for pathogens (viruses and bacteria), and testing data are limited because of typical sample hold times. Systems with Technology Acceptance Protocol-Ecology Basic Treatment must include one or more significant bacteria removal process such as media filtration, physical sorption, predation, reduced redox conditions, and/or solar inactivation. Where design options are available to enhance pathogen removal (i.e., pathogen-specific media mix offered by vendor), this design variation should be used.

**Appendix F: Biofiltration Standard and Checklist**

**Table F.1-2: Performance Standards for Technology Acceptance Protocol-Ecology Certification**

<b>Performance Goal</b>	<b>Influent Range</b>	<b>Criteria</b>
<b>Basic Treatment</b>	20 – 100 mg/L TSS	Effluent goal $\leq$ 20 mg/L TSS
	100 – 200 mg/L TSS	$\geq$ 80% TSS removal
	>200 mg/L TSS	> 80% TSS removal
<b>Enhanced (Dissolved Metals) Treatment</b>	Dissolved copper 0.005 – 0.02 mg/L	Must meet basic treatment goal and better than basic treatment currently defined as >30% dissolved copper removal
	Dissolved zinc 0.02 – 0.3 mg/L	Must meet basic treatment goal and better than basic treatment currently defined as >60% dissolved zinc removal
<b>Phosphorous Treatment</b>	Total phosphorous 0.1 – 0.5 mg/L	Must meet basic treatment goal and exhibit $\geq$ 50% total phosphorous removal
<b>Oil Treatment</b>	Total petroleum hydrocarbon > 10 mg/L	No ongoing or recurring visible sheen in effluent Daily average effluent Total petroleum hydrocarbon concentration < 10 mg/L Maximum effluent Total petroleum hydrocarbon concentration for a 15 mg/L for a discrete (grab) sample
<b>Pretreatment</b>	50 – 100 mg/L TSS	$\leq$ 50 mg/L TSS
	$\geq$ 200 mg/L TSS	$\geq$ 50% TSS removal

## F.2 Guidance on Sizing and Design of Non-Standard Biofiltration BMPs

This section explains the general process for design and sizing of non-standard biofiltration BMPs. This section assumes that the BMPs have been selected based on the criteria in Section F.1.

### F.2.1 Guidance on Design per Conditions of Certification/Verification

The biofiltration standard and checklist in this appendix requires that “the BMP is used in a manner consistent with manufacturer guidelines and conditions of its third-party certification.” Practically, what this means is that the BMP is used in the same way in which it was tested and certified. For example, it is not acceptable for a BMP of a given size to be certified/verified with a 100 gallon per minute treatment rate and be applied at a 150 gallon per minute treatment rate in a design.

Certifications or verifications issued by the Washington Technology Acceptance Protocol-Ecology program and the Technology Acceptance Reciprocity Partnership or New Jersey Corporation for Advance Testing programs are typically accompanied by a set of guidelines regarding appropriate design and maintenance conditions that would be consistent with the certification/verification. It is common for these approvals to specify the specific model of BMP, design capacity for given unit sizes, type of media that is the basis for approval, and/or other parameter. The applicant must demonstrate conclusively that the proposed application of the BMP is consistent with these criteria.

For alternate non-proprietary systems that do not have a Technology Acceptance Protocol-Ecology / Technology Acceptance Reciprocity Partnership / New Jersey Corporation for Advance Testing certification (but which still must provide quantitative data per Appendix F.1), it must be demonstrate that the configuration and design proposed for the project is reasonably consistent with the configuration and design under which the BMP was tested to demonstrate compliance with Appendix F.1.

### F.2.2 Sizing of Flow-Based Biofiltration BMP

**This sizing method is only available when the BMP meets the pollutant treatment performance standard in Appendix F.1.**

Proprietary biofiltration BMPs are typically designed as a flow-based BMPs (i.e., a constant treatment capacity with negligible storage volume). Additionally, proprietary biofiltration is only acceptable if no infiltration is feasible and where site-specific documentation demonstrates that the use of larger footprint biofiltration BMPs would be infeasible or if the proprietary biofiltration BMP is supplemented with a downstream retention BMP that achieves volume reduction equivalent to a non-proprietary BMP sized in accordance with Worksheet B.5-1. The applicable sizing method for biofiltration is therefore reduced to: Treat 1.5 times the DCV.

## Appendix F: Biofiltration Standard and Checklist

The following steps should be followed to demonstrate that the system is sized to treat 1.5 times the DCV.

1. Calculate the flow rate required to meet the pollutant treatment performance standard without scaling for the 1.5 factor. Options include either:
  - Calculate the runoff flow rate from a 0.2 inch per hour uniform intensity precipitation event (See methodology Appendix B.6.3), or
  - Conduct a continuous simulation analysis to compute the size required to capture and treat 80 percent of average annual runoff; for small catchments, 5-minute precipitation data should be used to account for short time of concentration. Nearest rain gage with 5-minute precipitation data is allowed for this analysis.
2. Multiply the flow rate from Step 1 by 1.5 to compute the design flow rate for the biofiltration system.
3. Based on the conditions of certification/verification (discussed above), establish the design capacity, as a flow rate, of a given sized unit.
4. Demonstrates that an appropriate unit size and number of units is provided to provide a flow rate that meets the required flow rate from Step 2.
5. Provide supplemental retention BMPs that achieves volume reduction equivalent per Appendix B.2.



**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

# **Guidance for Continuous Simulation and Hydromodification Management Sizing Factors**

# Appendix G Guidance for Continuous Simulation and Hydromodification Management Sizing Factors

## G.1 Guidance for Continuous Simulation Hydrologic Modeling for Hydromodification Management Studies in the City of Oceanside

### G.1.1 Introduction

Continuous simulation hydrologic modeling is used to demonstrate compliance with the performance standards for hydromodification management in San Diego. There are several available hydrologic models that can perform continuous simulation analyses. Each has different methods and parameters for determining the amount of rainfall that becomes runoff, and for representing the hydraulic operations of certain structural BMPs such as biofiltration with partial retention or biofiltration. This Appendix is intended to:

- Identify acceptable models for continuous simulation hydrologic analyses for hydromodification management;
- Provide guidance for selecting climatology input to the models;
- Provide standards for rainfall loss parameters to be used in the models;
- Provide standards for defining physical characteristics of LID components; and
- Provide guidance for demonstrating compliance with performance standards for hydromodification management.

This Appendix is not a user's manual for any of the acceptable models, nor a comprehensive manual for preparing a hydrologic model. This Appendix provides guidance for selecting model input parameters for the specific purpose of hydromodification management studies. The model preparer must be familiar with the user's manual for the selected software to determine how the parameters are entered to the model.

## **G.1.2 Software for Continuous Simulation Hydrologic Modeling**

The following software models may be used for hydromodification management studies in San Diego:

- HSPF – Hydrologic Simulation Program-FORTRAN, distributed by USEPA, public domain.
- SDHM – San Diego Hydrology Model, distributed by Clear Creek Solutions, Inc. This is an HSPF-based model with a proprietary interface that has been customized for use in San Diego for hydromodification management studies.
- SWMM – Storm Water Management Model, distributed by USEPA, public domain.

Third-party and proprietary software, such as XPSWMM or PCSWMM, may be used for hydromodification management studies in San Diego, provided that:

- Input and output data from the software can interface with public domain software such as SWMM. In other words, input files from the third party software should have sufficient functionality to allow export to public domain software for independent validation.
- The software's hydromodification control processes are substantiated.

## **G.1.3 Climatology Parameters**

### **G.1.3.1 Rainfall**

In all software applications for preparation of hydromodification management studies in San Diego, rainfall data must be selected from approved data sets that have been prepared for this purpose. As part of the development of the March 2011 Final HMP, long-term hourly rainfall records were prepared for public use. The rainfall record files are provided on the Project Clean Water website. The rainfall station map is provided in the March 2011 Final HMP and is included in this Appendix as Figure G.1-1.

Appendix G: Guidance for Continuous Simulation and Hydromodification Management Sizing Factors

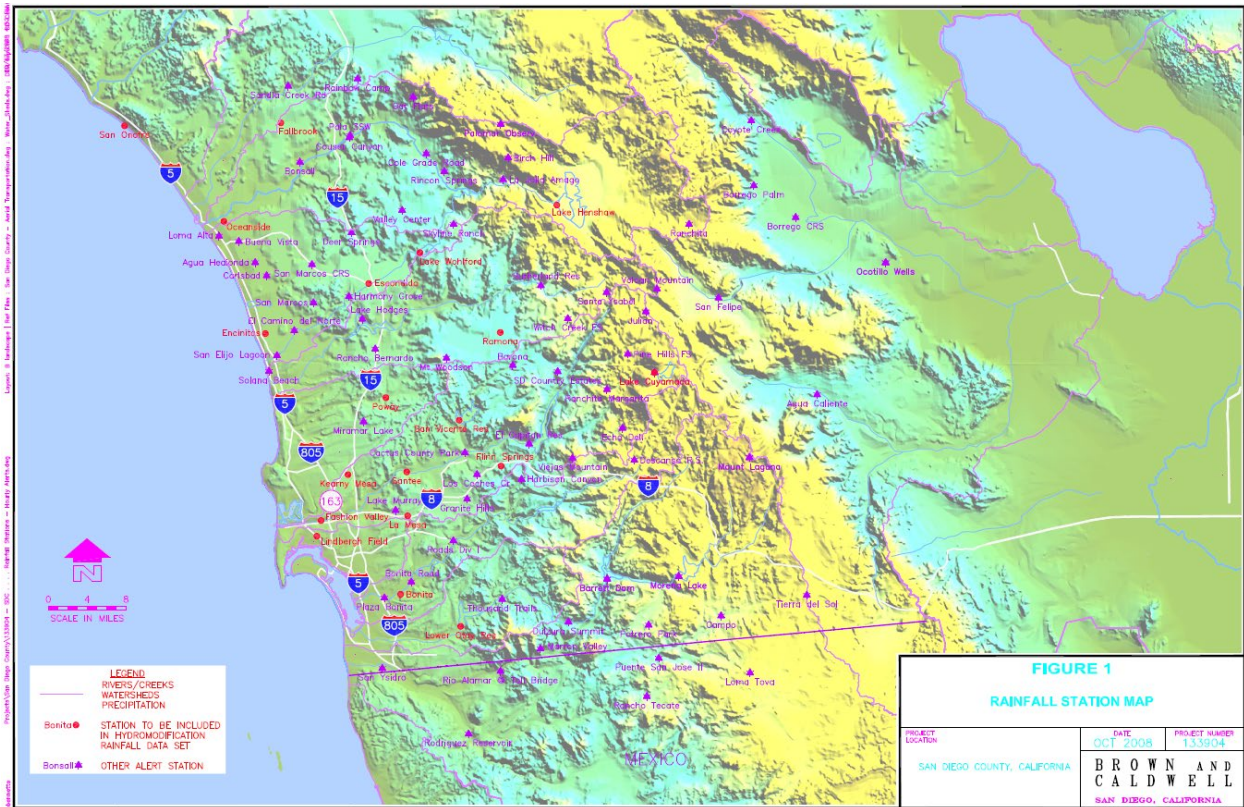


Figure G.1-1: Rainfall Station Map

Project applicants preparing continuous simulation models shall select the most appropriate rainfall data set from the rainfall record files provided on the Project Clean Water website. For a given project location, the following factors should be considered in the selection of the appropriate rainfall data set:

- In most cases, the rainfall data set in closest proximity to the project site will be the appropriate choice (refer to the rainfall station map).
- In some cases, the rainfall data set in closest proximity to the project site may not be the most applicable data set. Such a scenario could involve a data set with an elevation significantly different from the project site. In addition to a simple elevation comparison, the project proponent may also consult with the San Diego County’s average annual precipitation isopluvial map, which is provided in the San Diego County Hydrology Manual (2003). Review of this map could provide an initial estimate as to whether the project site is in a similar rainfall zone as compared to the rainfall stations. Generally, precipitation totals in San Diego County increase with increasing elevation.
- Where possible, rainfall data sets should be chosen so that the data set and the project location are both located in the same topographic zone (coastal, foothill, mountain) and major watershed unit (Upper San Luis Rey, Lower San Luis Rey, Upper San Diego River, Lower San Diego River, etc.).

## Appendix G: Guidance for Continuous Simulation and Hydromodification Management Sizing Factors

For SDHM users, the approved rainfall data sets are pre-loaded into the software package. SDHM users may select the appropriate rainfall gage within the SDHM program. HSPF or SWMM users shall download the appropriate rainfall record from the Project Clean Water website and load it into the software program.

Both the pre-development and post-project model simulation period shall encompass the entire rainfall record provided in the approved rainfall data set. Scaling the rainfall data is not permitted.

### G.1.3.2 Potential Evapotranspiration

Project applicants preparing continuous simulation models shall select a data set from the sources described below to represent potential evapotranspiration.

For HSPF users, this parameter may be entered as an hourly time series. The hourly time series that was used to develop the BMP Sizing Calculator parameters is provided on the project clean water website and may be used for hydromodification management studies in San Diego. For SDHM users, the hourly evaporation data set is pre-loaded into the program. HSPF users may download the evaporation record from the Project Clean Water website and load it into the software program.

For HSPF or SWMM users, this parameter may be entered as monthly values in inches per month or inches per day. Monthly values may be obtained from the California Irrigation Management Information System "Reference Evapotranspiration Zones" brochure and map (herein "CIMIS ETo Zone Map"), prepared by California Department of Water Resources, dated January 2012. The CIMIS ETo Zone Map is available from [www.cimis.gov](http://www.cimis.gov), and is provided in this Appendix as Figure G.1-2. Determine the appropriate reference evapotranspiration zone for the project from the CIMIS ETo Zone Map. The monthly average reference evapotranspiration values are provided below in Table G.1-1.

Appendix G: Guidance for Continuous Simulation and Hydromodification Management Sizing Factors

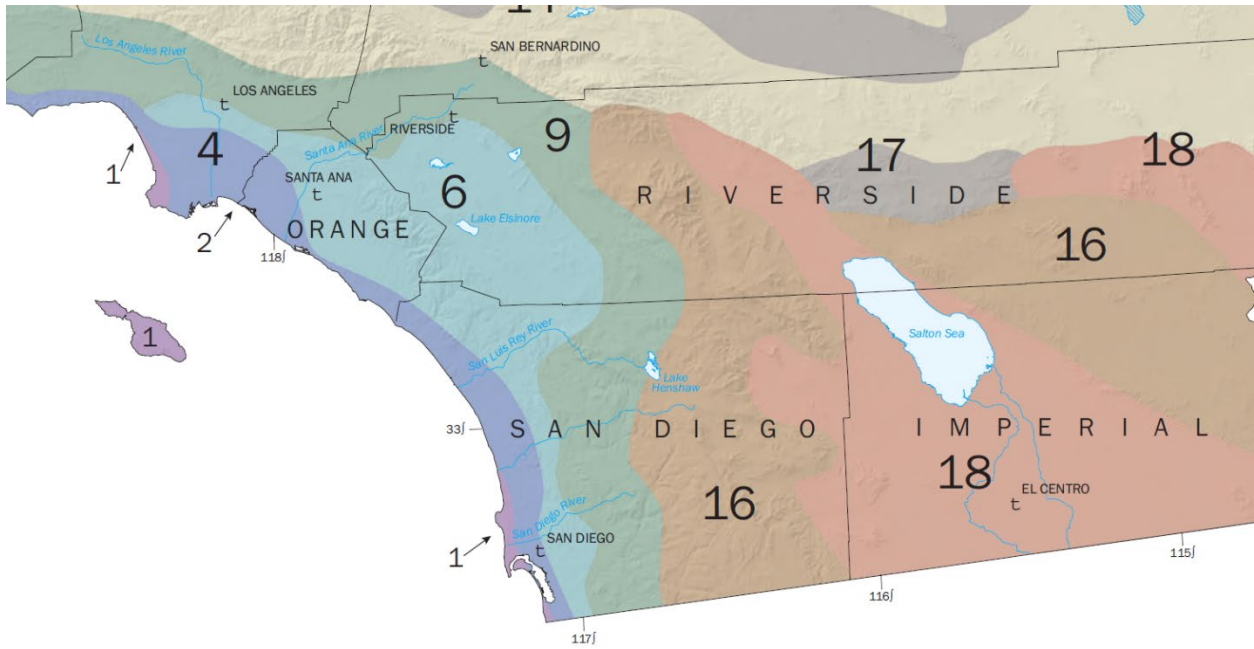


Figure G.1-2: California Irrigation Management Information System "Reference Evapotranspiration Zones"

**Appendix G: Guidance for Continuous Simulation and Hydromodification Management Sizing Factors**

**Table G.1-1: Monthly Average Reference Evapotranspiration by ETo Zone  
(inches/month and inches/day) for use in SWMM Models for Hydromodification Management Studies in San Diego County  
CIMIS Zones 1, 4, 6, 9, and 16 (See CIMIS ETo Zone Map)**

	January	February	March	April	May	June	July	August	September	October	November	December
Zone	in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month
1	0.93	1.4	2.48	3.3	4.03	4.5	4.65	4.03	3.3	2.48	1.2	0.62
4	1.86	2.24	3.41	4.5	5.27	5.7	5.89	5.58	4.5	3.41	2.4	1.86
6	1.86	2.24	3.41	4.8	5.58	6.3	6.51	6.2	4.8	3.72	2.4	1.86
9	2.17	2.8	4.03	5.1	5.89	6.6	7.44	6.82	5.7	4.03	2.7	1.86
16	1.55	2.52	4.03	5.7	7.75	8.7	9.3	8.37	6.3	4.34	2.4	1.55
	January	February	March	April	May	June	July	August	September	October	November	December
Days	31	28	31	30	31	30	31	31	30	31	30	31
Zone	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day
1	0.030	0.050	0.080	0.110	0.130	0.150	0.150	0.130	0.110	0.080	0.040	0.020
4	0.060	0.080	0.110	0.150	0.170	0.190	0.190	0.180	0.150	0.110	0.080	0.060
6	0.060	0.080	0.110	0.160	0.180	0.210	0.210	0.200	0.160	0.120	0.080	0.060
9	0.070	0.100	0.130	0.170	0.190	0.220	0.240	0.220	0.190	0.130	0.090	0.060
16	0.050	0.090	0.130	0.190	0.250	0.290	0.300	0.270	0.210	0.140	0.080	0.050

### **G.1.4 Land Characteristics and Loss Parameters**

In all software applications for preparation of hydromodification management studies in San Diego, rainfall loss parameters must be consistent with this Appendix unless the preparer can provide documentation to substantiate use of other parameters, subject to City approval. HSPF and SWMM use different processes and different sets of parameters. SDHM is based on HSPF, therefore parameters for SDHM and HSPF are presented together in Section G.1.4.1. Parameters that have been pre-loaded into SDHM may be used for other HSPF hydromodification management studies outside of SDHM. Parameters for SWMM are presented separately in Section G.1.4.2.

#### **G.1.4.1 Rainfall Loss Parameters for HSPF and SDHM**

Rainfall losses in HSPF are characterized by PERLND/PWATER parameters and IMPLND parameters, which describe processes occurring when rainfall lands on pervious lands and impervious lands, respectively. "BASINS Technical Notice 6, Estimating Hydrology and Hydraulic Parameters for HSPF," prepared by the USEPA, dated July 2000, provides details regarding these parameters and summary tables of possible ranges of these parameters. Table G.1-2, excerpted from the above-mentioned document, presents the ranges of these parameters.

For HSPF studies for hydromodification management in San Diego, PERLND/PWATER parameters and IMPLND parameters shall fall within the "possible" range provided in EPA Technical Note 6. To select specific parameters, HSPF users may use the parameters established for development of the San Diego BMP Sizing Calculator, and/or the parameters that have been established for SDHM. Parameters for the San Diego BMP Sizing Calculator and SDHM are based on research conducted specifically for HSPF modeling in San Diego.

Documentation of parameters selected for the San Diego BMP Sizing Calculator is presented in the document titled, San Diego BMP Sizing Calculator Methodology, prepared by Brown and Caldwell, dated January 2012 (herein "BMP Sizing Calculator Methodology"). The PERLND/PWATER parameters selected for development of the San Diego BMP Sizing Calculator represent a single composite pervious land cover that is representative of most pre-development conditions for sites that would commonly be managed by the BMP Sizing Calculator. The parameters shown below in Table G.1-3 are excerpted from the BMP Sizing Calculator Methodology.

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**Table G.1-2: HSPF PERLND/PWATER and IMPLND Parameters from EPA Technical Note 6**

Name	Definition	Units	Range of Values				Function of ...	Comment
			Typical		Possible			
			Min	Max	Min	Max		
<b>PWAT – PARM2</b>								
FOREST	Fraction forest cover	none	0.0	0.50	0.0	0.95	Forest cover	Only impact when SNOW is active
LZSN	Lower Zone Nominal Soil Moisture Storage	inches	3.0	8.0	2.0	15.0	Soils, climate	<b>Calibration</b>
INFILT	Index to Infiltration Capacity	in/hr	0.01	0.25	0.001	0.50	Soils, land use	<b>Calibration</b> , divides surface and subsurface flow
LSUR	Length of overland flow	feet	200	500	100	700	Topography	Estimate from high resolution topo maps or GIS
SLSUR	Slope of overland flow plane	ft/ft	0.01	0.15	0.001	0.30	Topography	Estimate from high resolution topo maps or GIS
KVARY	Variable groundwater recession	1/inches	0.0	3.0	0.0	5.0	Baseflow recession variation	Used when recession rate varies with GW levels
AGWRC	Base groundwater recession	none	0.92	0.99	0.85	0.999	Baseflow recession	<b>Calibration</b>
<b>PWAT – PARM3</b>								
PETMAX	Temp below which ET is reduced	deg. F	35.0	45.0	32.0	48.0	Climate, vegetation	Reduces ET near freezing, when SNOW is active
PETMIN	Temp below which ET is set to zero	deg. F	30.0	35.0	30.0	40.0	Climate, vegetation	Reduces ET near freezing, when SNOW is active
INFEXP	Exponent in infiltration equation	none	2.0	2.0	1.0	3.0	Soils variability	Usually default to 2.0
INFILD	Ratio of max/mean infiltration capacities	none	2.0	2.0	1.0	3.0	Soils variability	Usually default to 2.0
DEEPPFR	Fraction of GW inflow to deep recharge	none	0.0	0.20	0.0	0.50	Geology, GW recharge	Accounts for subsurface losses
BASETP	Fraction of remaining ET from baseflow	none	0.0	0.05	0.0	0.20	Riparian vegetation	Direct ET from riparian vegetation
AGWETP	Fraction of remaining ET from active GW	none	0.0	0.05	0.0	0.20	Marsh/wetlands extent	Direct ET from shallow GW
<b>PWAT – PARM4</b>								
CEPSC	Interception storage capacity	inches	0.03	0.20	0.01	0.40	Vegetation type/density, land use	Monthly values usually used
UZSN	Upper zone nominal soil moisture storage	inches	0.10	1.0	0.05	2.0	Surface soil conditions, land use	Accounts for near surface retention
NSUR	Manning's n (roughness) for overland flow	none	0.15	0.35	0.05	0.50	Surface conditions, residue, etc.	Monthly values often used for croplands
INTFW	Interflow inflow parameter	none	1.0	3.0	1.0	10.0	Soils, topography, land use	<b>Calibration</b> , based on hydrograph separation
IRC	Interflow recession parameter	none	0.5	0.70	0.30	0.85	Soils, topography, land use	Often start with a value of 0.7, and then adjust
LZETP	Lower zone ET parameter	none	0.2	0.70	0.1	0.9	Vegetation type/density, root depth	<b>Calibration</b>
<b>IWAT – PARM2</b>								
LSUR	Length of overland flow	feet	50	150	50	250	Topography, drainage system	Estimate from maps, GIS, or field survey
SLSUR	Slope of overland flow plane	ft/ft	0.01	0.05	0.001	0.15	Topography, drainage	Estimate from maps, GIS, or field survey
NSUR	Manning's n (roughness) for overland flow	none	0.03	0.10	0.01	0.15	Impervious surface conditions	Typical range is 0.05 to 0.10 for roads/parking lots
RETSC	Retention storage capacity	inches	0.03	0.10	0.01	0.30	Impervious surface conditions	Typical range is 0.03 to 0.10 for roads/parking lots
<b>IWAT – PARM3 (PETMAX and PETMIN, same values as shown for PWAT – PARM3)</b>								

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**Table G.1-3: HSPF PERLND/PWATER Parameters from BMP Sizing Calculator Methodology**

	Slope	Hydrologic Soil Group A			Hydrologic Soil Group B			Hydrologic Soil Group C			Hydrologic Soil Group D		
		5%	10%	15%	5%	10%	15%	5%	10%	15%	5%	10%	15%
PWAT_PAR M2	Units												
FOREST	None	0	0	0	0	0	0	0	0	0	0	0	0
LZSN	inches	5.2	4.8	4.5	5.0	4.7	4.4	4.8	4.5	4.2	4.8	4.5	4.2
INFILT	in/hr	0.090	0.070	0.045	0.070	0.055	0.040	0.050	0.040	0.032	0.040	0.030	0.020
LSUR	Feet	200	200	200	200	200	200	200	200	200	200	200	200
SLSUR	ft/ft	0.05	0.1	0.15	0.05	0.1	0.15	0.05	0.1	0.15	0.05	0.1	0.15
KVARY	1/inches	3	3	3	3	3	3	3	3	3	3	3	3
AGWRC	None	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
PWAT_PAR M3													
PETMAX (F)	F	35	35	35	35	35	35	35	35	35	35	35	35
PETMIN (F)	F	30	30	30	30	30	30	30	30	30	30	30	30
INFEXP	None	2	2	2	2	2	2	2	2	2	2	2	2
INFILD	None	2	2	2	2	2	2	2	2	2	2	2	2
DEEPPFR	None	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
BASETP	None	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
AGEWTP	None	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
PWAT_PAR M4													
CEPSC	inches	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
UZSN	inches	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
NSUR	None	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
INTFW	None	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
IRC	None	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
LZETP	None	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

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Parameters within SDHM are documented in "San Diego Hydrology Model User Manual," prepared by Clear Creek Solutions, Inc. (as of the development of the Manual, the current version of the SDHM User Manual is dated January 2012). Parameters established for SDHM represent "grass" (non-turf grasslands), "dirt," "gravel," and "urban" cover. The documented PERLND and IMPLND parameters for the various land covers and soil types have been pre-loaded into SDHM. SDHM users shall use the parameters that have been pre-loaded into the program without modification unless the preparer can provide documentation to substantiate use of other parameters.

### **G.1.4.2 Rainfall Loss Parameters for SWMM**

In SWMM, rainfall loss parameters (parameters that describe processes occurring when rainfall lands on pervious lands and impervious lands) are entered in the "subcatchment" module. In addition to specifying parameters, the SWMM user must also select an infiltration model.

The SWMM Manual provides details regarding the subcatchment parameters and summary tables of possible ranges of these parameters. For SWMM studies for hydromodification management in San Diego, subcatchment parameters shall fall within the range provided in the SWMM Manual. Some of the parameters depend on the selection of the infiltration model. For consistency across the San Diego region, SWMM users shall use the Green-Ampt infiltration model for hydromodification management studies. Table G.1-4 presents SWMM subcatchment parameters for use in hydromodification management studies in the San Diego region.

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**Table G.1-4: Subcatchment Parameters for SWMM Studies for Hydromodification Management in San Diego**

SWMM Parameter Name	Unit	Range	Use in San Diego
Name X-Coordinate Y-Coordinate Description Tag Rain Gage Outlet	N/A	N/A – project-specific	Project-specific
Area	acres (ac)	Project-specific	Project-specific
Width	feet (ft)	Project-specific	Project-specific
% Slope	percent (%)	Project-specific	Project-specific
% Imperv	percent (%)	Project-specific	Project-specific
N-imperv	--	0.011 – 0.024 presented in Table A.6 of SWMM Manual	default use 0.012 for smooth concrete, otherwise provide documentation of other surface consistent with Table A.6 of SWMM Manual
N-Perv	--	0.05 – 0.80 presented in Table A.6 of SWMM Manual	default use 0.15 for short prairie grass, otherwise provide documentation of other surface consistent with Table A.6 of SWMM Manual
Dstore-Imperv	inches	0.05 – 0.10 inches presented in Table A.5 of SWMM Manual	0.05
Dstore-Perv	inches	0.10 – 0.30 inches presented in Table A.5 of SWMM Manual	0.10
%ZeroImperv	percent (%)	0% – 100%	25%
Subarea routing	--	OUTLET IMPERVIOUS PERVIOUS	Project-specific, typically OUTLET
Percent Routed	%	0% – 100%	Project-specific, typically 100%
Infiltration	Method	HORTON GREEN_AMPT CURVE_NUMBER	GREEN_AMPT

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SWMM Parameter Name	Unit	Range	Use in San Diego
Suction Head (Green-Ampt)	Inches	1.93 – 12.60 presented in Table A.2 of SWMM Manual	Hydrologic Soil Group A: 1.5 Hydrologic Soil Group B: 3.0 Hydrologic Soil Group C: 6.0 Hydrologic Soil Group D: 9.0
Conductivity (Green-Ampt)	Inches per hour	0.01 – 4.74 presented in Table A.2 of SWMM Manual by soil texture class 0.00 – $\geq 0.45$ presented in Table A.3 of SWMM Manual by hydrologic soil group	Hydrologic Soil Group A: 0.3 Hydrologic Soil Group B: 0.2 Hydrologic Soil Group C: 0.1 Hydrologic Soil Group D: 0.025  Note: reduce conductivity by 25% in the post-project condition when native soils will be compacted. Conductivity may also be reduced by 25% in the pre-development condition model for redevelopment areas that are currently concrete or asphalt but must be modeled according to their underlying soil characteristics. For fill soils in post-project condition, see Section G.1.4.3.
Initial Deficit (Green-Ampt)		The difference between soil porosity and initial moisture content. Based on the values provided in Table A.2 of SWMM Manual, the range for completely dry soil would be 0.097 to 0.375	Hydrologic Soil Group A: 0.30 Hydrologic Soil Group B: 0.31 Hydrologic Soil Group C: 0.32 Hydrologic Soil Group D: 0.33  Note: in long-term continuous simulation, this value is not important as the soil will reach equilibrium after a few storm events regardless of the initial moisture content specified.
Groundwater	yes/no	yes/no	NO
LID Controls			Project Specific

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SWMM Parameter Name	Unit	Range	Use in San Diego
Snow Pack Land Uses Initial Buildup Curb Length			Not applicable to hydromodification management studies

**G.1.4.3 Pervious Area Rainfall Loss Parameters in Post-Project Condition (HSPF, SDHM, and SWMM)**

The following guidance applies to HSPF, SDHM, and SWMM. When modeling pervious areas in the post-project condition, fill soils shall be modeled as hydrologic soil group Type D soils, or the project applicant may provide an actual expected infiltration rate for the fill soil based on testing (must be approved by the City Engineer for use in the model). Where landscaped areas on fill soils will be re-tilled and/or amended in the post-project condition, the landscaped areas may be modeled as Type C soils. Areas to be re-tilled and/or amended in the post-project condition must be shown on the project plans. For undisturbed pervious areas (i.e., native soils, no fill), use the actual hydrologic soil group, the same as in the pre-development condition.

**G.1.5 Modeling Structural BMPs (Ponds and Lid Features)**

There are many ways to model structural BMPs. There are standard modules for several pond or LID elements included in SDHM and SWMM. Users may also set up project-specific stage-storage-discharge relationships representing structural BMPs. Regardless of the modeling method, certain characteristics of the structural BMP, including infiltration of water from the bottom of the structural BMP into native soils, porosity of bioretention soils and/or gravel sublayers, and other program-specific parameters must be consistent with those presented below, unless the preparer can provide documentation to substantiate use of other parameters, subject to City approval. The geometry of structural BMPs is project-specific and shall match the project plans.

**G.1.5.1 Infiltration into Native Soils Below Structural BMPs**

Infiltration into native soils below structural BMPs may be modeled as a constant outflow rate equal to the project site-specific design infiltration rate (Worksheet D.5-1) multiplied by the area of the infiltrating surface (and converted to cubic feet per second). This infiltration rate is not the same as an infiltration parameter used in the calculation of rainfall losses, such as the HSPF INFILT parameter or the Green-Ampt conductivity parameter in the SWMM subcatchment module. It must be site-specific and must be determined based on the methods presented in Appendix D of this manual.

For preliminary analysis when site-specific geotechnical investigation has not been completed, project

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applicants proposing infiltration into native soils as part of the structural BMP design shall prepare a sensitivity analysis to determine a potential range for the structural BMP size based on a range of potential infiltration rates. As shown in Appendices C and D of this manual, many factors influence the ability to infiltrate storm water. Therefore even when soils types A and B are present, which are generally expected to infiltrate storm water, the possibility that a very low infiltration rate could be determined at design level must be considered. The range of potential infiltration rates for preliminary analysis is shown below in Table G.1-5.

**Table G.1-5: Range of Potential Infiltration Rates to be Studied for Sensitivity Analysis when Native Infiltration is Proposed but Site-Specific Geotechnical Investigation has not been Completed**

Hydrologic Soil Group at Location of Proposed Structural BMP	Low Infiltration Rate for Preliminary Study (inches/hour)	High Infiltration Rate for Preliminary Study (inches/hour)
A	0.02	2.4
B	0.02	0.52
C	0	0.08
D	0	0.02

The infiltration rates shown above are for preliminary investigation only. Final design of a structural BMP must be based on the project site-specific design infiltration rate (Worksheet D.5-1).

### G.1.5.2 Structural BMPs That Do Not Include Sub-Layers (Ponds)

To model a pond, basin, or other depressed area that does not include processing runoff through sublayers of amended soil and/or gravel, create a stage storage discharge relationship for the pond, and supply the information to the model according to the program requirements. For HSPF users, the stage-storage-discharge relationship is provided in FTABLES. SDHM users may use the TRAPEZOIDAL POND element for a trapezoidal pond or IRREGULAR POND element to request the program to create the stage-storage-discharge relationship, use the SSD TABLE element to supply a user-created stage-storage-discharge relationship, or use other available modules such as TANK or VAULT. For SWMM users, the stage-storage relationship is supplied in the storage unit module, and the stage-discharge relationship may be represented by various other modules such as the orifice, weir, or outlet modules. Stage-storage and stage-discharge curves for structural BMPs must be fully documented in the project-specific HMP report and must be consistent with the structural BMP(s) shown on project plans.

For user-created stage-discharge relationships, refer to local drainage manual criteria for equations representing hydraulic behavior of outlet structures. Users relying on the software to develop the stage-discharge relationship may use the equations built into the program. This manual does not

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recommend that all program modules calculating stage-discharge relationships must be uniform because the flows to be controlled for hydromodification management are low flows, calculated differently from the single-storm event peak flows studied for flood control purposes, and hydromodification management performance standards do not represent any performance standard for flood control drainage design. Note that for design of emergency outlet structures, and any calculations related to single-storm event routing for flood control drainage design, stage-discharge calculations must be consistent with the local drainage design requirements. This may require separate calculations for stage-discharge relationship pursuant to local manuals. The HMP flow rates shall not be used for flood control calculations.

### G.1.5.3 Structural BMPs That Include Sub-Layers (Bioretention and Other LID)

#### G.1.5.3.1 Characteristics of Engineered Soil Media

The engineered soil media used in bioretention, biofiltration with partial retention, and biofiltration structural BMPs is a sandy loam. The following parameters presented in Table G.1-6 are characteristics of a sandy loam for use in continuous simulation models.

**Table G.1-6: Characteristics of Sandy Loam to Represent Engineered Soil Media in Continuous Simulation for Hydromodification Management Studies in San Diego**

Soil Texture	Porosity	Field Capacity	Wilting Point	Conductivity	Suction Head
Sandy Loam	0.4	0.2	0.1	5 inches/hour	1.5 inches

- Porosity is the volume of pore space (voids) relative to the total volume of soil (as a fraction).
- Field Capacity is the volume of pore water relative to total volume after the soil has been allowed to drain fully (as a fraction). Below this level, vertical drainage of water through the soil layer does not occur.
- Wilting point is the volume of pore water relative to total volume for a well dried soil where only bound water remains (as a fraction). The moisture content of the soil cannot fall below this limit.
- Conductivity is the hydraulic conductivity for the fully saturated soil (in/hr or mm/hr).
- Suction head is the average value of soil capillary suction along the wetting front (inches or mm).

Figures G.1-3 and G.1-4, from <https://stevenswater.com/news-and-articles/the-stevens-soil-resource-guide/>, illustrate unsaturated soil and soil saturation, field capacity, and wilting point.

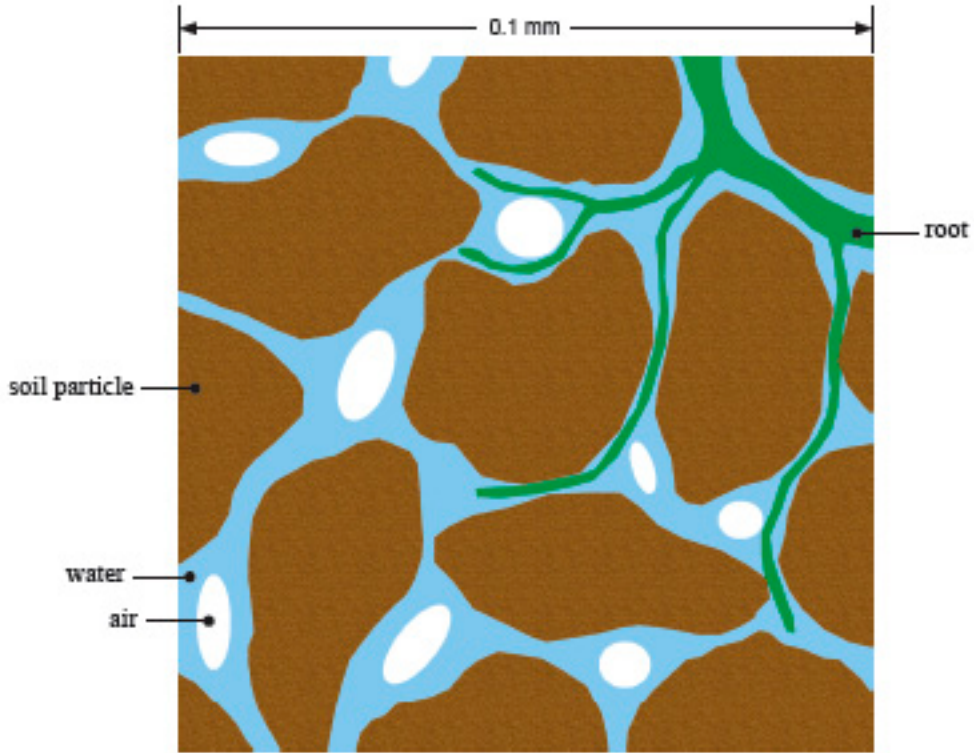


Figure G.1-3: Unsaturated Soil Composition

Unsaturated soil is composed of solid particles, organic material and pores. The pore space will contain air and water.

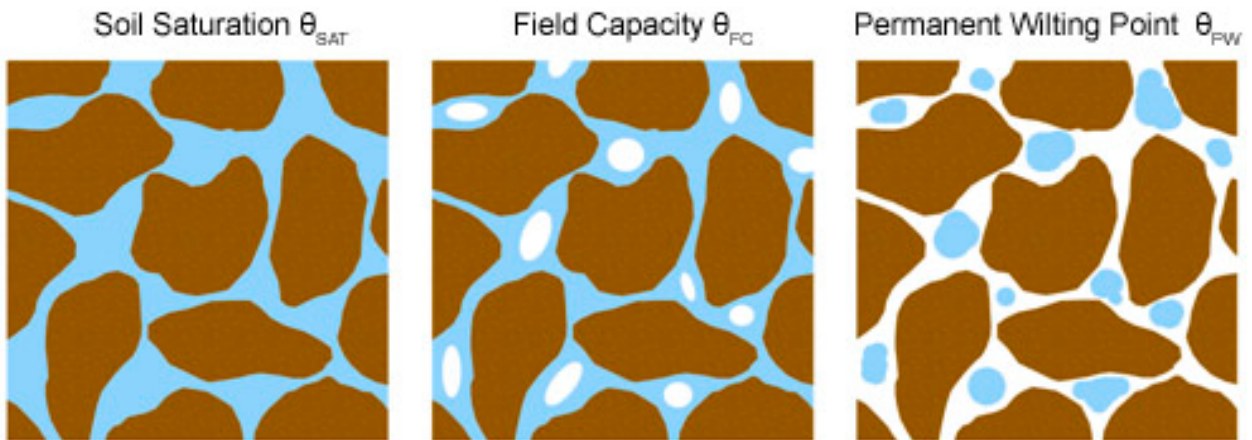


Figure G.1-4: Soil saturation, field capacity, and wilting point

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### G.1.5.3.2 Characteristics of Gravel

For the purpose of hydromodification management studies, it may be assumed that water moves freely through gravel, not limited by hydraulic properties of the gravel. For the purpose of calculating available volume, use porosity of 0.4, or void ratio of 0.67. Porosity is equal to void ratio divided by (1 + void ratio).

### G.1.5.3.3 Additional Guidance for SDHM Users

The module titled "bioretention/rain garden element" may be used to represent bioretention or biofiltration BMPs. SDHM users using the available "bioretention/rain garden element" shall customize the soil media characteristics to use the parameters from Table G.1-6 above, and select "gravel" for gravel sublayers. All other input variables are project-specific. "Native infiltration" refers to infiltration from the bottom of the structural BMP into the native soil. This variable is project-specific, see Section G.1.5.1.

### G.1.5.3.4 Additional Guidance for SWMM Users

The "bio-retention cell" LID control may be used to represent bioretention or biofiltration BMPs. Table G.1-7 provides parameters required for the standard "bio-retention cell" available in SWMM. The parameters are entered in the LID Control Editor.

**Table G.1-7: Parameters for SWMM "Bio-Retention Cell" Module for Hydromodification Management Studies in San Diego**

SWMM Parameter Name	Unit	Use in San Diego
<b><i>Surface</i></b>		
Berm Height also known as Storage Depth	inches	Project-specific
Vegetative Volume Fraction also known as Vegetative Cover Fraction	---	0
Surface Roughness	---	0 (this parameter is not applicable to bio-retention cell)
Surface Slope	---	0 (this parameter is not applicable to bio-retention cell)
<b><i>Soil</i></b>		
Thickness	inches	project-specific
Porosity	---	0.40
Field Capacity	---	0.2

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SWMM Parameter Name	Unit	Use in San Diego
Wilting Point	---	0.1
Conductivity	Inches/hour	5
Conductivity Slope	---	5
Suction Head	inches	1.5
<b><i>Storage</i></b>		
Thickness also known as Height	inches	Project-specific
Void Ratio	---	0.67
Seepage Rate also known as Conductivity	Inches/hour	Conductivity from the storage layer refers to infiltration from the bottom of the structural BMP into the native soil. This variable is project-specific, see Section G.5.1. Use 0 if the bio-retention cell includes an impermeable liner
Clogging Factor	---	0
<b><i>Underdrain</i></b>		
Flow Coefficient Also known as Drain Coefficient	---	Project-specific
Flow Exponent Also known as Drain Exponent	---	Project-specific, typically 0.5
Offset Height Also known as Drain Offset Height	Inches	Project-specific

**G.1.6 Flow Frequency and Duration**

The continuous simulation model will generate a flow record corresponding to the frequency of the rainfall data input as its output. This flow record must then be processed to determine pre-development and post-project flow rates and durations. Compliance with hydromodification management requirements of this manual is achieved when results for flow duration meet the performance standards. The performance standard is as follows (also presented in Chapter 6 of this manual):

1. For flow rates ranging from 10 percent, 30 percent or 50 percent of the pre-development 2-year runoff event ( $0.1Q_2$ ,  $0.3Q_2$ , or  $0.5Q_2$ ) to the pre-development 10-year runoff event ( $Q_{10}$ ), the post-project discharge rates and durations must not exceed the pre-development rates and

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durations by more than 10 percent. The specific lower flow threshold will depend on the erosion susceptibility of the receiving stream for the project site (see Section 6.3.4).

To demonstrate that a flow control facility meets the hydromodification management performance standard, a flow duration summary must be generated and compared for pre-development and post-project conditions. The following guidelines shall be used for determining flow rates and durations.

### G.1.6.1 Determining Flow Rates from Continuous Hourly Flow Output

Flow rates for hydromodification management studies in San Diego must be based on partial duration series analysis of the continuous hourly flow output. Partial duration series frequency calculations consider multiple storm events in a given year. To construct the partial duration series:

1. Parse the continuous hourly flow data into discrete runoff events. The following separation criteria may be used for separation of flow events: a new discrete event is designated when the flow falls below an artificially low flow value based on a fraction of the contributing watershed area (e.g., 0.002 to 0.005 cfs/acre) for a time period of 24 hours. Project applicants may consider other separation criteria provided the separation interval is not more than 24 hours and the criteria is clearly described in the submittal document.
2. Rank the peak flows from each discrete flow event, and compute the return interval or plotting position for each event.

Readers who are unfamiliar with how to compute the partial-duration series should consult reference books or online resources for additional information. For example, *Hydrology for Engineers*, by Linsley et al, 1982, discusses partial-duration series on pages 373-374 and computing recurrence intervals or plotting positions on page 359. *Handbook of Applied Hydrology*, by Chow, 1964, contains a detailed discussion of flow frequency analysis, including Annual Exceedance, Partial-Duration and Extreme Value series methods, in Chapter 8. The US Geological Survey (USGS) has several hydrologic study reports available online that use partial duration series statistics (see <http://water.usgs.gov/> and [http://water.usgs.gov/osw/bulletin17b/AGU\\_Langbein\\_1949.pdf](http://water.usgs.gov/osw/bulletin17b/AGU_Langbein_1949.pdf)).

Pre-development  $Q_2$  and  $Q_{10}$  shall be determined from the partial duration analysis for the pre-development hourly flow record. Pre-development  $Q_{10}$  is the upper threshold of flow rates to be controlled in the post-project condition. The lower flow threshold is a fraction of the pre-development  $Q_2$  determined based on the erosion susceptibility of the receiving stream. Simply multiply the pre-development  $Q_2$  by the appropriate fraction (e.g.,  $0.1Q_2$ ) to determine the lower flow threshold.

### G.1.6.2 Determining Flow Durations from Continuous Hourly Flow Output

Flow durations must be summarized within the range of flows to control. Flow duration statistics provide a simple summary of how often a particular flow rate is exceeded. To prepare this summary:

1. Rank the entire hourly runoff time series output.

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2. Extract the portion of the ranked hourly time series output from the lower flow threshold to the upper flow threshold – this is the portion of the record to be summarized.
3. Divide the applicable portion of the record into 100 equal flow bins (compute the difference between the upper flow threshold (cfs) and lower flow threshold (cfs) and divide this value by 99 to establish the flow bin size).
4. Count the number of hours of flow that fall into each flow bin.

Both pre-development and post-project flow duration summary must be based on the entire length of the flow record. Compare the post-project flow duration summary to the pre-development flow duration summary to determine if it meets performance criteria for post-project flow rates and durations (criteria presented under Section G.1.6).

## G.2 Sizing Factors for Hydromodification Management BMPs

This section presents sizing factors for design of flow control structural BMPs based on the sizing factor method identified in Chapter 6.3.5.1. The sizing factors included here have been updated based on the requirements in the 2015 MS4 permit and are different than the sizing factors presented in previous manuals. These updated values replace the previous sizing factors which shall no longer be used for sizing of hydromodification flow control BMPs. A discussion of the rationale for the update is included below.

The sizing factors included in previous edition was re-printed from the "San Diego BMP Sizing Calculator Methodology," dated January 2012, prepared by Brown and Caldwell (herein "BMP Sizing Calculator Methodology"). These sizing factors were linked to the specific details and descriptions that were presented in the BMP Sizing Calculator Methodology, which included certain assumptions and limited options for modifications. The sizing factors were developed based on the 2007 MS4 Permit. Some of the original sizing factors developed based on the 2007 MS4 Permit and presented in the BMP Sizing Calculator Methodology were not compatible with new requirements of the 2015 MS4 Permit, and therefore were not included in the February 2016 manual. Since publishing the 2016 Model Manual, the Copermittees have developed updated hydromodification factors that more accurately represent the BMP configurations specified in this model manual and account for the revised flow-duration performance standard of the 2015 MS4 Permit (110% exceedance allowance for entire flow-duration curve).

The updated sizing factors were generated using continuous simulation models in USEPA SWMM in accordance with the procedures, methodologies, and values presented in Appendix G.1. All sizing factors are in relation to the effective impervious area draining to the BMP.

The sizing factor method is intended for simple studies that do not include diversion, do not include significant offsite area draining through the project from upstream, and do not include offsite area downstream of the project area. Use of the sizing factors is limited to the specific structural BMPs described in this Appendix. When using the sizing factor methodology, the area fraction reported in the sizing tables represents the plan view area at the surface of the BMP before any ponding occurs.

Sizing factors are available for the following specific structural BMPs:

- Full infiltration condition:
  - **Infiltration:** sizing factors available for A and B soils represent a below-ground structure (dry well)

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- **Bioretention:** sizing factors available for A and B soils represent a bioretention area with engineered soil media and gravel storage layer, with no underdrain and no impermeable liner
- Partial infiltration condition:
  - **Biofiltration with partial retention:** sizing factors available for C and D soils represent a bioretention area with engineered soil media and gravel storage layer, with an underdrain, with gravel storage below the underdrain, with no impermeable liner
- No infiltration condition:
  - **Biofiltration:** sizing factors available for C and D soils represent a bioretention area with engineered soil media and gravel storage layer, with an underdrain, without gravel storage below the underdrain, with no impermeable liner
  - **Biofiltration (formerly known as "flow-through planter") with impermeable liner:** sizing factors available for C and D soils represent a biofiltration system with engineered soil media and gravel storage layer, with an underdrain, with or without gravel storage below the underdrain, with an impermeable liner
- Other:
  - **Cistern:** sizing factors available for A, B, C, or D soils represent a vessel with a low flow orifice outlet to meet the hydromodification management performance standard.

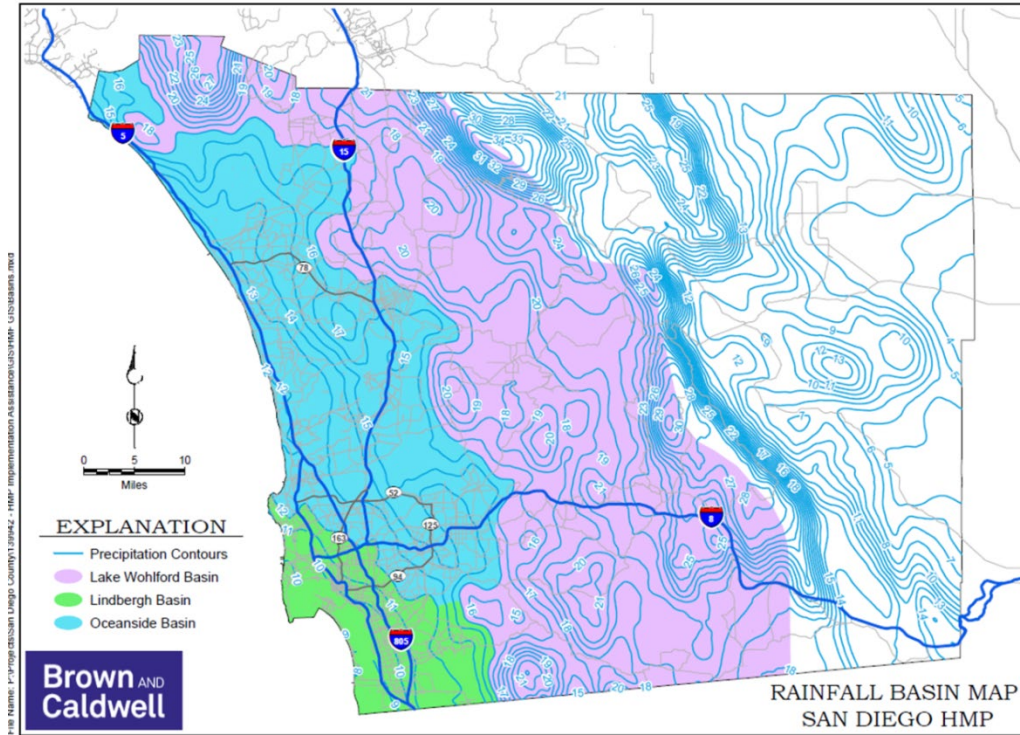
Sizing factors were created based on three rainfall basins: Lindbergh Field, Oceanside, and Lake Wohlford.

### *The following information is needed to use the sizing factors:*

- Determine the appropriate rainfall basin for the project site from Figure G.2-1, Rainfall Basin Map
- Hydrologic soil group at the project site (use available information pertaining to existing underlying soil type such as soil maps published by the Natural Resources Conservation Service)
- Pre-development and post-project slope categories (low = 0% – 5%, moderate = 5% – 15%, steep = >15%)
- Area tributary to the structural BMP
- Area weighted runoff factor (C) for the area draining to the BMP from Table G.2-1. Note: runoff coefficients and adjustments presented in Appendices B.1 and B.2 are for pollutant control only and are not applicable for hydromodification management studies
- Fraction of Q2 to control (see Chapter 6.3.4)

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When using the sizing factor method, Worksheet G.2-1 may be used to present the calculations of the required minimum areas and/or volumes of BMPs as applicable. Additionally, the “BMP Sizing Spreadsheet V3.0” available at [projectcleanwater.org](http://projectcleanwater.org) implements the sizing factor methodology.



**Figure G.2-1: Appropriate Rain Gauge for Project Sites**

**Table G.2-1: Runoff factors for surfaces draining to BMPs for Hydromodification Sizing Factor Method**

Surface	Runoff Factor
Roofs	1.0
Concrete	1.0
Pervious Concrete	0.10
Porous Asphalt	0.10
Grouted Unit Pavers	1.0
Solid Unit Pavers on granular base, min. 3/16 inch joint space	0.20
Crushed Aggregate	0.10
Turf block	0.10
Amended, mulched soils	0.10

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Surface	Runoff Factor
Landscape	0.10

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**Worksheet G.2-1: Sizing Factor Worksheet**

Site Information			
Project Name:		Hydrologic Unit	
Project Applicant:		Rain: Gauge:	
Jurisdiction:		Total Project Area:	
Assessor's Parcel Number :		Low Flow Threshold:	
BMP Name:		BMP Type:	

Areas Draining to BMP						Sizing Factors			Minimum BMP Size		
DMA Name	Area (sf)	Soil Type	Pre-Project Slope	Post Project Surface Type	Runoff Factor (From Table G.2-1)	Surface Area	Surface Volume	Subsurface Volume	Surface Area (sf)	Surface Volume (cf)	Subsurface Volume (cf)
<b>Total DMA Area</b>									<b>Minimum BMP Size*</b>		
									<b>Proposed BMP Size*</b>		

\*Minimum BMP Size = Total of rows above.

\*Proposed BMP Size ≥ Minimum BMP size.

### G.2.1 Unit Runoff Ratios

Table G.2-2 presents unit runoff ratios for calculating pre-development  $Q_2$ , to be used when applicable to determine the lower flow threshold for low flow orifice sizing for biofiltration with partial retention, biofiltration, biofiltration with impermeable liner, or cistern BMPs. There is no low flow orifice in the infiltration BMP or bioretention BMP. The unit runoff ratios are re-printed from the BMP Sizing Calculator methodology. Unit runoff ratios for "urban" and "impervious" cover categories were not transferred to this manual due to the requirement to control runoff to pre-development condition (see Chapter 6.3.3).

*How to use the unit runoff ratios:*

Obtain unit runoff ratio from Table G.2-2 based on the project's rainfall basin, hydrologic soil group, and pre-development slope (for redevelopment projects, pre-development slope may be considered if historic topographic information is available, otherwise use pre-project slope). Multiply the area tributary to the structural BMP (A, acres) by the unit runoff ratio ( $Q_2$ , cfs/acre) to determine the pre-development  $Q_2$  to determine the lower flow threshold, to use for low flow orifice sizing.

**Table G.2-2: Unit Runoff Ratios for Sizing Factor Method**

Unit Runoff Ratios for Sizing Factor Method				
Rain Gauge	Soil	Slope	$Q_2$	$Q_{10}$
			(cfs/acre)	(cfs/ac)
Lake Wohlford	A	Low	0.256	0.518
Lake Wohlford	A	Moderate	0.275	0.528
Lake Wohlford	A	Steep	0.283	0.531
Lake Wohlford	B	Low	0.371	0.624
Lake Wohlford	B	Moderate	0.389	0.631
Lake Wohlford	B	Steep	0.393	0.633
Lake Wohlford	C	Low	0.49	0.729
Lake Wohlford	C	Moderate	0.495	0.733
Lake Wohlford	C	Steep	0.496	0.735
Lake Wohlford	D	Low	0.548	0.784
Lake Wohlford	D	Moderate	0.554	0.788
Lake Wohlford	D	Steep	0.556	0.788
Oceanside	A	Low	0.256	0.679
Oceanside	A	Moderate	0.277	0.694
Oceanside	A	Steep	0.285	0.7
Oceanside	B	Low	0.377	0.875

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Oceanside	B	Moderate	0.391	0.879
Oceanside	B	Steep	0.395	0.881
Oceanside	C	Low	0.488	0.981
Oceanside	C	Moderate	0.497	0.985
Oceanside	C	Steep	0.499	0.986
Oceanside	D	Low	0.571	0.998
Oceanside	D	Moderate	0.575	0.999
Oceanside	D	Steep	0.576	0.999
Lindbergh	A	Low	0.057	0.384
Lindbergh	A	Moderate	0.073	0.399
Lindbergh	A	Steep	0.082	0.403
Lindbergh	B	Low	0.199	0.496
Lindbergh	B	Moderate	0.22	0.509
Lindbergh	B	Steep	0.23	0.513
Lindbergh	C	Low	0.335	0.601
Lindbergh	C	Moderate	0.349	0.61
Lindbergh	C	Steep	0.354	0.613
Lindbergh	D	Low	0.429	0.751
Lindbergh	D	Moderate	0.437	0.753
Lindbergh	D	Steep	0.439	0.753

### G.2.1.1 Low Flow Control Orifice Design

When used as hydromodification flow control BMPs, biofiltration with partial retention, biofiltration, and cistern BMPs include a low flow control orifice to control the rate that flow is released from the underdrain or primary outlet. The sizing factors were developed using a standard process for sizing the low flow control orifice, therefore BMPs designed using the sizing factor method must size the low flow control orifice using the same basis. The low flow control orifice must be designed to release the lower flow threshold flow rate (fraction of pre-development Q<sub>2</sub>) when the water surface elevation in the BMP is equal to the crest elevation of the next outflow structure. To size the low flow control orifice, determine the head on the orifice measured from the bottom of the orifice to the minimum elevation of the next outflow structure of the BMP. The next outflow structure is typically the BMP overflow structure, except in some multi-use BMPs (e.g., BMPs that are designed for flood control in addition to hydromodification management). In this application, the difference between the bottom of the orifice and the centroid of the orifice is small relative to the total head for the calculation and may be neglected in the calculation by measuring from the orifice invert. This calculation is automated in the “BMP Sizing Spreadsheet V3.0” posted on [www.projectcleanwater.org](http://www.projectcleanwater.org).

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### *Steps to size the low flow control orifice:*

- Determine pre-development Q<sub>2</sub> using the unit runoff ratios above.
- Multiply pre-development Q<sub>2</sub> by 0.1 to determine the low flow threshold flow rate. Note sizing factors are only available for streams with high susceptibility to erosion where the low flow threshold is 0.1Q<sub>2</sub>.
- Determine the head (H) on the orifice measured from the bottom of the orifice to the minimum elevation of the next outflow structure of the BMP.
- Use the orifice equation (below) and solve for the maximum orifice area to release the lower flow threshold flow rate.
- Consider how the orifice will be created. Determine the constructible dimension(s) (e.g., a standard drill bit diameter) that will produce an orifice with an area equal to or less than the maximum orifice area. The final orifice area determined based on constructible dimensions shall not exceed the maximum orifice area.

$$Q = C \times A \times (64.4 \times H)^{0.5}$$

Where:

Q = Flow rate in cubic feet per second

C = Orifice coefficient; in this application use C = 0.65

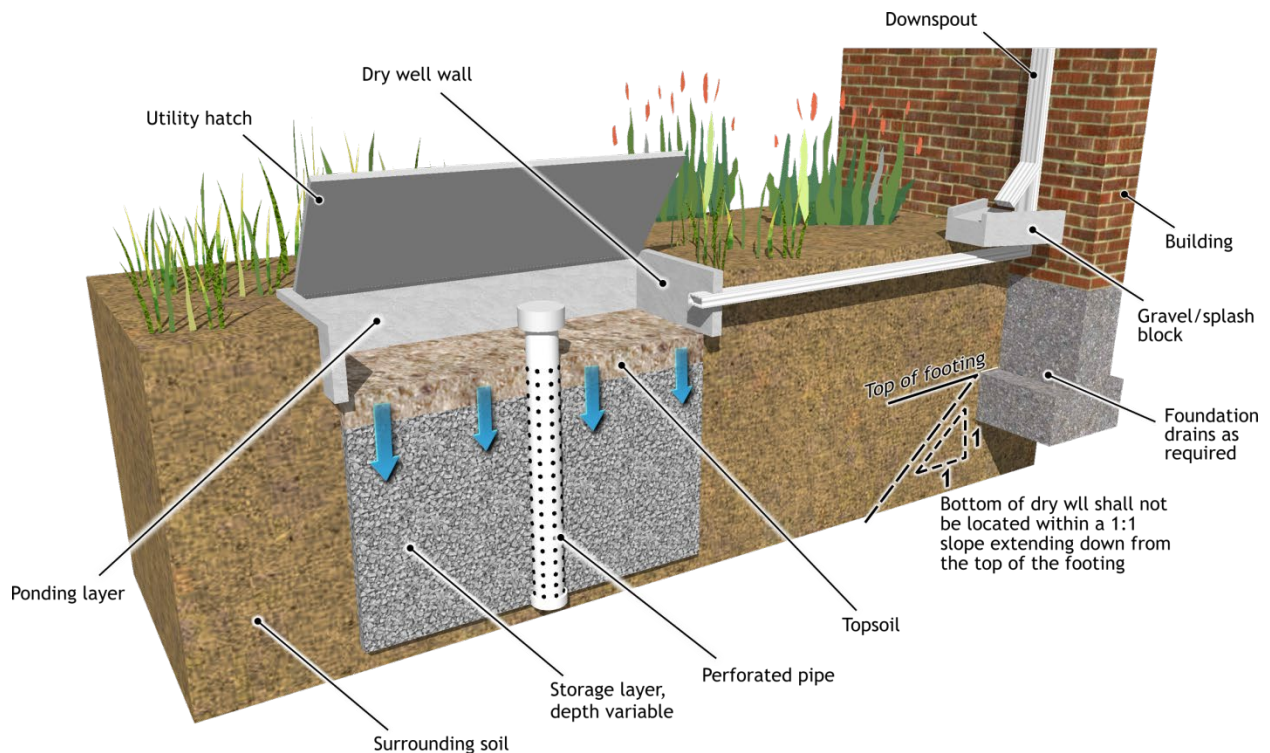
A = Area in square feet

H = Head in feet

## G.2.2 Sizing Factors for "Infiltration" BMP

Table G.2-3 presents sizing factors for calculating the required surface area (A) and volume (V1) for an infiltration BMP. There is no underdrain and therefore no low flow orifice in the infiltration BMP. Sizing factors were developed for hydrologic soil groups A and B only. This BMP is not applicable in hydrologic soil groups C and D. The infiltration BMP is a below-ground structure (dry well) that consists of three layers:

- Ponding layer: a nominal 36-inch ponding layer shall be included below the overflow elevation.
- Design infiltration rate: the design infiltration rate shall be greater than 0.5 inches per hour.
- Overflow structure: San Diego Regional Standard Drawing Type I Catch Basin (D-29). For the purposes of hydromodification flow control other type of overflow structures are allowed.



**Infiltration Facility BMP Example Illustration**

Reference: "San Diego BMP Sizing Calculator Methodology," prepared by Brown and Caldwell, dated January 2012

### *How to use the sizing factors for flow control BMP Sizing:*

Obtain sizing factors from Table G.2-3 based on the project's lower flow threshold fraction of Q2, hydrologic soil group, pre-project slope, and rain gauge (rainfall basin). Multiply the area tributary to

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the structural BMP (A, square feet) by the area weighted runoff factor (C, unitless) (see Table G.2-1) by the sizing factors to determine the required surface area (A, square feet) for the infiltration BMP. The civil engineer shall provide the necessary surface area of the BMP on the plans.

***Additional steps to use this BMP as a combined pollutant control and flow control BMP:***

The BMP sized using the sizing factors in Table G.2-3 meets both pollutant control and flow control requirements.

**Table G.2-3: Sizing Factors for Hydromodification Flow Control Infiltration BMPs Designed Using Sizing Factor Method**

Lower Flow Threshold	Soil Group	Pre-Project Slope	Rain Gauge	A
0.1Q <sub>2</sub>	A	Flat	Lindbergh	0.055
0.1Q <sub>2</sub>	A	Moderate	Lindbergh	0.055
0.1Q <sub>2</sub>	A	Steep	Lindbergh	0.055
0.1Q <sub>2</sub>	B	Flat	Lindbergh	0.045
0.1Q <sub>2</sub>	B	Moderate	Lindbergh	0.045
0.1Q <sub>2</sub>	B	Steep	Lindbergh	0.045
0.1Q <sub>2</sub>	C	Flat	Lindbergh	0.035
0.1Q <sub>2</sub>	C	Moderate	Lindbergh	0.035
0.1Q <sub>2</sub>	C	Steep	Lindbergh	0.035
0.1Q <sub>2</sub>	D	Flat	Lindbergh	0.03
0.1Q <sub>2</sub>	D	Moderate	Lindbergh	0.03
0.1Q <sub>2</sub>	D	Steep	Lindbergh	0.03
0.1Q <sub>2</sub>	A	Flat	Oceanside	0.06
0.1Q <sub>2</sub>	A	Moderate	Oceanside	0.06
0.1Q <sub>2</sub>	A	Steep	Oceanside	0.06
0.1Q <sub>2</sub>	B	Flat	Oceanside	0.05
0.1Q <sub>2</sub>	B	Moderate	Oceanside	0.05
0.1Q <sub>2</sub>	B	Steep	Oceanside	0.05
0.1Q <sub>2</sub>	C	Flat	Oceanside	0.05
0.1Q <sub>2</sub>	C	Moderate	Oceanside	0.05
0.1Q <sub>2</sub>	C	Steep	Oceanside	0.045
0.1Q <sub>2</sub>	D	Flat	Oceanside	0.035
0.1Q <sub>2</sub>	D	Moderate	Oceanside	0.035
0.1Q <sub>2</sub>	D	Steep	Oceanside	0.035
0.1Q <sub>2</sub>	A	Flat	L. Wohlford	0.085
0.1Q <sub>2</sub>	A	Moderate	L. Wohlford	0.085

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Lower Flow Threshold	Soil Group	Pre-Project Slope	Rain Gauge	A
0.1Q <sub>2</sub>	A	Steep	L Wohlford	0.085
0.1Q <sub>2</sub>	B	Flat	L Wohlford	0.07
0.1Q <sub>2</sub>	B	Moderate	L Wohlford	0.07
0.1Q <sub>2</sub>	B	Steep	L Wohlford	0.07
0.1Q <sub>2</sub>	C	Flat	L Wohlford	0.055
0.1Q <sub>2</sub>	C	Moderate	L Wohlford	0.055
0.1Q <sub>2</sub>	C	Steep	L Wohlford	0.055
0.1Q <sub>2</sub>	D	Flat	L Wohlford	0.04
0.1Q <sub>2</sub>	D	Moderate	L Wohlford	0.04
0.1Q <sub>2</sub>	D	Steep	L Wohlford	0.04

Q<sub>2</sub> = 2-year pre-project flow rate based upon partial duration analysis of long-term hourly rainfall records

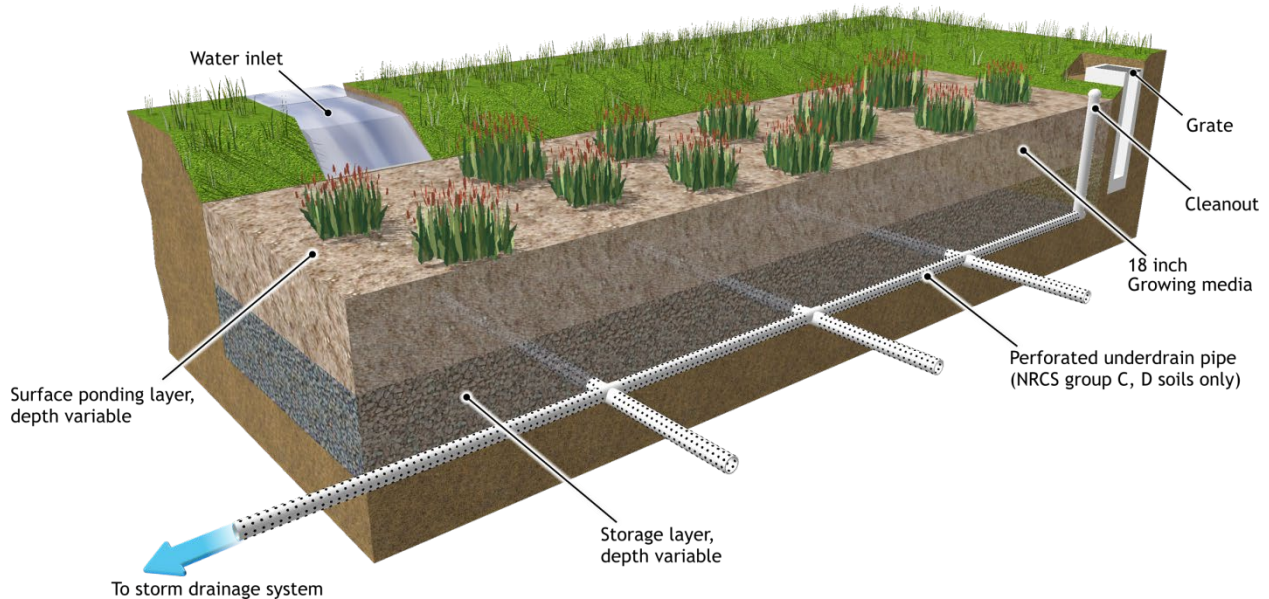
A = Surface area sizing factor for flow control

### G.2.3 Sizing Factors for Biofiltration with Partial Retention and Biofiltration

Table G.2-5 presents sizing factors for calculating the required surface area (A), surface volume (V1), and sub-surface volume (V2) for a biofiltration with partial retention and biofiltration BMP. The BMPs consist of three layers:

- Ponding layer: 12-inches active storage, [minimum] 2-inches of freeboard above overflow relief
- Media layer: 18-inches of soil [biofiltration soil media]
- Filter Course: 6-inches
- Storage layer: 12-inches of gravel at 40 percent porosity. The underdrain offset shall be 3-inches.
- Overflow structure: San Diego Regional Standard Drawing Type I Catch Basin (D-29). For the purposes of hydromodification flow control other type of overflow structures are allowed.

This BMP includes an impermeable liner to prevent infiltration into underlying soils.



**Biofiltration BMP Example Illustration**

Reference: "San Diego BMP Sizing Calculator Methodology," prepared by Brown and Caldwell, dated January 2012

***How to use the sizing factors for flow control BMP Sizing:***

Obtain sizing factors from Table G.2-4 based on the project's lower flow threshold fraction of Q2,

## Appendix G: Guidance for Continuous Simulation and Hydromodification Management Sizing Factors

hydrologic soil group, pre-project slope, and rain gauge (rainfall basin). Multiply the area tributary to the structural BMP (A, square feet) by the area weighted runoff factor (C, unitless) (see Table G.2-1) by the sizing factors to determine the required surface area (A, square feet). Select a low flow control orifice for the underdrain that will discharge the lower flow threshold flow at the overflow riser elevation. Standard head (H) for this calculation (based on the standard detail) is 3.75 feet for all soil groups. The civil engineer shall provide the necessary surface area of the BMP and the underdrain and orifice detail on the plans.

### *Additional steps to use this BMP as a combined pollutant control and flow control BMP:*

The BMP sized using the sizing factors in Table G.2-4 meets both pollutant control and flow control requirements.

**Table G.2-4: Sizing Factors for Hydromodification Flow Control Biofiltration with Partial Retention and Biofiltration BMPs Designed Using Sizing Factor Method**

Lower Flow Threshold	Soil Group	Pre-Project Slope	Rain Gauge	A	Aggregate Below Orifice Invert
0.1Q <sub>2</sub>	A	Flat	Lindbergh	0.08	18
0.1Q <sub>2</sub>	A	Moderate	Lindbergh	0.08	18
0.1Q <sub>2</sub>	A	Steep	Lindbergh	0.08	18
0.1Q <sub>2</sub>	B	Flat	Lindbergh	0.065	18
0.1Q <sub>2</sub>	B	Moderate	Lindbergh	0.065	18
0.1Q <sub>2</sub>	B	Steep	Lindbergh	0.06	18
0.1Q <sub>2</sub>	C	Flat	Lindbergh	0.05	6
0.1Q <sub>2</sub>	C	Moderate	Lindbergh	0.05	6
0.1Q <sub>2</sub>	C	Steep	Lindbergh	0.05	6
0.1Q <sub>2</sub>	D	Flat	Lindbergh	0.05	3
0.1Q <sub>2</sub>	D	Moderate	Lindbergh	0.05	3
0.1Q <sub>2</sub>	D	Steep	Lindbergh	0.05	3
0.1Q <sub>2</sub>	A	Flat	Oceanside	0.08	18
0.1Q <sub>2</sub>	A	Moderate	Oceanside	0.075	18
0.1Q <sub>2</sub>	A	Steep	Oceanside	0.075	18
0.1Q <sub>2</sub>	B	Flat	Oceanside	0.07	18
0.1Q <sub>2</sub>	B	Moderate	Oceanside	0.07	18
0.1Q <sub>2</sub>	B	Steep	Oceanside	0.07	18
0.1Q <sub>2</sub>	C	Flat	Oceanside	0.07	6
0.1Q <sub>2</sub>	C	Moderate	Oceanside	0.07	6
0.1Q <sub>2</sub>	C	Steep	Oceanside	0.07	6

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Lower Flow Threshold	Soil Group	Pre-Project Slope	Rain Gauge	A	Aggregate Below Orifice Invert
0.1Q <sub>2</sub>	D	Flat	Oceanside	0.07	3
0.1Q <sub>2</sub>	D	Moderate	Oceanside	0.07	3
0.1Q <sub>2</sub>	D	Steep	Oceanside	0.07	3
0.1Q <sub>2</sub>	A	Flat	L Wohlford	0.11	18
0.1Q <sub>2</sub>	A	Moderate	L Wohlford	0.11	18
0.1Q <sub>2</sub>	A	Steep	L Wohlford	0.105	18
0.1Q <sub>2</sub>	B	Flat	L Wohlford	0.09	18
0.1Q <sub>2</sub>	B	Moderate	L Wohlford	0.085	18
0.1Q <sub>2</sub>	B	Steep	L Wohlford	0.085	18
0.1Q <sub>2</sub>	C	Flat	L Wohlford	0.065	6
0.1Q <sub>2</sub>	C	Moderate	L Wohlford	0.065	6
0.1Q <sub>2</sub>	C	Steep	L Wohlford	0.065	6
0.1Q <sub>2</sub>	D	Flat	L Wohlford	0.06	3
0.1Q <sub>2</sub>	D	Moderate	L Wohlford	0.06	3
0.1Q <sub>2</sub>	D	Steep	L Wohlford	0.06	3

Q<sub>2</sub> = 2-year pre-project flow rate based upon partial duration analysis of long-term hourly rainfall records

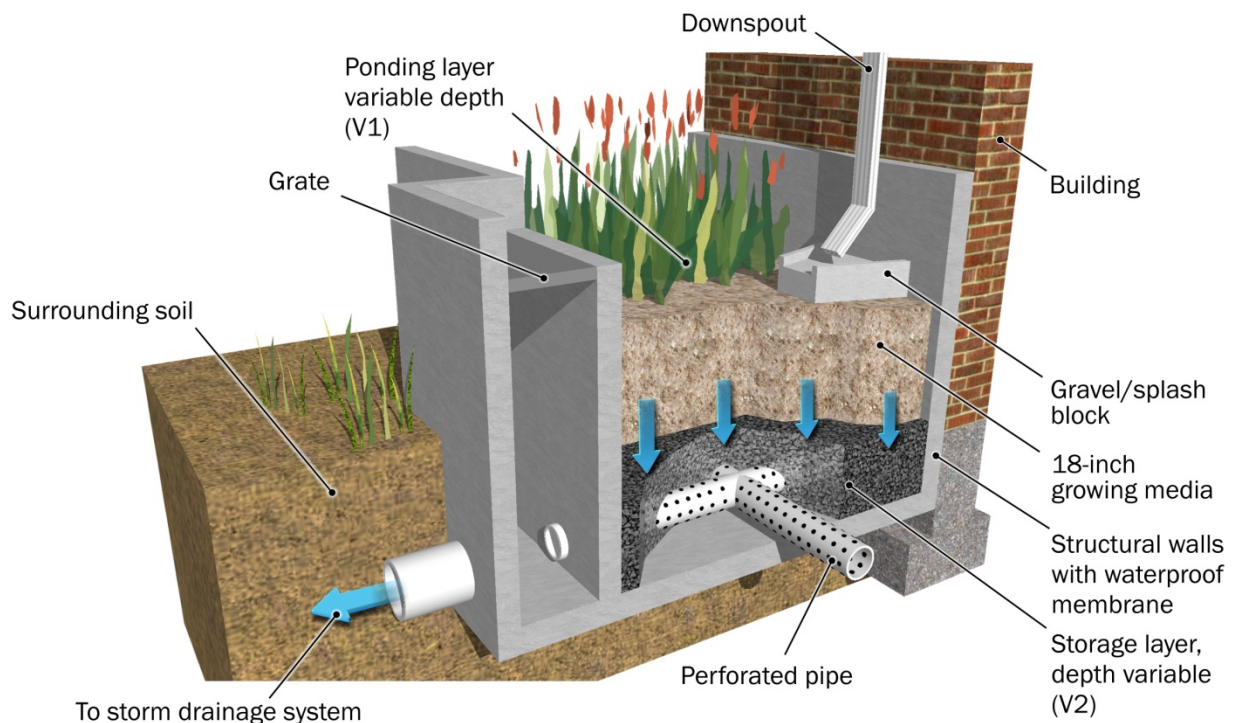
A = Surface area sizing factor for flow control

### G.2.4 Sizing Factors for Biofiltration

Table G.2-6 presents sizing factors for calculating the required surface area (A), surface volume (V1), and sub-surface volume (V2) for a biofiltration BMP with impermeable liner (formerly known as flow-through planter). The BMP consists of four layers:

- Ponding layer: 12-inches active storage, [minimum] 2-inches of freeboard above overflow relief
- Media layer: 18-inches of soil [biofiltration soil media]
- Filter Course: 6-inches
- Storage layer: 12-inches of gravel at 40 percent porosity. The underdrain offset shall be 3-inches.
- Overflow structure: San Diego Regional Standard Drawing Type I Catch Basin (D-29). For the purposes of hydromodification flow control other type of overflow structures are allowed.

This BMP includes an underdrain with a low flow orifice 18 inches (1.5 feet) below the bottom of the growing medium. This BMP includes an impermeable liner to prevent infiltration into underlying soils.



Biofiltration BMP Example Illustration

## Appendix G: Guidance for Continuous Simulation and Hydromodification Management Sizing Factors

Reference: "San Diego BMP Sizing Calculator Methodology," prepared by Brown and Caldwell, dated January 2012

### *How to use the sizing factors for flow control BMP Sizing:*

Obtain sizing factors from Table G.2-5 based on the project's lower flow threshold fraction of Q<sub>2</sub>, hydrologic soil group, pre-project slope, and rain gauge (rainfall basin). Multiply the area tributary to the structural BMP (A, square feet) by the area weighted runoff factor (C, unitless) (see Table G.2-1) by the sizing factors to determine the required surface area (A, square feet). Select a low flow control orifice for the underdrain that will discharge the lower flow threshold flow at the overflow riser elevation. Standard head (H) for this calculation (based on the standard detail) is 3.75 feet for all soil groups. The civil engineer shall provide the necessary surface area of the BMP and the underdrain and orifice detail on the plans.

### *Additional steps to use this BMP as a combined pollutant control and flow control BMP:*

The BMP sized using the sizing factors in Table G.2-5 meets both pollutant control and flow control requirements except for surface drawdown requirements. Applicant must perform surface drawdown calculations and if needed develop a vector management plan (Refer to Section 6.3.7) or revise the BMP design to meet the drawdown requirements. If changes are made to the BMP design applicants must perform site specific continuous simulation modeling (Refer to Appendix G).

**Table G.2-5: Sizing Factors for Hydromodification Flow Control Biofiltration BMPs (formerly known as Flow-Through Planters) Designed Using Sizing Factor Method**

Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A
0.1Q <sub>2</sub>	A	Flat	Lindbergh	0.320
0.1Q <sub>2</sub>	A	Moderate	Lindbergh	0.300
0.1Q <sub>2</sub>	A	Steep	Lindbergh	0.285
0.1Q <sub>2</sub>	B	Flat	Lindbergh	0.105
0.1Q <sub>2</sub>	B	Moderate	Lindbergh	0.100
0.1Q <sub>2</sub>	B	Steep	Lindbergh	0.095
0.1Q <sub>2</sub>	C	Flat	Lindbergh	0.055
0.1Q <sub>2</sub>	C	Moderate	Lindbergh	0.050
0.1Q <sub>2</sub>	C	Steep	Lindbergh	0.050
0.1Q <sub>2</sub>	D	Flat	Lindbergh	0.050
0.1Q <sub>2</sub>	D	Moderate	Lindbergh	0.050
0.1Q <sub>2</sub>	D	Steep	Lindbergh	0.050
0.1Q <sub>2</sub>	A	Flat	Oceanside	0.150
0.1Q <sub>2</sub>	A	Moderate	Oceanside	0.140

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Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A
0.1Q <sub>2</sub>	A	Steep	Oceanside	0.135
0.1Q <sub>2</sub>	B	Flat	Oceanside	0.085
0.1Q <sub>2</sub>	B	Moderate	Oceanside	0.085
0.1Q <sub>2</sub>	B	Steep	Oceanside	0.085
0.1Q <sub>2</sub>	C	Flat	Oceanside	0.075
0.1Q <sub>2</sub>	C	Moderate	Oceanside	0.075
0.1Q <sub>2</sub>	C	Steep	Oceanside	0.075
0.1Q <sub>2</sub>	D	Flat	Oceanside	0.070
0.1Q <sub>2</sub>	D	Moderate	Oceanside	0.070
0.1Q <sub>2</sub>	D	Steep	Oceanside	0.070
0.1Q <sub>2</sub>	A	Flat	L Wohlford	0.285
0.1Q <sub>2</sub>	A	Moderate	L Wohlford	0.275
0.1Q <sub>2</sub>	A	Steep	L Wohlford	0.270
0.1Q <sub>2</sub>	B	Flat	L Wohlford	0.150
0.1Q <sub>2</sub>	B	Moderate	L Wohlford	0.145
0.1Q <sub>2</sub>	B	Steep	L Wohlford	0.145
0.1Q <sub>2</sub>	C	Flat	L Wohlford	0.070
0.1Q <sub>2</sub>	C	Moderate	L Wohlford	0.070
0.1Q <sub>2</sub>	C	Steep	L Wohlford	0.070
0.1Q <sub>2</sub>	D	Flat	L Wohlford	0.060
0.1Q <sub>2</sub>	D	Moderate	L Wohlford	0.060
0.1Q <sub>2</sub>	D	Steep	L Wohlford	0.060

Q<sub>2</sub> = 2-year pre-project flow rate based upon partial duration analysis of long-term hourly rainfall records

A = Surface area sizing factor for flow control

### G.2.5 Sizing Factors for "Cistern" BMP

Table G.2-6 presents sizing factors for calculating the required volume ( $V_1$ ) for a cistern BMP. In this context, a "cistern" is a detention facility that stores runoff and releases it at a controlled rate. A cistern can be a component of a harvest and use system, however the sizing factor method will not account for any retention occurring in the system. The sizing factors were developed assuming runoff is released from the cistern. The sizing factors presented in this section are to meet the hydromodification management performance standard only. The cistern BMP is based on the following assumptions:

- Cistern configuration: The cistern is modeled as a 4-foot tall vessel. However, designers could use other configurations (different cistern heights), as long as the lower outlet orifice is sized to properly restrict outflows and the minimum required volume is provided.
- Cistern upper outlet: The upper outlet from the cistern would consist of a weir or other flow control structure with the overflow invert set at an elevation of  $7/8$  of the water height associated with the required volume of the cistern –  $V$ . For the assumed 4-foot water depth in the cistern associated with the sizing factor analysis, the overflow invert is assumed to be located at an elevation of 3.5 feet above the bottom of the cistern. The overflow weir would be sized to pass the peak design flow based on the tributary drainage area.

#### *How to use the sizing factors:*

Obtain sizing factors from Table G.2-6 based on the project's lower flow threshold fraction of  $Q_2$ , hydrologic soil group, pre-development slope, and rain gauge (rainfall basin). Multiply the area tributary to the structural BMP ( $A$ , square feet) by the area weighted runoff factor ( $C$ , unitless) (see Table G.2-1) by the sizing factors to determine the required volume ( $V_1$ , cubic feet). Select a low flow orifice that will discharge the lower flow threshold flow when there is 3.5 feet of head over the lower outlet orifice (or adjusted head as appropriate if the cistern configuration is not 4 feet tall). The civil engineer shall provide the necessary volume of the BMP and the lower outlet orifice detail on the plans.

#### **Additional steps to use this BMP as a combined pollutant control and flow control BMP:**

A cistern could be a component of a full retention, partial retention, or no retention BMP depending on how the outflow is disposed. However use of the sizing factor method for design of the cistern in a combined pollutant control and flow control system is not recommended. The sizing factor method for designing a cistern does not account for any retention or storage occurring in BMPs combined with the cistern (i.e., cistern sized using sizing factors may be larger than necessary because sizing factor method does not recognize volume losses occurring in other elements of a combined system). Furthermore when the cistern is designed using the sizing factor method, the cistern outflow must be set to the low flow threshold flow for the drainage area, which may be inconsistent with requirements for other elements of a combined system. To optimize a system in which a cistern provides temporary

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storage for runoff to be either used onsite (harvest and use), infiltrated, or biofiltered, project-specific continuous simulation modeling is recommended. Refer to Sections 5.6 and 6.3.6.

**Table G.2-6: Sizing Factors for Hydromodification Flow Control Cistern Facilities Designed Using Sizing Factor Method**

Lower Flow Threshold	Soil Group	Slope	Rain Gauge	V
0.1Q <sub>2</sub>	A	Flat	Lindbergh	0.54
0.1Q <sub>2</sub>	A	Moderate	Lindbergh	0.51
0.1Q <sub>2</sub>	A	Steep	Lindbergh	0.49
0.1Q <sub>2</sub>	B	Flat	Lindbergh	0.19
0.1Q <sub>2</sub>	B	Moderate	Lindbergh	0.18
0.1Q <sub>2</sub>	B	Steep	Lindbergh	0.18
0.1Q <sub>2</sub>	C	Flat	Lindbergh	0.11
0.1Q <sub>2</sub>	C	Moderate	Lindbergh	0.11
0.1Q <sub>2</sub>	C	Steep	Lindbergh	0.11
0.1Q <sub>2</sub>	D	Flat	Lindbergh	0.09
0.1Q <sub>2</sub>	D	Moderate	Lindbergh	0.09
0.1Q <sub>2</sub>	D	Steep	Lindbergh	0.09
0.1Q <sub>2</sub>	A	Flat	Oceanside	0.26
0.1Q <sub>2</sub>	A	Moderate	Oceanside	0.25
0.1Q <sub>2</sub>	A	Steep	Oceanside	0.25
0.1Q <sub>2</sub>	B	Flat	Oceanside	0.16
0.1Q <sub>2</sub>	B	Moderate	Oceanside	0.16
0.1Q <sub>2</sub>	B	Steep	Oceanside	0.16
0.1Q <sub>2</sub>	C	Flat	Oceanside	0.14
0.1Q <sub>2</sub>	C	Moderate	Oceanside	0.14
0.1Q <sub>2</sub>	C	Steep	Oceanside	0.14
0.1Q <sub>2</sub>	D	Flat	Oceanside	0.12
0.1Q <sub>2</sub>	D	Moderate	Oceanside	0.12
0.1Q <sub>2</sub>	D	Steep	Oceanside	0.12
0.1Q <sub>2</sub>	A	Flat	L Wohlford	0.53
0.1Q <sub>2</sub>	A	Moderate	L Wohlford	0.49
0.1Q <sub>2</sub>	A	Steep	L Wohlford	0.49
0.1Q <sub>2</sub>	B	Flat	L Wohlford	0.28
0.1Q <sub>2</sub>	B	Moderate	L Wohlford	0.28
0.1Q <sub>2</sub>	B	Steep	L Wohlford	0.28
0.1Q <sub>2</sub>	C	Flat	L Wohlford	0.14

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Lower Flow Threshold	Soil Group	Slope	Rain Gauge	V
0.1Q <sub>2</sub>	C	Moderate	L Wohlford	0.14
0.1Q <sub>2</sub>	C	Steep	L Wohlford	0.14
0.1Q <sub>2</sub>	D	Flat	L Wohlford	0.12
0.1Q <sub>2</sub>	D	Moderate	L Wohlford	0.12
0.1Q <sub>2</sub>	D	Steep	L Wohlford	0.12

Q<sub>2</sub> = 2-year pre-project flow rate based upon partial duration analysis of long-term hourly rainfall records  
V = Cistern volume sizing factor

**Appendix**

**H**

**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

# **Guidance for Investigating Potential Critical Coarse Sediment Yield Areas**

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January 2022

# Appendix H Guidance for Investigating Potential Critical Coarse Sediment Yield Areas

## Introduction

Identification of potential critical coarse sediment yield areas for San Diego County has been prepared based on GLU analysis. Criteria for the GLU analysis were developed and documented in the "San Diego County Regional WMAA" (herein "Regional WMAA"). Regional-level mapping of potential critical coarse sediment yield areas was prepared using regional data sets and included in the Regional WMAA. The original Regional WMAA document can be found on the Project Clean Water website at the following address:

[https://projectcleanwater.org/download/cosd\\_wmaa/](https://projectcleanwater.org/download/cosd_wmaa/)

The regional-level mapping was distributed to WQIP preparers to incorporate into the WMAA attachment to the WQIP for all watersheds in San Diego County. The regional-level mapping is based on the following sources:

Dataset	Source	Year	Description
Elevation	USGS	2013	1/3 <sup>rd</sup> Arc Second (~10 meter cells) digital elevation model for San Diego County
Land Cover	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS
Geology	Kennedy, M.P., and Tan, S.S.	2002	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale.
	Kennedy, M.P., and Tan, S.S.	2008	Geologic Map of the San Diego 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 3, 1:100,000 scale.
	Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle, Southern California, United States Geological Survey, Southern California Areal Mapping Project, Open File Report 2004-1361, 1:100,000 scale.
	Jennings et al.	2010	"Geologic Map of California," California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale

## **Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

The regional data set is a function of the inherent data resolution of the macro-level data sets and may not conform to all site conditions, or does not reflect changes to particular areas that have occurred since the underlying data was developed. This means slopes, geology, or land cover at the project site can be mischaracterized in the regional data set. This Appendix presents criteria for the GLU analysis, excerpted from the Regional WMAA, to be used when detailed project-level investigation of GLUs onsite is needed.

A project applicant should first check the map included in the WMAA for the watershed in which the project resides to determine if potential critical coarse sediment yield areas may exist within the project drainage boundaries (i.e., within or draining through the project). Generally, if the WMAA map does not indicate potential critical coarse sediment yield areas may exist within the project drainage boundaries, no further analysis is necessary. However, the City Engineer has the discretion to require additional project-level investigation even when the WMAA map does not indicate the presence of potential critical coarse sediment yield areas within the project site.

If the project is shown to impact potential critical coarse sediment yield areas based on the WMAA map, or if the City Engineer requires, project-level GLU analysis can be performed (see Section 6.2.1). Project-level GLU analysis will either confirm or invalidate the finding of the Regional WMAA maps. For project-level GLU analysis, the civil engineer shall determine slopes, geology, and land cover categories existing at the project site, and intersect this data to determine GLUs existing at the project site. The data provided in H.1 will assist the civil engineer to characterize the site.

When it has been determined based on the GLU analysis that potential critical coarse sediment yield areas are present within the project boundary, and it has been determined that downstream systems require protection (see Section 6.2.2), additional analysis may be performed that may refine the extents of actual critical coarse sediment yield areas to be protected onsite (see Section 6.2.3). Procedures for additional analysis are provided in H.2.

## H.1 Criteria for GLU Analysis

There are four slope categories in the GLU analysis. Category numbers shown (1 to 4) were assigned for the purpose of GIS processing.

- 0% to 10% (1)
- 10% to 20% (2)
- 20% to 40% (3)
- >40% (4)

There are seven geology categories in the GLU analysis:

- Coarse bedrock (CB)
- Coarse sedimentary impermeable (CSI)
- Coarse sedimentary permeable (CSP)
- Fine bedrock (FB)
- Fine sedimentary impermeable (FSI)
- Fine sedimentary permeable (FSP)
- Other (O)

There are six land cover categories in the GLU analysis:

- Agriculture/grass
- Forest
- Developed
- Scrub/shrub
- Other
- Unknown

Project site slopes shall be classified into the categories based on project-level topography. Project site geology may be determined from geologic maps (may be the same as regional-level information) or classified in the field by a qualified geologist. Table H-1.1 provides information to classify geologic map units into each geology category. Project site land cover shall be determined from aerial photography and/or field visit. For reference, Table H-1.2 provides information to classify land cover categories from the SanGIS Ecology-Vegetation data set into land cover categories. The civil engineer shall not rely on the SanGIS Ecology-Vegetation data set to identify actual land cover at the project site (for project-level investigation land cover must be confirmed by aerial photo or field visit). Intersect the geologic categories, land cover categories, and slope categories within the project

## **Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

boundary to create GLUs. The GLUs listed in Table H-1.3 (also shown in Table 6-1) are considered to be potential critical coarse sediment yield areas. Note the GLU nomenclature is presented in the following format: Geology – Land Cover – Slope Category (e.g., "CB-Agricultural/Grass-3" for a GLU consisting of coarse bedrock geology, agricultural/grass land cover, and 20% to 40% slope).

## Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas

**Table H.1-1: Geologic Grouping for Different Map Units**

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
gr-m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
grMz	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Jcr	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Jhc	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Jsp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ka	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kbm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kbp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcc	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcm	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kdl	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgbf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgdf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgh	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm1	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm2	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm3	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm4	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgr	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgu	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Khg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ki	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kis	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kjd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
KJem	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
KJld	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB

**Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

<b>Map Unit</b>	<b>Map Name</b>	<b>Anticipated Grain size of Weathered Material</b>	<b>Bedrock or Sedimentary</b>	<b>Impermeable/ Permeable</b>	<b>Geology Grouping</b>
Kjv	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klb	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klh	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Km	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmgs	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kpa	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kpv	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kqbd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Krm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Krr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kt	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ktr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kvc	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwsr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Mzd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzq	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzs	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
sch	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Kp	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ql	El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
QTf	El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Ec	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
K	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
Kccg	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Kcs	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI

**Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

<b>Map Unit</b>	<b>Map Name</b>	<b>Anticipated Grain size of Weathered Material</b>	<b>Bedrock or Sedimentary</b>	<b>Impermeable/ Permeable</b>	<b>Geology Grouping</b>
Kl	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Ku	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
Qvof	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmsc	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmss	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tp	San Diego & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tpm	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsc	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tscu	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsd	San Diego & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsdcg	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsdss	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsm	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tso	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tst	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tt	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tta	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmv	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsi	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa11	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa12	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa13	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoc	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop1	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI

**Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

<b>Map Unit</b>	<b>Map Name</b>	<b>Anticipated Grain size of Weathered Material</b>	<b>Bedrock or Sedimentary</b>	<b>Impermeable/ Permeable</b>	<b>Geology Grouping</b>
Qvop10	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop11	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop11a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop12	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop13	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop2	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop3	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop4	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop5	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop6	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsa	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qof	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof2	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Q	Jennings; CA	Coarse	Sedimentary	Permeable	CSP
Qa	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qd	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qf	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qmb	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP

**Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

<b>Map Unit</b>	<b>Map Name</b>	<b>Anticipated Grain size of Weathered Material</b>	<b>Bedrock or Sedimentary</b>	<b>Impermeable/ Permeable</b>	<b>Geology Grouping</b>
Qw	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyf	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qt	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa1-2	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa2-6	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa5	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa6	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa7	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoc	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qc	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qu	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop2-4	San Diego 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop3	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop4	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop6	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qya	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyc	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Mzu	San Diego & Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
gb	Jennings; CA	Fine	Bedrock	Impermeable	FB
JTRm	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kat	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kc	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgb	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
KJvs	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kmv	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Ksp	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB

**Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

<b>Map Unit</b>	<b>Map Name</b>	<b>Anticipated Grain size of Weathered Material</b>	<b>Bedrock or Sedimentary</b>	<b>Impermeable/ Permeable</b>	<b>Geology Grouping</b>
Kvsp	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kwmt	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Qv	Jennings; CA	Fine	Bedrock	Impermeable	FB
Tba	San Diego 30' x 60'	Fine	Bedrock	Impermeable	FB
Tda	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Tv	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Tvsr	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgdfg	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Ta	San Diego 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tcs	Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Td	San Diego & Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Td+Tf	San Diego 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qls	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tm	Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tf	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tfr	El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
To	San Diego & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qpe	San Diego & Oceanside 30' x 60'	Fine	Sedimentary	Permeable	FSP
Mexico	San Diego 30' x 60'	NA	NA	Permeable	Other
Kuo	San Diego 30' x 60'	NA (Offshore)	NA	Permeable	Other
Teo	San Diego & Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Tmo	Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Qmo	San Diego 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
QTso	San Diego 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
af	San Diego & Oceanside 30' x 60'	Variable, dependent on source material	Sedimentary		Other

## Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas

**Table H.1-2: Land Cover Grouping for SanGIS Ecology-Vegetation Data Set**

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
1	42000 Valley and Foothill Grassland	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Agricultural/Grass
2	42100 Native Grassland		Agricultural/Grass
3	42110 Valley Needlegrass Grassland		Agricultural/Grass
4	42120 Valley Sacaton Grassland		Agricultural/Grass
5	42200 Non-Native Grassland	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Agricultural/Grass
6	42300 Wildflower Field		Agriculture/Grass
7	42400 Foothill/Mountain Perennial Grassland		Agriculture/Grass
8	42470 Transmontane Dropseed Grassland		Agriculture/Grass
9	45000 Meadow and Seep		Agriculture/Grass
10	45100 Montane Meadow		Agriculture/Grass
11	45110 Wet Montane Meadow		Agriculture/Grass
12	45120 Dry Montane Meadows		Agriculture/Grass
13	45300 Alkali Meadows and Seeps		Agriculture/Grass
14	45320 Alkali Seep		Agriculture/Grass
15	45400 Freshwater Seep		Agriculture/Grass
16	46000 Alkali Playa Community		Agriculture/Grass
17	46100 Badlands/Mudhill Forbs		Agriculture/Grass
18	Non-Native Grassland		Agriculture/Grass
19	18000 General Agriculture	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Agriculture/Grass
20	18100 Orchards and Vineyards		Agriculture/Grass
21	18200 Intensive Agriculture		Agriculture/Grass
22	18200 Intensive Agriculture - Dairies, Nurseries, Chicken Ranches		Agriculture/Grass
23	18300 Extensive Agriculture - Field/Pasture, Row Crops		Agriculture/Grass
24	18310 Field/Pasture		Agriculture/Grass
25	18310 Pasture		Agriculture/Grass
26	18320 Row Crops		Agriculture/Grass
27	12000 Urban/Developed	Developed	Developed
28	12000 Urban/Developed		Developed
29	81100 Mixed Evergreen Forest	Forest	Forest
30	81300 Oak Forest		Forest
31	81310 Coast Live Oak Forest		Forest
32	81320 Canyon Live Oak Forest		Forest
33	81340 Black Oak Forest		Forest

**Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

<b>Id</b>	<b>SanGIS Legend</b>	<b>SanGIS Grouping</b>	<b>Land Cover Grouping</b>
34	83140 Torrey Pine Forest		Forest
35	83230 Southern Interior Cypress Forest		Forest
36	84000 Lower Montane Coniferous Forest		Forest
37	84100 Coast Range, Klamath and Peninsular Coniferous Forest		Forest
38	84140 Coulter Pine Forest	Forest	Forest
39	84150 Bigcone Spruce (Bigcone Douglas Fir)-Canyon Oak Forest		Forest
40	84230 Sierran Mixed Coniferous Forest		Forest
41	84500 Mixed Oak/Coniferous/Bigcone/Coulter		Forest
42	85100 Jeffrey Pine Forest		Forest
43	11100 Eucalyptus Woodland		Non-Native Vegetation, Developed Areas, or Unvegetated Habitat
44	60000 RIPARIAN AND BOTTOMLAND HABITAT	Riparian and Bottomland Habitat	Forest
45	61000 Riparian Forests		Forest
46	61300 Southern Riparian Forest		Forest
47	61310 Southern Coast Live Oak Riparian Forest		Forest
48	61320 Southern Arroyo Willow Riparian Forest		Forest
49	61330 Southern Cottonwood-willow Riparian Forest		Forest
50	61510 White Alder Riparian Forest		Forest
51	61810 Sonoran Cottonwood-willow Riparian Forest		Forest
52	61820 Mesquite Bosque		Forest
53	62000 Riparian Woodlands		Forest
54	62200 Desert Dry Wash Woodland		Forest
55	62300 Desert Fan Palm Oasis Woodland		Forest
56	62400 Southern Sycamore-alder Riparian Woodland		Forest
57	70000 WOODLAND	Woodland	Forest
58	71000 Cismontane Woodland		Forest

**Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

<b>Id</b>	<b>SanGIS Legend</b>	<b>SanGIS Grouping</b>	<b>Land Cover Grouping</b>	
59	71100 Oak Woodland		Forest	
60	71120 Black Oak Woodland		Forest	
61	71160 Coast Live Oak Woodland		Forest	
62	71161 Open Coast Live Oak Woodland		Forest	
63	71162 Dense Coast Live Oak Woodland		Forest	
64	71162 Dense Coast Love Oak Woodland		Forest	
65	71180 Engelmann Oak Woodland		Woodland	Forest
66	71181 Open Engelmann Oak Woodland			Forest
67	71182 Dense Engelmann Oak Woodland	Forest		
68	72300 Peninsular Pinon and Juniper Woodlands	Forest		
69	72310 Peninsular Pinon Woodland	Forest		
70	72320 Peninsular Juniper Woodland and Scrub	Forest		
71	75100 Elephant Tree Woodland	Forest		
72	77000 Mixed Oak Woodland	Forest		
73	78000 Undifferentiated Open Woodland	Forest		
74	79000 Undifferentiated Dense Woodland	Forest		
75	Engelmann Oak Woodland	Forest		
76	52120 Southern Coastal Salt Marsh	Bog and Marsh		Other
77	52300 Alkali Marsh			Other
78	52310 Cismontane Alkali Marsh			Other
79	52400 Freshwater Marsh			Other
80	52410 Coastal and Valley Freshwater Marsh		Other	
81	52420 Transmontane Freshwater Marsh		Other	
82	52440 Emergent Wetland		Other	
83	44000 Vernal Pool	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Other	
84	44320 San Diego Mesa Vernal Pool		Other	
85	44322 San Diego Mesa Claypan Vernal Pool (southern mesas)		Other	
86	13100 Open Water		Other	

**Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

<b>Id</b>	<b>SanGIS Legend</b>	<b>SanGIS Grouping</b>	<b>Land Cover Grouping</b>
87	13110 Marine	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Other
88	13111 Subtidal		Other
89	13112 Intertidal		Other
90	13121 Deep Bay		Other
91	13122 Intermediate Bay		Other
92	13123 Shallow Bay		Other
93	13130 Estuarine		Other
94	13131 Subtidal		Other
95	13133 Brackishwater		Other
96	13140 Freshwater		Non-Native Vegetation, Developed Areas, or Unvegetated Habitat
97	13200 Non-Vegetated Channel, Floodway, Lakeshore Fringe	Other	
98	13300 Saltpan/Mudflats	Other	
99	13400 Beach	Other	
100	21230 Southern Foredunes	Dune Community	Scrub/Shrub
101	22100 Active Desert Dunes		Scrub/Shrub
102	22300 Stabilized and Partially-Stabilized Desert Sand Field		Scrub/Shrub
103	24000 Stabilized Alkaline Dunes		Scrub/Shrub
104	29000 ACACIA SCRUB		Scrub/Shrub
105	63000 Riparian Scrubs	Riparian and Bottomland Habitat	Scrub/Shrub
106	63300 Southern Riparian Scrub		Scrub/Shrub
107	63310 Mule Fat Scrub		Scrub/Shrub
108	63310 Mulefat Scrub		Scrub/Shrub
109	63320 Southern Willow Scrub		Scrub/Shrub
110	63321 Arundo donax Dominant/Southern Willow Scrub		Scrub/Shrub
111	63330 Southern Riparian Scrub		Scrub/Shrub
112	63400 Great Valley Scrub		Scrub/Shrub
113	63410 Great Valley Willow Scrub		Scrub/Shrub
114	63800 Colorado Riparian Scrub		Scrub/Shrub
115	63810 Tamarisk Scrub		Scrub/Shrub
116	63820 Arrowweed Scrub		Scrub/Shrub
117	31200 Southern Coastal Bluff Scrub	Scrub and Chaparral	Scrub/Shrub
118	32000 Coastal Scrub		Scrub/Shrub
119	32400 Maritime Succulent Scrub		Scrub/Shrub
120	32500 Diegan Coastal Sage Scrub		Scrub/Shrub

**Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

<b>Id</b>	<b>SanGIS Legend</b>	<b>SanGIS Grouping</b>	<b>Land Cover Grouping</b>
121	32510 Coastal form		Scrub/Shrub
122	32520 Inland form (> 1,000 ft. elevation)		Scrub/Shrub
123	32700 Riversidian Sage Scrub		Scrub/Shrub
124	32710 Riversidian Upland Sage Scrub		Scrub/Shrub
125	32720 Alluvial Fan Scrub		Scrub/Shrub
126	33000 Sonoran Desert Scrub		Scrub/Shrub
127	33100 Sonoran Creosote Bush Scrub		Scrub/Shrub
128	33200 Sonoran Desert Mixed Scrub		Scrub/Shrub
129	33210 Sonoran Mixed Woody Scrub		Scrub/Shrub
130	33220 Sonoran Mixed Woody and Succulent Scrub		Scrub and Chaparral
131	33230 Sonoran Wash Scrub	Scrub/Shrub	
132	33300 Colorado Desert Wash Scrub	Scrub/Shrub	
133	33600 Encelia Scrub	Scrub/Shrub	
134	34000 Mojavean Desert Scrub	Scrub/Shrub	
135	34300 Blackbush Scrub	Scrub/Shrub	
136	35000 Great Basin Scrub	Scrub/Shrub	
137	35200 Sagebrush Scrub	Scrub/Shrub	
138	35210 Big Sagebrush Scrub	Scrub/Shrub	
139	35210 Sagebrush Scrub	Scrub/Shrub	
140	36110 Desert Saltbush Scrub	Scrub/Shrub	
141	36120 Desert Sink Scrub	Scrub/Shrub	
142	37000 Chaparral	Scrub/Shrub	
143	37120 Southern Mixed Chaparral	Scrub/Shrub	
144	37120 Southern Mixed Chapparral	Scrub/Shrub	
145	37121 Granitic Southern Mixed Chaparral	Scrub/Shrub	
146	37121 Southern Mixed Chaparral	Scrub/Shrub	
147	37122 Mafic Southern Mixed Chaparral	Scrub/Shrub	
148	37130 Northern Mixed Chaparral	Scrub/Shrub	
149	37131 Granitic Northern Mixed Chaparral	Scrub/Shrub	
150	37132 Mafic Northern Mixed Chaparral	Scrub/Shrub	
151	37200 Chamise Chaparral	Scrub/Shrub	
152	37210 Granitic Chamise Chaparral	Scrub/Shrub	
153	37220 Mafic Chamise Chaparral	Scrub/Shrub	
154	37300 Red Shank Chaparral	Scrub/Shrub	

**Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

<b>Id</b>	<b>SanGIS Legend</b>	<b>SanGIS Grouping</b>	<b>Land Cover Grouping</b>	
155	37400 Semi-Desert Chaparral		Scrub/Shrub	
156	37500 Montane Chaparral		Scrub/Shrub	
157	37510 Mixed Montane Chaparral		Scrub/Shrub	
158	37520 Montane Manzanita Chaparral		Scrub/Shrub	
159	37530 Montane Ceanothus Chaparral		Scrub/Shrub	
160	37540 Montane Scrub Oak Chaparral		Scrub/Shrub	
161	37800 Upper Sonoran Ceanothus Chaparral		Scrub/Shrub	
162	37830 Ceanothus crassifolius Chaparral		Scrub/Shrub	
163	37900 Scrub Oak Chaparral		Scrub/Shrub	
164	37A00 Interior Live Oak Chaparral		Scrub/Shrub	
165	37C30 Southern Maritime Chaparral		Scrub and Chaparral	Scrub/Shrub
166	37G00 Coastal Sage-Chaparral Scrub			Scrub/Shrub
167	37K00 Flat-topped Buckwheat			Scrub/Shrub
168	39000 Upper Sonoran Subshrub Scrub			Scrub/Shrub
169	Diegan Coastal Sage Scrub			Scrub/Shrub
170	Granitic Northern Mixed Chaparral	Scrub/Shrub		
171	Southern Mixed Chaparral	Scrub/Shrub		
172	11000 Non-Native Vegetation	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Unknown	
173	11000 Non-Native VegetationVegetation		Unknown	
174	11200 Disturbed Wetland		Unknown	
175	11300 Disturbed Habitat		Unknown	
176	13000 Unvegetated Habitat		Unknown	
177	Disturbed Habitat		Unknown	

## Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas

**Table H.1-3: Potential Critical Coarse Sediment Yield Areas**

GLU	Geology	Land Cover	Slope (%)
CB-Agricultural/Grass-3	Coarse Bedrock	Agricultural/Grass	20% - 40%
CB-Agricultural/Grass-4	Coarse Bedrock	Agricultural/Grass	>40%
CB-Forest-2	Coarse Bedrock	Forest	10 – 20%
CB-Forest-3	Coarse Bedrock	Forest	20% - 40%
CB-Forest-4	Coarse Bedrock	Forest	>40%
CB-Scrub/Shrub-4	Coarse Bedrock	Scrub/Shrub	>40%
CB-Unknown-4	Coarse Bedrock	Unknown	>40%
CSI-Agricultural/Grass-2	Coarse Sedimentary Impermeable	Agricultural/Grass	10 – 20%
CSI-Agricultural/Grass-3	Coarse Sedimentary Impermeable	Agricultural/Grass	20% - 40%
CSI-Agricultural/Grass-4	Coarse Sedimentary Impermeable	Agricultural/Grass	>40%
CSP-Agricultural/Grass-4	Coarse Sedimentary Permeable	Agricultural/Grass	>40%
CSP-Forest-3	Coarse Sedimentary Permeable	Forest	20% - 40%
CSP-Forest-4	Coarse Sedimentary Permeable	Forest	>40%
CSP-Scrub/Shrub-4	Coarse Sedimentary Permeable	Scrub/Shrub	>40%

## **H.2 Optional Additional Analysis When Potential Critical Coarse Sediment Yield Areas are Present Onsite**

(Adapted from "Step 1" of Section 2.3.i of "Santa Margarita Region HMP," dated May 2014)

## **Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

As stated in Chapter 6.2.3 of this manual, when it has been determined based on a GLU analysis that potential critical coarse sediment yield areas are present within the project boundary, and it has been determined that downstream systems require protection, additional analysis may be performed that may refine the extents of actual critical coarse sediment yield areas to be protected onsite. The following text, adapted from Chapter 2 of the Santa Margarita Region HMP dated May 2014, describes the process.

### **Step 1: Determine whether the Portion of the Project Site is a Significant Source of Bed Sediment Supply to the Channel Receiving Runoff**

A triad approach will be completed to determine whether the project site is a Significant Source of Bed Sediment Supply to the channel receiving runoff and includes the following components:

- A. Site soil assessment, including an analysis and comparison of the Bed Sediment in the receiving channel and the onsite channel;
- B. Determination of the capability of the channels on the project site to deliver the site Bed Sediment (if present) to the receiving channel; and
- C. Present and potential future condition of the receiving channel.

#### **A. Site soil assessment, including an analysis and comparison of the Bed Sediment in the channel receiving runoff and the onsite channels**

A geotechnical and sieve analysis is the first piece of information to be used in a triad approach to determine if the project site is a Significant Source of Bed Sediment Supply to the assessment channel. An investigation must be completed of the assessment channel to complete a sieve analysis of the Bed Sediment. Two samples will be taken of the assessment channel using the “reach” approach (TS13A, 2007 [United States Army Corps of Engineers. 2007. Guidelines for Sampling Bed Material, Technical Supplement 13A, Part 654 of National Engineering Handbook, New England District. August]). Samples in each of the two locations should be taken using the surface and subsurface bulk sample technique (TS13A, 2007) for a total of four samples. Pebble counts may be required for some channels.

A similar sampling assessment should be conducted on the project site. First-order and greater channels that may be impacted by the PDP (drainage area changed, stabilized, lined or replaced with underground conduits) will be analyzed in each subwatershed. First-order channels are identified as the unbranched channels that drain from headwater areas and develop in the uppermost topographic depressions, where two or more contour crenulations (notches or indentations) align and point upslope (National Engineering Handbook, 2007). First-order channels may, in fact, be field ditches, gullies, or ephemeral gullies (National Engineering Handbook, 2007). One channel per subwatershed that may be impacted on the project site must be assessed. A subwatershed is defined as tributary to a single discharge point at the project site boundary.

The sieve analysis should report the coarsest 90% (by weight) of the sediment for comparison between the site and the assessment channel. The User should render an opinion if the Bed Sediment found

## **Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas**

on the site is of similar gradation to the Bed Sediment found in the receiving channel. The opinion will be based on the following information:

- Sieve analysis results
- Soil erodibility (K) factor
- Topographic relief of the project area
- Lithology of the soils on the project site

The User should rate the similarity of onsite Bed Sediment and Bed Sediment collected in the receiving channel as high, medium, or low.

This site soil assessment serves as the first piece of information for the triad approach.

### **B. Determination of the capability of the onsite channels to deliver Bed Sediment Supply (if present) to the channel receiving runoff from the project site.**

The second piece of information is to qualitatively assess the sediment delivery potential of the channels on the project site to deliver the Bed Sediment Supply to the channel receiving runoff from the project site, or the Bed Sediment delivery potential or ratio. There are few documented procedures to estimate the Bed Sediment delivery ratio (see: Williams, J. R., 1977: Sediment delivery ratios determined with sediment and runoff models. IAHS Publication (122): 168-179, as an example); it is affected by a number of factors, including the sediment source, proximity to the receiving channel, onsite channel density, project sub-watershed area, slope, length, land use and land cover, and rainfall intensity. The User will qualitatively assess the Bed Sediment delivery potential and rate the potential as high, medium, or low.

### **C. Present and potential future condition of the channel receiving runoff from the project site.**

The final piece of information is the present and potential future condition of the channel receiving runoff from the project site. The User should assess the receiving channel for the following:

- Bank stability – Receiving channels with unstable banks may be more sensitive to changes in Bed Sediment Load.
- Degree of incision – Receiving channels with moderate to high incision may be more sensitive to changes in Bed Sediment Load.
- Bed Sediment gradation – Receiving channels with more coarse Bed Sediment (such as gravel) are better able to buffer change in Bed Sediment Load as compared to beds with finer gradation of Bed Sediment (sand).
- Transport vs. supply limited channels. Receiving channels that are transport limited may be better able to buffer changes in Bed Sediment Load as compared to channels that are supply limited.

## Appendix H: Guidance for Investigation Potential Critical Coarse Sediment Yield Areas

The User will qualitatively assess the channel receiving runoff from the project site using the gathered observations and rate the potential for adverse response based on a change in Bed Sediment Load as high, medium, or low.

### [Interpreting the results of A, B, and C]

The User should use the triad assessment approach, weighting each of the components based on professional judgment to determine if the project site provides a Significant Source of Bed Sediment Supply to the receiving channel, and the impact the PDP would have on the receiving channel. The final assessment and recommendation must be documented in the HMP portion of the [SWQMP].

The recommendation may be any of the following:

- Site is a Significant Source of Bed Sediment Supply – all channels on the project site must be preserved or by-passed within the site plan.
- Site is a source of Bed Sediment Supply – some of the channels on the project site must be preserved (with identified channels noted).
- Site is not a Significant Source of Bed Sediment Supply.

The final recommendation will be guided by the triad assessment. Projects with predominantly “high” values for each of the three assessment areas would indicate preservation of channels on the project site. Sites with predominantly “medium” values may warrant preservation of some of the channels on the project site, and sites with generally “low” values would not require site design considerations for Bed Sediment Load.

**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

# **Forms and Checklists**

# Appendix I Forms and Checklists



**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

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**CITY OF OCEANSIDE BMP DESIGN MANUAL APPENDICES**

## **Guidance on Green Streets**

# Appendix K Guidance on Green Streets

## K.1 Green Streets Introduction

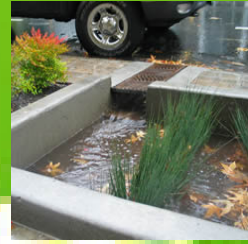
Green Streets, which includes Green Infrastructure (GI), incorporates elements found in natural areas into the City road right of way. GI is the living network that connects impervious areas to landscape areas, natural areas, and waterways. GI captures rainfall; cools buildings and pavement; and creates natural pathways for wildlife. GI includes Low Impact Development (LID) techniques, which mimic nature to capture and treat stormwater as close to the source as possible. When implemented, GI creates living green streets that capture, store, and infiltrate stormwater to treat it as a resource and improve the County environment. Green Streets, including Green Infrastructure (GI), and Low Impact Development (LID) solutions are intended to be sustainable, attractive, and cost effective. The range of opportunities includes tree wells, landscape areas, dispersion areas, biofiltration, permeable pavement, and removal of impervious pavement. These strategies use natural processes to reduce the volume of runoff, peak flow, and pollutants.

## K.2 PDP Compliance and Green Streets Standard

MS4 Permit provision E.3.b.(3), and the USEPA Green Streets guidance document cited therein, establishes a qualitative, non-structural standard for Green Streets design. If the USEPA Green Streets guidance is followed for portions of a PDP within the public right-of-way, the City of Oceanside may exempt the Green Streets portion from both the volume-based pollutant control and flow-based hydromodification management requirements specified in MS4 Permit provision E.3.c.

Please refer to "Managing Wet Weather with Green Infrastructure – Municipal Handbook: Green Streets" (USEPA, 2008) for additional guidance.

## **K.3 USEPA Green Streets Guidance**



MANAGING WET WEATHER WITH  
GREEN INFRASTRUCTURE

MUNICIPAL HANDBOOK

GREEN STREETS

# **Managing Wet Weather with Green Infrastructure**

## **Municipal Handbook**

### **Green Streets**

prepared by

**Robb Lukes**  
**Christopher Kloss**  
**Low Impact Development Center**

The Municipal Handbook is a series of documents to help local officials implement green infrastructure in their communities.

**December 2008**



EPA-833-F-08-009



#### **Front Cover Photos**

Top: rain garden; permeable pavers; rain barrel; planter; tree boxes.

Large photo: green alley in Chicago



# Green Streets

## Introduction

By design and function, urban areas are covered with impervious surfaces: roofs, roads, sidewalks, and parking lots. Although all contribute to stormwater runoff, the effects and necessary mitigation of the various types of surfaces can vary significantly. Of these, roads and travel surfaces present perhaps the largest urban pollution sources and also one of the greatest opportunities for green infrastructure use.

The Federal Highway Administration (FHA) estimates that more than 20% of U.S. roads are in urban areas.<sup>1</sup> Urban roads, along with sidewalks and parking lots, are estimated to constitute almost two-thirds of the total impervious cover and contribute a similar ratio of runoff.<sup>2</sup> While a significant source of runoff, roads are also a part of the infrastructure system, conveying stormwater along gutters to inlets and the buried pipe network. Effective road drainage, translated as moving stormwater into the conveyance system quickly, has been a design priority while opportunities for enhanced environmental management have been overlooked especially in the urban environment.

**Table 1. Examples of Stormwater Pollutants Typical of Roads.**<sup>3,4</sup>

<b>Pollutant</b>	<b>Source</b>	<b>Effects</b>
Trash	---	Physical damage to aquatic animals and fish, release of poisonous substances
Sediment/solids	Construction, unpaved areas	Increased turbidity, increased transport of soil bound pollutants, negative effects on aquatic organisms reproduction and function
Metals • Copper • Zinc • Lead • Arsenic	<ul style="list-style-type: none"> <li>• Vehicle brake pads</li> <li>• Vehicle tires, motor oil</li> <li>• Vehicle emissions and engines</li> <li>• Vehicle emissions, brake linings, automotive fluids</li> </ul>	Toxic to aquatic organisms and can accumulate in sediments and fish tissues
Organics associated with petroleum (e.g., PAHs)	Vehicle emissions, automotive fluids, gas stations	Toxic to aquatic organisms
Nutrients	Vehicle emissions, atmospheric deposition	Promotes eutrophication and depleted dissolved oxygen concentrations

The altered flow regime from traditional roadways, increased runoff volume, more frequent runoff events, and high runoff peak flows, are damaging to the environment and a risk to property downstream. These erosive flows in receiving streams will cause down cutting and channel shifting in some places and excessive sedimentation in others. The unnatural flow regime destroys stream habitat and disrupts aquatic systems.

Compounding the deliberate rapid conveyance of stormwater, roads also are prime collection sites for pollutants. Because roads are a component of the stormwater conveyance system, are impacted by atmospheric deposition, and exposed to vehicles, they collect a wide suite of pollutants and deliver them into the conveyance system and ultimately receiving streams (See Table 1). The metals, combustion by-products, and automotive fluids from vehicles can present a toxic mix that combines with the ubiquitous nutrients, trash, and suspended solids.

While other impervious surfaces can be replaced, for example using green roofs to decrease the amount of impervious roof surface, for the most part, impervious roads will, for some time to come, constitute a significant percentage of urban imperviousness because of their current widespread existence.

**Green Streets** achieve multiple benefits, such as improved water quality and more livable communities, through the integration of stormwater treatment techniques which use natural processes and landscaping.

Reducing road widths and other strategies to limit the amount of impervious surface are critical, but truly addressing road runoff requires mitigating its effects.

Roads present many opportunities for green infrastructure application. One principle of green infrastructure involves reducing and treating stormwater close to its source. Urban transportation right-of-ways integrated with green techniques are often called “green streets”. Green streets provide a source control for a main contributor of stormwater runoff and pollutant load. In addition, green infrastructure approaches complement street facility upgrades, street aesthetic improvements, and urban tree canopy efforts that also make use of the right-of-way and allow it to achieve multiple goals and benefits. Using the right-of-way for treatment also links green with gray infrastructure by making use of the engineered conveyance of roads and providing connections to conveyance systems when needed.

Green streets are beneficial for new road construction and retrofits. They can provide substantial economic benefits when used in transportation applications. Billions of dollars are spent annually on road construction and rehabilitation, with a large percentage focused on rehabilitation especially in urban areas. Coordinating green infrastructure installation with broader transportation improvements can significantly reduce the marginal cost of stormwater management by including it within larger infrastructure improvements. Also, and not unimportantly, right-of-way installations allow for easy public maintenance. A large municipal concern regarding green infrastructure use is maintenance; using roads and right-of-ways as locations for green infrastructure not only addresses a significant pollutant source, but also alleviates access and maintenance concerns by using public space.

In urban areas, roads present many opportunities for coordinated green infrastructure use. Some municipalities are capitalizing on the benefits gained by introducing green infrastructure in transportation applications. This paper will evaluate programs and policies that have been used to successfully integrate green infrastructure into roads and right-of-ways.

### **Green Street Designs**

Green streets can incorporate a wide variety of design elements including street trees, permeable pavements, bioretention, and swales. Although the design and appearance of green streets will vary, the functional goals are the same: provide source control of stormwater, limit its transport and pollutant conveyance to the collection system, restore predevelopment hydrology to the extent possible, and provide environmentally enhanced roads. Successful application of green techniques will encourage soil and vegetation contact and infiltration and retention of stormwater.

### **Alternative Street Designs (Street Widths)**

A green street design begins before any BMPs are considered. When building a new street or streets, the layout and street network must be planned to respect the existing hydrologic functions of the land (preserve wetlands, buffers, high-permeability soils, etc.) and to minimize the impervious area. If retrofitting or redeveloping a street, opportunities to eliminate unnecessary impervious area should be explored.

### ***Implementation Hurdles***

Many urban and suburban streets, sized to meet code requirements for emergency service vehicles and provide a free flow of traffic, are oversized for their typical everyday functions. The Uniform Fire Code requires that streets have a *minimum 20 feet of unobstructed width*; a street with parking on both sides would require a width of at least 34 feet. In addition to stormwater concerns, wide streets have many detrimental implications on neighborhood livability, traffic conditions, and pedestrian safety.<sup>5</sup>

### **Oregon State Code Granting Authority for Street Standards to Local Government**

ORS 92.044 - Local governments shall *supersede and prevail over any specifications and standards for roads and streets set forth in a uniform fire code adopted by the State Fire Marshal, a municipal fire department or a county firefighting agency...* Local governments shall consider the needs of the fire department or fire-fighting agency when adopting the final specifications and standards.

The Transportation Growth and Management Program of Oregon, through a Stakeholder Design Team, developed a guide for reducing street widths titled the *Neighborhood Street Design Guidelines*.<sup>6</sup> The document provides a helpful framework for cities to conduct an inclusive review of street design profiles with the goal of reducing widths. Solutions for accommodating emergency vehicles while minimizing street widths are described in the document. They include alternative street parking configurations, vehicle pullout space, connected street networks, prohibiting parking near intersections, and smaller block lengths.



**Figure 1. The street-side swale and adjacent porous concrete sidewalk are located in the High Point neighborhood of Seattle, WA (Source: Abby Hall, US EPA).**

In 1997, Oregon, which has adopted the *Uniform Fire Code*, specifically granted local government the authority to establish alternative street design standards but requires them to consult with fire departments before standards are adopted. Table 2 provides examples of alternative street widths allowed in U.S. jurisdictions.<sup>7</sup>

### **Swales**

Swales are vegetated open channels designed to accept sheet flow runoff and convey it in broad shallow flow. The intent of swales is to reduce stormwater volume through infiltration, improve water quality through vegetative and soil filtration, and reduce flow velocity by increasing channel roughness. In the simple roadside grassed form, they have been a common historical

component of road design. Additional benefit can be attained through more complex forms of swales, such as those with amended soils, bioretention soils, gravel storage areas, underdrains, weirs, and thick diverse vegetation.

### ***Implementation Hurdles***

There is a common misconception of open channel drainage being at the bottom of a street development hierarchy in which curb and gutter are at the top. Seattle's Street Edge Alternative Project and other natural drainage swale pilot projects have demonstrated that urban swales not only mitigate stormwater impacts, but they can also enhance the urban environment.<sup>8</sup>

**Table 2. Examples of Alternative Street Widths**

Jurisdiction	Street Width	Parking Condition
Phoenix, AZ	28'	parking both sides
Santa Rosa, CA	30'	parking both sides, <1000ADT
	26'-28'	parking one side
	20'	no parking
	20'	neck downs @ intersection
Orlando, FL	28'	parking both sides, res. Lots<55' wide
	22'	parking both sides, res. Lots>55' wide
Birmingham, MI	26'	parking both sides
	20'	parking one side
Howard County, MD	24'	parking unregulated
Kirkland, WA	12'	alley
	20'	parking one side
	24'	parking both sides – low density only
	28'	parking both sides
Madison, WI	27'	parking both sides, <3DU/AC
	28'	parking both sides, 3-10 DU/AC

ADT: Average Daily Traffic

DU/AC: dwelling units per acre

**Bioretention Curb Extensions and Sidewalk Planters**

Bioretention is a versatile green street strategy. Bioretention features can be tree boxes taking runoff from the street, indistinguishable from conventional tree boxes. Bioretention features can also be attractive attention grabbing planter boxes or curb extensions. Many natural processes occur within bioretention cells: infiltration and storage reduces runoff volumes and attenuates peak flows; biological and chemical reactions occur in the mulch, soil matrix, and root zone; and stormwater is filtered through vegetation and soil.

**Implementation Hurdles**

A few municipal DOT programs have instituted green street requirements in roadway projects, but as of yet, specifications for street bioretention have not yet been incorporated into municipal DOT specifications. Many cities do have street bioretention pilot projects; two of the well documented programs are noted in the table. Several concerns and considerations have prevented standard implementation of bioretention by DOTs.



**Figure 2. This bioretention area takes runoff from the street through a trench drain in the sidewalk as well as runoff from the sidewalk through curb cuts**  
(Source: Abby Hall, US EPA).

**Table 3. Municipalities with Swale Specifications and Standard Details**

Municipality	Document	Section Title	Section #
City of Austin <sup>9</sup>	Standard Specifications and Standard Details	Grass-Lined Swale and Grass-Lined Swale with Stone Center	627S
City of Seattle <sup>10</sup>	2008 Standard Specifications for Municipal Construction	Natural Drainage Systems	7-21

**Table 4. Municipalities with Bioretention Pilot Projects in the Right-of-Way**

Municipality	Bioretention Type	Document
Maplewood, MN	Rain gardens	<i>Implementing Rainwater in Urban Stormwater Management</i> <sup>11</sup>
Portland, OR	<ul style="list-style-type: none"> <li>• Curb extensions</li> <li>• Planters</li> <li>• Rain gardens</li> </ul>	<i>2006 Stormwater Management Facility Monitoring Report</i> <sup>12</sup>

The diversity of shapes, sizes, and layouts bioretention can take is a significant obstacle to their incorporation with DOT specifications and standards. Street configurations, topography, soil conditions, and space availability are some of the factors that will influence the design of the bioretention facility. These variables make documentation of each new bioretention project all the more important. By building a menu of templates from local bioretention projects, future projects with similar conditions will be easier to implement and cost less to design. The documentation should include copies of the details and specifications for the materials used. A section on construction and operation issues, costs, lessons learned, and recommendations for similar designs should also be included in project documentation. Portland’s Bureau of Environmental Services has proven adept at documenting each of its Green Streets projects and making them accessible online.<sup>13</sup>

Utilities are a chief constraint to implementing bioretention as a retrofit in urban areas. The Prince George’s County, MD Bioretention Design Specifications and Criteria manual recommends applying the same clearance criteria recommended for storm drainage pipes.<sup>14</sup> Municipal design standards should specify the appropriate clearance from bioretention or allowable traversing.

**Prince George’s County, MD - 2.12.1.16 Utility Clearance**

Utility clearances that apply to storm drainage pipe and structure placement also apply to bioretention. Standard utility clearances for storm drainage pipes have been established at 1' vertical and 5' horizontal. However, bioretention systems are shallow, non-structural IMP's consisting of mostly plant and soil components, (often) with a flexible underdrain discharge pipe. For this reason, other utilities may traverse a bioretention facility without adverse impact. Conduits and other utility lines may cross through the facility but construction and maintenance operations must include safeguard provisions. In some instances, bioretention could be utilized where utility conflicts would make structural BMP applications impractical.

Plants are another common concern of municipal staff, whether it is maintenance, salt tolerance, or plant height with regard to safety and security. Cities actively implementing LID practices in public spaces maintain lists of plants which fit the vegetated stormwater management practice niche. These are plants that flourish in the regional climate conditions, are adapted to periodic flooding, are low maintenance, and, if in cold climates, salt tolerant. Most often these plants are natives, but sometimes an approved non-native will best fit necessary criteria. A municipal plant list should be periodically updated based on maintenance experience, and vegetation health surveys.

**Permeable Pavement**

Permeable pavement comes in four forms: permeable concrete, permeable asphalt, permeable interlocking concrete pavers, and grid pavers. Permeable concrete and asphalt are similar to their impervious counterparts but are open graded or have reduced fines and typically have a special binder added. Methods for pouring, setting, and curing these permeable pavements also differ from the impervious versions. The concrete and grid pavers are modular systems. Concrete pavers are installed with gaps between them that allow water to pass through to the base. Grid pavers are typically a durable plastic matrix that can be filled with gravel or vegetation. All of the permeable pavement systems have an aggregate base in common which provides structural support, runoff storage, and pollutant removal through filtering and adsorption. Aside from a rougher unfinished surface, permeable concrete and asphalt look very similar to their impervious versions. Permeable concrete and asphalt and certain permeable concrete pavers are ADA compliant.

## Implementation Hurdles

Of all the green streets practices, municipal DOTs have been arguably most cautious about implementing permeable pavements, though it should be noted that some DOTs have, for decades, specified open-graded asphalt for low use roadways because of lower cost; to minimize vehicle hydroplaning; and to reduce road noise. The reticence to implement on a large-scale, however, is understandable given the lack of predictability and experience behind impervious pavements. However, improved technology, new and ongoing research, and a growing number of pilot projects are dispelling common myths about permeable pavements.



**Figure 3. PerVIOUS pavers used in the roadway of a neighborhood development in Wilsonville, OR**  
(Source: Abby Hall, US EPA).

The greatest concern among DOT staff seems to be a perceived lack of long-term performance and maintenance data. Universities and DOTs began experimenting with permeable pavements in parking lots, maintenance yards, and pedestrian areas as early as twenty years ago in the U.S., even earlier in Europe. There is now a wealth of data on permeable pavements successfully used for these purposes in nearly every climate region of the country. In recent years, the cities of Portland, OR, Seattle, WA, and Waterford, CT and several private developments have constructed permeable pavement pilots within the roadway with positive results.

The two typical maintenance activities are periodic sweeping and vacuuming. The City of Olympia, WA has experimented with several methods of clearing debris from permeable concrete sidewalks. Each of the methods was evaluated on the ease of use, debris removal, and the performance pace. The cost analysis by

Olympia, WA found that the maintenance cost for pervious pavement was still lower than the traditional pavement when the cost of stormwater management was considered.

Permeable pavement concerns in the roadway often raise concerns of safety, maintenance, and durability. Municipalities can replace impervious surfaces in other non-critical areas such as sidewalks, alleys, and municipal parking lots. These types of applications help municipalities build experience and a market for the technology.

**Table 5. Municipalities with Permeable Pavement Specifications and Standard Details**

Municipality	Document	Section Title	Section #
Portland	2007 Standard Construction Specifications	Unit Pavers (includes permeable pavers)	00760
Olympia	WSDOT Specification	Pervious Concrete Sidewalks	8-30

Freeze/thaw and snow plows are the major concerns for permeable pavements in cold climate communities. However, these concerns have proven to be generally unwarranted when appropriate design and maintenance practices are employed. A well designed permeable pavement structure will always drain and never freeze solid. The air voids in the pavement allow plenty of space for moisture to freeze and ice crystals to expand. Also, rapid drainage through the pavement eliminates the occurrence of freezing puddles and black ice. Cold climate municipalities will need to make adjustments to snow plowing and deicing programs for permeable pavement areas. Snow plow blades must be raised enough to prevent scraping the surface of permeable pavements, particularly paver systems. Also, sand should not be applied.

**Table 6. A Study in Olympia, WA Comparison of the cost of permeable concrete sidewalks to the cost of traditional impervious sidewalks<sup>15</sup>**

Traditional Concrete Sidewalk		Permeable Concrete Sidewalk	
Construction Cost	Maintenance Cost	Construction Cost	Maintenance Cost
\$5,003,000*	\$156,000	\$2,615,000*	\$147,000
Total = \$5,159,000 \$101.16 per square yard		Total = \$2,762,000 \$54.16 per square yard	

\*The cost of stormwater management (stormwater pond) for the added impervious surface is factored into the significantly higher cost of constructing the traditional concrete sidewalk. Maintenance of the stormwater pond is also factored into the traditional concrete sidewalk maintenance cost.

### Sidewalk trees and tree boxes

From reducing the urban heat island effect and reducing stormwater runoff to improving the urban aesthetic and improving air quality, much is expected of street trees. Street trees are even good for the economy. Customers spend 12% more in shops on streets lined with trees than on those without trees.<sup>16</sup>

However, most often street trees are given very little space to grow in often inhospitable environments. The soil around street trees often becomes compacted during the construction of paved surfaces and minimized as underground utilities encroach on root space. If tree roots are surrounded by compacted soils or are deprived of air and water by impervious streets and sidewalks, their growth will be stunted, their health will decline, and their expected life span will be cut short.

By providing adequate soil volume and a good soil mixture, the benefits obtained from a street tree multiply. To obtain a healthy soil volume, trees can simply be provided larger tree boxes, or structural soils, root paths, or “silva cells” can be used under sidewalks or other paved areas to expand root zones. These allow tree roots the space they need to grow to full size. This increases the health of the tree and provides the benefits of a mature sized tree, such as shade and air quality benefits, sooner than a tree with confined root space.



**Figure 4. Trees planted at the same time but with different soil volumes, Washington DC**  
(Source: Casey Trees)

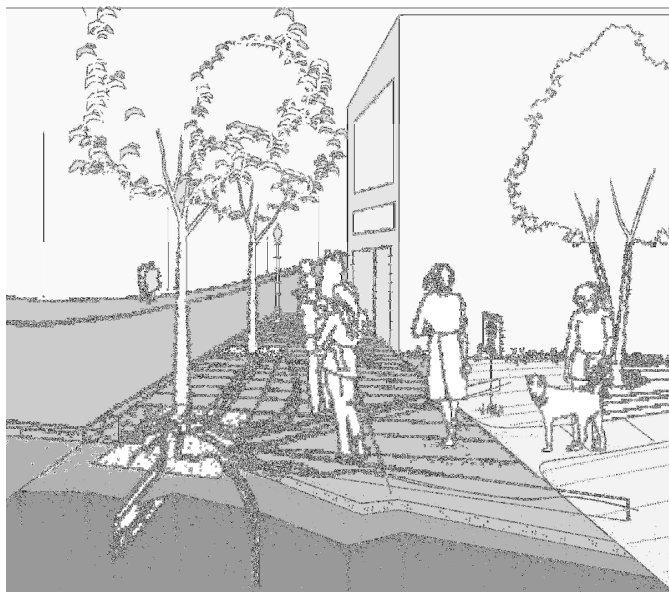
**Table 7. Healthy Tree Volume and Permeable Pavement Specifications and Standard Details**

Jurisdictions	Minimum Soil Volume	Section Title	Section #
Prince William County, VA	Large tree	970 cf	Design Construction Manual (Sec 800)
	Medium tree	750 cf	
	Small tree	500 cf	
Alexandria, VA		300 cf	Landscape Guidelines II.B. (2)

## Implementation Hurdles

Providing an adequate root volume for trees comes down to a trade off between space in the right-of-way and added construction costs. The least expensive way to obtain the volume needed for roots to grow to full size is providing adequate space unhindered by utilities or other encroachments. However, it is often hard to reserve space dedicated just to street trees in an urban right-of-way with so many other uses competing for the room they need. As a result, some creative solutions, though they cost more to install, have become useful alternatives in crowded subsurface space. Structural soils, root paths, and “silva cells” leave void space for roots and still allow sidewalks to be constructed near trees.

Root Paths can be used to increase tree root volume by connecting a small tree root volume with a larger subsurface volume nearby. A tunnel-like system extends from the tree underneath a sidewalk and connects to an open space on the other side.



**Figure 5. Root Paths direct tree roots under paving and into better soil areas for tree root growth**  
(Source: Arlington County, VA).

Silva Cells<sup>17</sup> are another option for supporting sidewalks near trees while still providing enough space for roots to grow. These plastic milk crate-like frames fit together and act as a supporting structure for a sidewalk while leaving room for uncompacted soil and roots inside the frame.

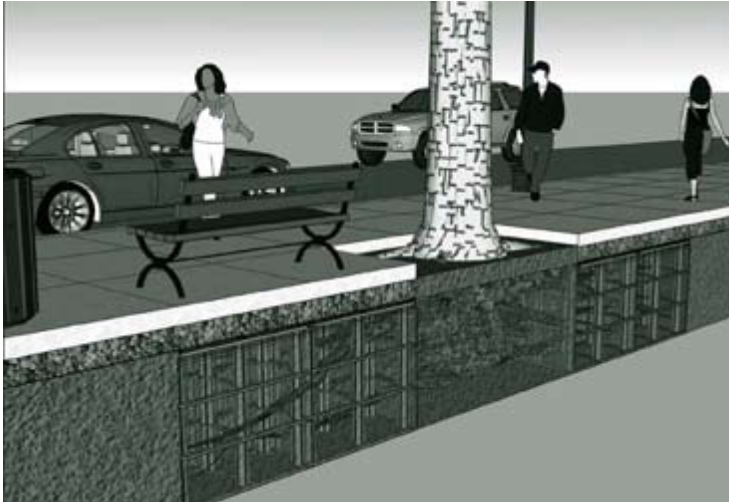
Permeable pavement sidewalks are another enhancement to the root space. They provide moisture and air to roots under sidewalks. Soils under permeable pavements can still become compacted. Structural soils<sup>18</sup> are a good companion tree planting practice to permeable pavement. When planting a tree in structural soils an adequate tree root volume is excavated and filled with a mix of stone and soil that still provides void space for healthy roots and allows for sidewalks, plazas or other paved surfaces to be constructed over them.

## Case Studies

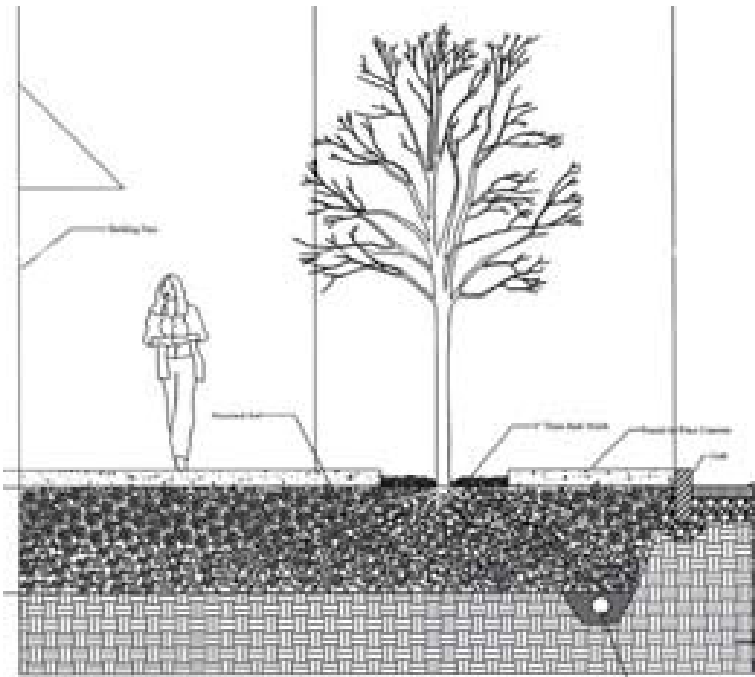
### Portland, OR: Green Street Pilot Projects

Portland, Oregon is a national leader in developing green infrastructure. Portland’s innovation in stormwater management was necessitated by the need to satisfy a Combined Sewer Overflow consent decree, Safe Drinking Water Act requirements, impending Total Maximum Daily Load limitations, Superfund cleanup measures and basement flooding. Through the 1990s, over 3 billion gallons of combined sewer overflow discharged to the Willamette River every year.<sup>19</sup> All of these factors plus leadership and local desires to create green solutions and industries compelled the city to implement green infrastructure as a complement to adding capacity to the sewer system with large pipe overflow interceptors. Despite gaps in long-term performance data, Portland took a proactive approach in implementing green infrastructure pilot projects.

Portland’s green infrastructure pilot projects have their roots in the city’s 2001 Sustainable Infrastructure Committee. The committee, consisting of representatives from Portland’s three infrastructure management Bureaus, documented the city’s ongoing efforts toward sustainable infrastructure, gathered research on green infrastructure projects from around the country, and identified opportunities for local pilots.<sup>20, 21, 22</sup>



**Figure 6. Silva cell structures support the sidewalk while providing root space for street trees**  
 (Source: Deep Root Partners, LP).



**Figure 7. Structural soils provide void space for root growth and load-bearing for sidewalk**  
 (Source: Urban Horticulture Institute, Cornell University).

One of the Bureau of Environmental Services' (BES) earliest green infrastructure retrofit projects within the right-of-way was a set of two stormwater curb extensions on NE Siskiyou Street. Portland had been retrofitting many streets with curb extensions for the purpose of pedestrian safety, but this was the first done for the purpose of treating street runoff. In a simulated 25-year storm event flow test, the curb extensions captured 85% of the runoff volume that would be discharged to the combined sewer system and reduced peak flow by 88%.<sup>23</sup>

Between 2003 and 2007, Portland designed and implemented a variety of Green Street pilots. Funding sources for these projects have come from BES, Portland Department of Transportation, U.S. EPA, and an Innovative Wet Weather Fund. BES combined funds with an EPA grant to create the Innovative Wet Weather Fund. In 2004, nearly \$3 million from the Innovative Wet Weather Fund was budgeted for a long list of projects from city green roofs, public-private projects, and a number of pilot projects within the right-of-way.<sup>24</sup> Several pilots have been cost competitive with or less costly than conventional upgrades. The Bureau recognizes that costs will decrease once these projects become more routine. Many of the pilot project costs included one time costs such as the development of outreach materials and standard drawings.



**Figure 8: NE Siskiyou Vegetated Curb Extensions**  
 Source: City of Portland – Bureau of Environmental Services

**Table 8. Portland, OR - Green Street Pilot Projects**

Location	Design	Year Completed	Cost
NE Siskiyou b/w NE 35 <sup>th</sup> Pl. and NE 36 <sup>th</sup> Ave	Stormwater curb extension	2003	\$20,000
3 blocks of the Westmoreland Neighborhood	Permeable Pavers in parking lanes and curb to curb	2004	\$412,000
SE Ankeny b/w SE 56 <sup>th</sup> and SE 57 <sup>th</sup> Ave.	Stormwater curb extensions	2004	\$11,946
NE Fremont b/w NE 131st and 132 <sup>nd</sup> Av	Stormwater curb extension	2005	\$20,400
SW 12 <sup>th</sup> Ave b/w SW Montgomery and Mill	Stormwater planters	2005	\$34,850
East Holladay Park	Pervious paver parking lot	2005	\$165,000
4 blocks of North Gay Avenue b/w N Wygant and N Sumner	Porous concrete in curb lanes and curb to curb; porous asphalt in curb lanes and curb to curb	2005	--
SW Texas	Stormwater wetlands and swales	2007	\$2.3 million
Division St. – New Seasons Market	Stormwater planters and swales	--	--
SE Tibbetts and SE 21 <sup>st</sup> Ave.	Stormwater curb extension and planters	--	--

Source: Portland Bureau of Environmental Services, 2008  
<http://www.portlandonline.com/bes/index.cfm?c=44463&>

Each of the pilot projects have been well documented by BES. A consistent format has been used to describe pilot background, features, engineering design, landscaping, project costs, maintenance, monitoring, and, most importantly, lessons learned. These case studies as well as other Green Street documentation can be found on BES’s Sustainable Stormwater webpage, <http://www.portlandonline.com/BES/index.cfm?c=34598>. Due to physical factors (drainage, slope, soil, existing utilities, multiple uses) and development factors (retrofit, redevelopment, and new construction), there will be many variations on Green Streets. As part of the program, a continually updated Green Street Profile Notebook will catalog the successful green street projects. Users can use the Notebook for permitting guidance, to identify green streets facilities appropriate for various factors, but the document is not a technical document with standard details.

## The Green Streets Team

The City of Portland, OR is widely acknowledged for long term, forward thinking, and comprehensive transportation and environmental planning. Portland recognized the fact that 66% of the City’s total runoff is collected from streets and the right-of-way.<sup>25</sup> The city also saw the potential for transportation corridors to meet multiple objectives, including:

- Comprehensively address numerous City goals for neighborhood livability, sustainable development, increased green spaces, stormwater management, and groundwater protection;
- Integrate infrastructure functions by creating “linear parks” along streets that provide both pedestrian/bike areas and stormwater management;
- Avoid the key impacts of unmanaged stormwater whereby surface waterbodies are degraded, and water quality suffers;
- Manage stormwater with investments citizens can support, participate in, and see;
- Manage stormwater as a resource, rather than a waste;
- Protect pipe infrastructure investments (extend the life of pipe infrastructure, limit the additional demand on the combined sewer system as development occurs);
- Protect wellhead areas by managing stormwater on the surface; and
- Provide increased neighborhood amenities and value.

In a two phased process from 2005 to 2007, the Green Streets Team, a cross agency and interdisciplinary team, developed a comprehensive green streets policy and a way forward for the green streets agenda. Phase 1 identified challenges and issues and began a process for addressing them. Barriers to the public initiation of green street projects included a code and standards that would disallow or discourage green street strategies, long term performance unknowns, and maintenance responsibilities. To address these barriers, the Green Streets Team organized into subgroups focusing on outreach, technical guidance, infrastructure, maintenance, and resources.

Phase 2 of the Green Streets project synthesized the opportunities and solutions identified in Phase 1 into a citywide Green Streets Program. The first priority for this phase was the drafting of a binding citywide policy. The resolution was adopted by the Portland City Council in March 2007.

**Prior to the start of the Portland effort, 90% of implemented green street projects were issued by private permits rather than city initiated projects.**

<b>Six Approaches to Implementing Green Streets</b>	
<b>Pathway</b>	<b>Implementation</b>
City-initiated street improvement projects	City designs, manages, maintains
City-initiated stormwater retrofits	City designs, manages, maintains
Neighborhood-initiated LIDs	
Developer-initiated subdivisions with public streets	Developer designs and builds via City permit and review process, then turns over new right of way to the City after warranty period
Developer-initiated subdivisions with private streets	Developer designs and builds via City permit and review process, and turns over to home-owner association
Developer-related initiated frontage improvements on existing public streets	Developer designs and builds new sidewalks and curbs via City permit and review process, usually because the City required it via a building permit or via a land division

*Source: Portland Green Streets, Phase 1*

## Portland City Council Approved Green Streets Policy

Goal: City of Portland will promote and incorporate the use of green street facilities in public and private development.

City elected officials and staff will:

### 1. Infrastructure Projects in the Right of Way:

- a. Incorporate green street facilities into all City of Portland funded development, redevelopment or enhancement projects as required by the City's September 2004 (or updated) Stormwater Management Manual. Maintain these facilities according to the May 2006 (or updated) Green Streets Maintenance Policy.

If a green street facility (infiltrating or flow through) is not incorporated into the Infrastructure Project, or only partial management is achieved, then an off site project or off site management fee will be required.

- b. Any City of Portland funded development, redevelopment or enhancement project, that does not trigger the Stormwater Manual but requires a street opening permit or occurs in the right of way, shall pay into a "% for Green" Street fund. The amount shall be 1% of the construction costs for the project.

*Exceptions: Emergency maintenance and repair projects, repair and replacement of sidewalks and driveways, pedestrian and trail replacement, tree planting, utility pole installation, street light poles, traffic, signal poles, traffic control signs, fire hydrants, where this use of funds would violate contracted or legal restrictions.*

### 2. Project Planning and Design:

- a. Foster communication and coordination among City Bureaus to encourage consideration of watershed health and improved water quality through use of green street facilities as part of planning and design of Bureau projects.
- b. Coordinate Bureau work programs and projects to implement Green Streets as an integrated aspect of City infrastructure.
- c. Plan for large-scale use of Green Streets as a means of better connecting neighborhoods, better use of the right of way, and enhancing neighborhood livability.
- d. Strive to develop new and innovative means to cost-effectively construct new green street facilities.
- e. Develop standards and incentives (such as financial and technical resources, or facilitated permit review) for Green Streets projects that can be permitted and implemented by the private sector. These standards and incentives should be designed to encourage incorporation of green street facilities into private development, redevelopment and enhancement projects.

### 3. Project and Program Funding:

- a. Seek opportunities to leverage the work and associated funding of projects in the same geographic areas across Bureaus to create Green Street opportunities.
- b. Develop a predictable and sustainable means of funding implementation and maintenance of Green Street projects.

### 4. Outreach:

- a. Educate citizens, businesses, and the development community/industry about Green Streets and how they can serve as urban greenways to enhance, improve, and connect neighborhoods to encourage their support, demand and funding for these projects.
- b. Establish standard maintenance techniques and monitoring protocols for green street facilities across bureaus, and across groups within bureaus.

### 5. Project Evaluation:

- a. Conduct ongoing monitoring of green street facilities to evaluate facility effectiveness as well as performance in meeting multiple City objectives for:
  - Gallons managed;
  - Projects distributed geographically by watershed and by neighborhood; and

The second priority for Phase 2 was developing communication and planning procedures for incorporating multi-bureaus plans into the scheduled Portland DOT Capital Improvement Program (CIP). Three timeframes for green street project planning were recommended. In the short term, the CIP Planning Group, backed by the citywide policy directive, will shift to a focus on "identifying and evaluating opportunities to partner." For example, coordinating Water Bureau and BES pipe replacement

projects with DOT maintenance, repair, and improvement projects. The mid-term approach is more proactive and involves forecasting potential green street projects using existing bureau data and GIS tools. As for the long term, green street objectives will be incorporated into the citywide systems plan which guides city bureaus for the next 20 years.

The Green Street Team methodology propelled Portland's early green street pilot projects into a comprehensive, citywide multi-bureau program. The program built on previous efforts by the Sustainable Infrastructure Committee as well as other efforts such as the 2005 Portland Watershed Management Plan, established a City Council mandated policy, and institutionalized green street development. The outcome of this approach is multi-agency buy-in and responsibility for the effort. For instance, because of their knowledge of plant maintenance, Portland Parks and Recreation is responsible for the maintenance of some DOT installations.

### **Chicago, IL: Green Alleys Program**

The City of Chicago, Illinois has an alley system that is perhaps the largest in the world. These 13,000 publicly owned alleys result in 1,900 miles, or 3,500 acres, of impermeable surfaces in addition to the street network. Because the alley system was not originally paved, there are no sewer connections as part of the original design. Over time the alleys were paved and flooding in garages and basements began to occur as a result of unmanaged stormwater runoff. Since the city already spends \$50 million each year to clean and upgrade 4,400 miles of sewer lines and 340,000 related structures, the preferred solution to the flooded alleys is one that doesn't put more stress on an already overburdened and expensive sewer system.<sup>26</sup>

In 2003, the Chicago Department of Transportation (CDOT) used permeable pavers and French drain pilot applications to remedy localized flooding problems in alleys in the 48<sup>th</sup> Ward.<sup>27</sup> These applications proved to be successful and by 2006, CDOT launched its Green Alley Program with the release of the Chicago Green Alley Handbook (Handbook).<sup>28</sup>

The Chicago Green Alley Program is unique because it marries green infrastructure practices in the public right-of-way with green infrastructure efforts on private property. The user-friendly Handbook, which describes both facets of the program including the design techniques and their benefits, is an award winning document. The American Society of Landscape Architects awarded the creators of the Handbook the 2007 Communications Honor Award for the clear graphics and simple, yet effective, message.<sup>29</sup> The Handbook explains to the residents why green infrastructure is important, how to be good stewards of the Green Alley in their neighborhood, and what sorts of "green" practices they can implement on their property to reduce waste, save water, and help manage stormwater wisely.

While the initial impetus behind the Green Alley Program was stormwater management, Chicago decided to use this opportunity to address other environmental concerns as well as reducing the urban heat island effect, recycling, energy conservation, and light pollution.

#### ***Green Infrastructure in the Right-of-Way***

Chicago's Green Alley Program uses the following five techniques in the public right-of-way to "green" the alley:

1. Changing the grade of the alley to drain to the street rather than pond water in the alley or drain toward garages or private property.
2. Using permeable pavement that allows water to percolate into the ground rather than pond on the surface.
3. Using light colored paving material that reflects sunlight rather than adsorbing it, reducing urban heat island effect.

4. Incorporating recycled materials into the pavement mix to reduce the need for virgin materials and reduce the amount of waste going into the landfill.
5. Using energy efficient light fixtures that focus light downward, reducing light pollution.

Four design approaches were created using these techniques. Based on the local conditions, the most appropriate approach is selected. In areas where soils are well-draining, permeable pavement is used. In areas where buildings come right up to the edge of pavement and infiltrated water could threaten foundations, impermeable pavement strips are used on the outside with a permeable pavement strip down the middle. In areas where soils do not provide much infiltration capacity, the alley is regraded to drain properly and impermeable pavement made with recycled materials is used. Another approach utilizes an infiltration trench down the middle of the alley. Light colored (high albedo) pavement, recycled materials, and energy efficient, glare reducing lights are a part of each design approach.



**Figure 9: Permeable Asphalt Installation Using Ground Tire Rubber.**

*Source: Chicago Department of Transportation, Sustainable Development Initiatives; Streetscape and Urban Design Program, CDOT Division of Project Development.*

### ***Green Infrastructure on Private Property***

The Handbook also describes actions that property owners can take to “green” their own piece of Chicago. The Handbook describes the costs, benefits, and utility of the following practices:

- Recycling;
- Composting;
- Planting a tree;
- Using native landscape vegetation;
- Constructing a rain garden;
- Installing a rain barrel;
- Using permeable pavement for patios;
- Installing energy efficient lighting; and
- Utilizing natural detention.

By bringing this wide range of “green” practices to the attention of homeowners, the positive impacts of the Green Alley Program spread beyond the boundaries of the right-of-way, increasing awareness and providing practical resources to help community members be a part of the solution.

### ***Chicago Green Alley Cost Considerations***

When the program began in 2006, repaving the alleys with impermeable pavement ranged in cost from \$120,000 to \$150,000, whereas a total Green Alley reconstruction was more along the lines of \$200,000 to \$250,000.<sup>30</sup> While less expensive conventional rehabilitation options may seem more attractive, they don’t provide a solution to the localized flooding issues or the combined sewer system overflow problems. Sewer system connections could be established to solve the localized flooding problem, but it would add to the already overburdened sewer system and increase the cost of the reconstruction to that of the impermeable alley option. Consequently, the higher priced Green Alley option proved to be the best investment as it has multiple benefits in addition to solving localized flooding and reducing flow into the combined sewer system. The additional benefits of the Green Alley Program include not only urban heat

island effect reduction, material recycling, energy conservation, and light pollution reduction, but also the creation of a new market.

In 2006, when the Green Alley Program began, the city paid about \$145 per cubic yard of permeable concrete. Just one year later, the cost of permeable concrete had dropped to only \$45 per cubic yard. Compared with the cost of ordinary concrete, \$50 per cubic yard, permeable concrete may have seemed like an infeasible option in the past to customers wanting to purchase concrete.<sup>31</sup> After the city's initial investment in the local permeable concrete market, the product cost has come down making permeable concrete a more affordable option for other consumers besides the city. This has resulted in an increased application of permeable concrete throughout the region.



**Figure 10: Permeable Pavers and Permeable Concrete Chicago Alleys**  
(Source: Abby Hall, US EPA)

The success of the Chicago Green Alley Program is evident. Not only are the alleys been “greened” as a result of the program, the surrounding properties and even the surrounding neighborhoods are experiencing the positive impacts of the program’s implementation.

### **Conclusions and Recommendations**

Incorporating green streets as a feature of urban stormwater management requires matching road function with environmental performance. Enhancing roads with green elements can improve their primary function as a transportation corridor while simultaneously mitigating their negative environmental impacts. In theory and practice many municipalities are not far removed from dedicated green streets programs. Street tree and other greenscaping programs are often identified and promoted along urban transportation corridors. Adapting them to become fully functional green streets requires minor design modifications and an evaluation of how to maximize the benefits of environmental systems.

Portland’s green streets program demonstrates how common road and right-of-way elements (e.g., traffic calming curb extensions, tree boxes) can be modified and optimized to provide stormwater management in addition to other benefits. The curb cuts and design variations to allow runoff to enter the vegetated areas are subtle changes with a significant impact and demonstrate how stormwater can be managed successfully at the source. One of the biggest successes of the program was reassessing common design features and realizing that environmental performance can be improved by integrating stormwater management.

Where Portland used vegetation, Chicago’s Green Alley Program similarly demonstrates that hardscape elements can be an integral part of a greening program. By incorporating permeable pavements that simulate natural infiltration, Chicago enhances the necessary transportation function of alleys while enhancing infrastructure and environmental management. Portland also contrasts the “soft” and “hard”

elements of green streets by using both permeable pavements and vegetated elements. The green options available demonstrate the flexibility of green infrastructure to satisfy road function and environmental objectives and highlight why transportation corridors are well suited for green infrastructure.

**Elements necessary for a successful green streets program:**

- **Pilot projects are critical.** The most successful municipal green street programs to date all began with well documented and monitored pilot projects. These projects have often been at least partially grant funded and receive the participation of locally active watershed groups working with the city infrastructure programs. The pilot projects are necessary to demonstrate that green streets can work in the local environment, can be relied upon, and fit with existing infrastructure. Pilot projects will help to dispel myths and resolve concerns.
- **Leadership in sustainability from the top.** The cities with the strongest green streets programs are those with mayors and city councils that have fully bought into sustainable infrastructure. Council passed green policies and mayoral sustainability mandates or mission statements are needed to institutionalize green street approaches and bring it beyond the token green project.
- **Buy-in from all municipal infrastructure departments.** By their nature, green streets cross many municipal programs. Green street practices impact stormwater management, street design, underground utilities, public lighting, green space planning, public work maintenance, and budgeting. When developing green streets, all of the relevant agencies must be represented. Also, coordination between the agencies on project planning is important for keeping green infrastructure construction costs low. Superior green street design at less cost occurs when sewer and water line replacement projects can be done in tandem with street redevelopment. These types of coordination efforts must happen at the long-term planning stage.
- **Documentation.** Green street projects need to be documented on two levels, the design and construction level and on a citywide tracking level. Due to the different street types and siting conditions, green street designs will take on many variations. By documenting the costs, construction, and design, the costs of similar future projects can be minimized and construction or design problems can be avoided or addressed. Tracking green street practices across the city is crucial for managing maintenance and quantifying aggregate benefits.
- **Public outreach.** Traditional pollution prevention outreach goes hand in hand with green street programs. Properly disposing of litter, yard waste, and hazardous chemicals and appropriately applying yard chemicals will help prolong the life of green street practices. An information campaign should also give the public an understanding of how green infrastructure works and the benefits and trade offs. In many cases, remedial maintenance of green street practices will be performed by neighboring property owners; they need to know how to maintain the practices to keep them performing optimally.

As public spaces, roads are prime candidates for green infrastructure improvements. In addition to enabling legislation, and technical guidance, developing a green streets program requires an institutional re-evaluation of how right-of-ways are most effectively managed. This process typically includes:

- Assessing the necessary function of the road and selecting the minimum required street width to reduce impervious cover;
- Enhancing streetscaping elements to manage stormwater and exploring opportunities to integrate stormwater management into roadway design; and
- Integrating transportation and environmental planning to capitalize on economic benefits.

The use of green streets offers the capability of transforming a significant stormwater and pollutant source into an innovative treatment system. Green streets optimize the performance of public space easing maintenance concerns and allowing municipalities to coordinate the progression and implementation of stormwater control efforts. In addition, green streets optimize the performance of both the transportation and water infrastructure. Effectively incorporating green techniques into the transportation network provides significant opportunity to decrease infrastructure demands and pollutant transport.

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<sup>1</sup> National Cooperative Highway Research Program, *Evaluation of Best Management Practices and Low Impact Development for Highway Runoff Control*, National Academy of Sciences – National Research Council, 2006.

<sup>2</sup> Lance Frazer, *Paving Paradise: The Peril of Impervious Cover*, Environmental Health Perspectives, Volume 113, Number 7, July 2005.

<sup>3</sup> See note 1.

<sup>4</sup> *Pollutants Commonly Found in Stormwater Runoff*, <http://www.stormwaterauthority.org/pollutants/default.aspx> (accessed July 2008).

<sup>5</sup> Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities: <http://www.ite.org/css/> (Ch. 6, pages. 65-87)

<sup>6</sup> *Neighborhood Street Design Guidelines*, prepared by Neighborhood Streets Project Stakeholders. November 2000 <http://www.oregon.gov/LCD/docs/publications/neighstreet.pdf> (accessed June 2008)

<sup>7</sup> *Narrow Streets Database*, <http://www.sonic.net/abcaia/narrow.htm> (accessed July 2008).

<sup>8</sup> City of Seattle. Street Edge Alternatives Project [http://www.ci.seattle.wa.us/util/About\\_SPU/Drainage\\_&\\_Sewer\\_System/Natural\\_Drainage\\_Systems/Street\\_Edge\\_Alternatives/index.asp](http://www.ci.seattle.wa.us/util/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/Street_Edge_Alternatives/index.asp)

<sup>9</sup> City of Austin, Engineering Services Division. Standard Specifications and Details Website: <http://www.ci.austin.tx.us/sd/>

<sup>10</sup> See note 9

<sup>11</sup> *Implementing Rainwater in Urban Stormwater Management* [http://www.ci.maplewood.mn.us/index.asp?Type=B\\_BASIC&SEC=%7BF2C03470-D6B5-4572-98F0-F79819643C2A%7D](http://www.ci.maplewood.mn.us/index.asp?Type=B_BASIC&SEC=%7BF2C03470-D6B5-4572-98F0-F79819643C2A%7D) (accessed July 2008).

<sup>12</sup> 2006 Stormwater Management Facilities Monitoring Report <http://www.portlandonline.com/bes/index.cfm?c=36055> (accessed July 2008).

<sup>13</sup> City of Portland. Green Streets website. <https://www.sustainableportland.org/BES/index.cfm?c=44407> (last accessed July, 2008).

<sup>14</sup> Prince George's County, MD. *Bioretention Design Specifications and Criteria*. [http://www.co.pg.md.us/Government/AgencyIndex/DER/ESD/Bioretention/pdf/bioretention\\_design\\_manual.pdf](http://www.co.pg.md.us/Government/AgencyIndex/DER/ESD/Bioretention/pdf/bioretention_design_manual.pdf) (accessed July 2008).

<sup>15</sup> City of Olympia. *Memorandum: Traditional versus Pervious Concrete Sidewalk – Construction and Maintenance Costs*. Feb. 2005. <http://www.ci.olympia.wa.us/cityutilities/stormwater/scienceandinnovations/porouspavement.htm>.

<sup>16</sup> The Case for Trees, Casey Trees, Washington, D.C.: <http://www.caseytrees.org/resources/casefortrees.html#EconGrowth>

<sup>17</sup> Deep Root, LLC. <http://www.deeproot.com>

<sup>18</sup> Cornell University, Urban Horticulture Institute. <http://www.hort.cornell.edu/UHI/>

<sup>19</sup> City of Portland Bureau of Environmental Services, *CSO Program*, <http://www.portlandonline.com/BES/index.cfm?c=31030>, (accessed July 2008).

<sup>20</sup> City of Portland Sustainable Infrastructure Committee, *Sustainable Infrastructure Report*. December 2001. <http://www.portlandonline.com/shared/cfm/image.cfm?id=82893> (last accessed July, 2008).

<sup>21</sup> City of Portland Sustainable Infrastructure Subcommittee, *Sustainable Infrastructure: Alternative Paving Materials*. Oct. 2003. <http://www.portlandonline.com/shared/cfm/image.cfm?id=82898>, (accessed July 2008).

<sup>22</sup> City of Portland Sustainable Infrastructure Subcommittee, *Sustainable Infrastructure: Streetscape Task Force*. Nov. 2003. <http://www.portlandonline.com/shared/cfm/image.cfm?id=82897>, (accessed July 2008).

<sup>23</sup> City of Portland Bureau of Environmental Services, *Flow Test Report: Siskiyou Curb Extension*. August 4, 2004. <http://www.portlandonline.com/shared/cfm/image.cfm?id=63097> (accessed July 2008).

<sup>24</sup> City of Portland Bureau of Environmental Services, *Environmental Assessment: Innovative Wet Weather Program*, April 2004.

<sup>25</sup> Portland Stormwater Advisory Committee, 2004.

<sup>26</sup> Chicago Department of Transportation, Sustainable Development Initiatives; Streetscape and Urban Design Program, CDOT Division of Project Development: [http://www.railvolution.com/rv2006\\_pdfs/rv2006\\_217c.pdf](http://www.railvolution.com/rv2006_pdfs/rv2006_217c.pdf)

<sup>27</sup> 48<sup>th</sup> Ward Green Initiatives: <http://www.masmith48.org/greeniniatives/greeniniatives.html>

<sup>28</sup> The Chicago Green Alley Handbook, Chicago Department of Transportation: [http://egov.cityofchicago.org/webportal/COCWebPortal/COC\\_EDITORIAL/GreenAlleyHandbook.pdf](http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/GreenAlleyHandbook.pdf)

<sup>29</sup> American Society of Landscape Architects, 2007 Professional Awards: [http://www.asla.org/awards/2007/07winners/212\\_hdg.html](http://www.asla.org/awards/2007/07winners/212_hdg.html)

<sup>30</sup> DeJong, Aaron, A Pilot Project Takes Off, Sustainable Urban Redevelopment: [http://www.surmag.com/index.php?option=com\\_content&task=view&id=10&Itemid=2](http://www.surmag.com/index.php?option=com_content&task=view&id=10&Itemid=2)

<sup>31</sup> Saulny, Susan, In Miles of Alleys, Chicago Finds it's Next Environmental Frontier, *New York Times* November 26, 2007.

# Glossary of Key Terms

<b>50% Rule</b>	Refers to an MS4 Permit standard for redevelopment PDPs (PDPs on previously developed sites) that defines whether the redevelopment PDP must meet storm water management requirements for the entire development or only for the newly created or replaced impervious surface. Refer to <b>Section 1.7</b> .
<b>Aggregate</b>	Hard, durable material of mineral origin typically consisting of gravel, crushed stone, crushed quarry or mine rock. Gradation varies depending on application within a BMP as bedding, filter course, or storage.
<b>Aggregate Storage Layer</b>	Layer within a BMP that serves to provide a conduit for conveyance, detention storage, infiltration storage, saturated storage, or a combination thereof.
<b>Alternative Compliance Programs</b>	A program that allows PDPs to participate in an offsite mitigation project in lieu of implementing the onsite structural BMP performance requirements required under the MS4 Permit. Refer to <b>Section 1.8</b> for more information on alternative compliance programs.
<b>Bed Sediment</b>	The part of the sediment load in channel flow that moves along the bed by sliding or saltation, and part of the suspended sediment load, that principally constitutes the channel bed.
<b>Bedding</b>	Aggregate used to establish a foundation for structures such as pipes, manholes, and pavement.
<b>Biodegradation</b>	Decomposition of pollutants by biological means.
<b>Biofiltration BMPs</b>	Biofiltration BMPs are shallow basins filled with treatment media and drainage rock that treat storm water runoff by capturing and detaining inflows prior to controlled release through minimal incidental infiltration, evapotranspiration, or discharge via underdrain or surface outlet structure. Treatment is achieved through filtration, sedimentation, sorption, biochemical processes and/or vegetative uptake. These BMPs must be sized to:[a] Treat 1.5 times the DCV not reliably retained onsite, OR[b] Treat the DCV not reliably retained onsite with a flow-thru design that has a total volume, including pore spaces and pre-filter detention volume, sized to hold at least 0.75 times

the portion of the DCV not reliably retained onsite. (See **Section 5.5.3** and **Appendix B.5** for illustration and additional information).

**Biofiltration Treatment** Treatment from a BMP meeting the biofiltration standard.

**Biofiltration with  
Partial Retention BMPs**

Biofiltration with partial retention BMPs are shallow basins filled with treatment media and drainage rock that manage storm water runoff through infiltration, evapotranspiration, and biofiltration. Partial retention is characterized by a subsurface stone infiltration storage zone in the bottom of the BMP below the elevation of the discharge from the underdrains. The discharge of biofiltered water from the underdrain occurs when the water level in the infiltration storage zone exceeds the elevation of the underdrain outlet. (See **Section 5.5.2.1** for illustration and additional information).

**Bioretention BMPs**

Vegetated surface water systems that filter water through vegetation and soil, or engineered media prior to infiltrating into native soils. Bioretention BMPs in this manual retain the entire DCV prior to overflow to the downstream conveyance system. (See **Section 5.5.1.2** for illustration and additional information).

**BMP**

A procedure or device designed to minimize the quantity of runoff pollutants and / or volumes that flow to downstream receiving water bodies. Refer to **Section 2.2.2.1**.

**BMP Sizing Calculator**

An on-line tool that was developed under the 2007 MS4 Permit to facilitate the sizing factor method for designing flow control BMPs for hydromodification management. The BMP Sizing Calculator has been discontinued as of June 30, 2014.

**Cistern**

A vessel for storing water. In this manual, a cistern is typically a rain barrel, tank, vault, or other artificial reservoir.

**Coarse Sediment Yield  
Area**

A GLU with coarse-grained geologic material (material that is expected to produce greater than 50% sand when weathered). See the following terms modifying coarse sediment yield area: critical, potential critical.

**Compact Biofiltration  
BMP**

A biofiltration BMP, either proprietary or non-proprietary in origin, that is designed to provide storm water pollutant control within a smaller footprint than a typical biofiltration BMP, usually through use of specialized media that is able to efficiently treat high storm water inflow rates.

<b>Conditions of Approval</b>	Requirements a jurisdiction may adopt for a project in connection with a discretionary action (e.g., issuance of a use permit). COAs may include features to be incorporated into the final plans for the project and may also specify uses, activities, and operational measures that must be observed over the life of the project.
<b>Contemporary Design Standards</b>	This term refers to design standards that are reasonably consistent with the current state of practice and are based on desired outcomes that are reasonably consistent with the context of the MS4 Permit and Model BMP Design Manual. For example, a detention basin that is designed solely to mitigate peak flow rates would not be considered a contemporary water quality BMP design because it is not consistent with the goal of water quality improvement. Current state of the practice recognizes that a drawdown time of 24 to 72 hour is typically needed to promote settling. For practical purposes, design standards can be considered “contemporary” if they have been published within the last 10 years, preferably in California or Washington State, and are specifically intended for storm water quality management.
<b>Continuous Simulation Modeling</b>	A method of hydrological analysis in which a set of rainfall data (typically hourly for 30 years or more) is used as input, and a continuous runoff hydrograph is calculated over the same time period. Continuous simulation models typical track dynamic soil and storage conditions during and between storm events. The output is then analyzed statistically for the purposes of comparing runoff patterns under different conditions (for example, pre- and post-development-project).
<b>Copermittees</b>	See Jurisdiction.
<b>Critical Channel Flow (Qc)</b>	The channel flow that produces the critical shear stress that initiates bed movement or that erodes the toe of channel banks. When measuring Qc, it should be based on the weakest boundary material – either bed or bank.
<b>Critical Coarse Sediment Yield Areas</b>	A GLU with coarse-grained geologic material and high relative sediment production, where the sediment produced is critical to the receiving stream (a source of bed material to the receiving stream). See also: potential critical coarse sediment yield area.

<b>Critical Shear Stress</b>	The shear stress that initiates channel bed movement or that erodes the toe of channel banks. See also critical channel flow.
<b>DCV</b>	A volume of storm water runoff produced from the 85th percentile, 24-hour storm event. See <b>Section 2.2.2.2</b> .
<b>De Minimis DMA</b>	De minimis DMAs are very small areas that are not considered to be significant contributors of pollutants, and are considered not practicable to drain to a BMP. See <b>Section 5.2.2</b> .
<b>Depth</b>	The distance from the top, or surface, to the bottom of a BMP component.
<b>Detention</b>	Temporarily holding back storm water runoff via a designed outlet (e.g., underdrain, orifice) to provide flow rate and duration control.
<b>Detention Storage</b>	Storage that provides detention as the outflow mechanism.
<b>Development Footprint</b>	The limits of all grading and ground disturbance, including landscaping, associated with a project.
<b>Development Project</b>	Construction, rehabilitation, redevelopment, or reconstruction of any public or private projects. Includes both new development and redevelopment. Also includes whole of the action as defined by CEQA. See <b>Section 1.3</b> .
<b>Direct Discharge</b>	The connection of project site runoff to an exempt receiving water body, which could include an exempt river reach, reservoir or lagoon. To qualify as a direct discharge, the discharge elevation from the project site outfall must be at or below either the normal operating water surface elevation or the reservoir spillway elevation, and properly designed energy dissipation must be provided. “Direct discharge” may be more specifically defined by each municipality.
<b>Direct Infiltration</b>	Infiltration via methods or devices, such as dry wells or infiltration trenches, designed to bypass the mantle of surface soils that is unsaturated and more organically active and transmit runoff directly to deeper subsurface soils.
<b>DMAs</b>	See <b>Section 3.3.3</b> .

<b>Drawdown Time</b>	The time required for a storm water detention or infiltration facility to drain and return to the dry-weather condition. For detention facilities, drawdown time is a function of basin volume and outlet orifice size. For infiltration facilities, drawdown time is a function of basin volume and infiltration rate.
<b>Enclosed Embayments (Enclosed Bays)</b>	Enclosed bays are indentations along the coast that enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between the headlands or outermost bay works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. Enclosed bays do not include inland surface waters or ocean waters. In San Diego: Mission Bay and San Diego Bay.
<b>Environmentally Sensitive Areas (ESAs)</b>	Areas that include but are not limited to all Clean Water Act Section 303(d) impaired water bodies; areas designated as Areas of Special Biological Significance by the State Water Board and SDRWQCB; State Water Quality Protected Areas; water bodies designated with the RARE beneficial use by the State Water Board and SDRWQCB; and any other equivalent environmentally sensitive areas which have been identified by the Copermittees.
<b>Filter Course</b>	Aggregate used to prevent particle migration between two different materials when storm water runoff passes through.
<b>Filter Fabric</b>	A permeable textile material, also termed a non-woven geotextile, that prevents particle migration between two different materials when storm water runoff passes through.
<b>Filtration</b>	Controlled seepage of storm water runoff through media, vegetation, or aggregate to reduce pollutants via physical separation.
<b>Flow Control</b>	Control of runoff rates and durations as required by the HMP.
<b>Flow Control BMP</b>	A structural BMP designed to provide control of post-project runoff flow rates and durations for the purpose of hydromodification management.
<b>Flow-thru Treatment</b>	Treatment from a BMP meeting the flow-thru treatment control standard.

<b>Flow-Thru Treatment BMPs</b>	Flow-thru treatment control BMPs are structural, engineered facilities that are designed to remove pollutants from storm water runoff using treatment processes that do not incorporate significant biological methods. Flow-thru BMPs include vegetated swales, media filters, sand filters, and dry extended detention basins. (See <b>Section 5.5.4</b> for illustration and additional information).
<b>Forebay</b>	An initial storage area at the entrance to a structural BMP designed to trap and settle out solid pollutants such as sediment in a concentrated location, to provide pre-treatment within the structural BMP and facilitate removal of solid pollutants during maintenance operations.
<b>Full Infiltration</b>	Infiltration of a storm water runoff volume equal to the DCV.
<b>Geomorphic Assessment</b>	A quantification or measure of the changing properties of a stream channel.
<b>Geomorphically Significant Flows</b>	Flows that have the potential to cause, or accelerate, stream channel erosion or other adverse impacts to beneficial stream uses. The range of geomorphically significant flows was determined as part of the development of the March 2011 Final HMP, and has not changed under the 2013 MS4 Permit. However, under the 2013 MS4 Permit, Q2 and Q10 must be based on the pre-development condition rather than the pre-project condition, meaning that no pre-project impervious area may be considered in the computation of pre-development Q2 and Q10.
<b>GLUs</b>	Classifications that provide an estimate of sediment yield based upon three factors: geology, hillslope, and land cover. GLUs are developed based on the methodology presented in the SCCWRP Technical Report 605 titled “Hydromodification Screening Tools: GIS-Based Catchment Analyses of Potential Changes in Runoff and Sediment Discharge” (SCCWRP, 2010).
<b>Gross Pollutants</b>	In storm water, generally litter (trash), organic debris (leaves, branches, seeds, twigs, grass clippings), and coarse sediments (inorganic breakdown products from soils, pavement, or building materials).
<b>Harvest and Use BMP</b>	Harvest and use (aka rainwater harvesting) BMPs capture and store storm water runoff for later use. These BMPs are engineered to store a specified volume of water and have no design surface discharge until

this volume is exceeded. (See **Section 5.5.1.1** for illustration and additional information).

**HMP** A plan implemented by the Copermittees so that post-project runoff shall not exceed estimated pre-development rates and/or durations by more than 10%, where increased runoff would result in increased potential for erosion or other adverse impacts to beneficial uses. The March 2011 Final HMP and the updated MS4 Permit are the basis of the flow control requirements of this manual.

**Hungry Water** Also known as "sediment-starved" water, "hungry" water refers to channel flow that is hungry for sediment from the channel bed or banks because it currently contains less bed material sediment than it is capable of conveying. The "hungry water" phenomenon occurs when the natural sediment load decreases and the erosive force of the runoff increases as a natural counterbalance, as described by Lane's Equation.

**Hydraulic Head** Energy represented as a difference in elevation, typically as the difference between the inlet and outlet water surface elevation for a BMP.

**Hydraulic Residence Time** The length of time between inflow and outflow that runoff remains in a BMP.

**Hydrologic Soil Group** Classification of soils by the Natural Resources Conservation Service (NRCS) into A, B, C, and D groups according to infiltration capacity.

**Hydromodification** The change in the natural watershed hydrologic processes and runoff characteristics (i.e., interception, infiltration, overland flow, interflow and groundwater flow) caused by urbanization or other land use changes that result in increased stream flows and sediment transport. In addition, alteration of stream and river channels, installation of dams and water impoundments, and excessive stream-bank and shoreline erosion are also considered hydromodification, due to their disruption of natural watershed hydrologic processes.

**Hydromodification Management BMP** A structural BMP for the purpose of hydromodification management, either for protection of critical coarse sediment yield areas or for flow control. See also flow control BMP.

<b>Impervious Surface</b>	<p>Any material that prevents or substantially reduces infiltration of water into the soil.</p>
<b>Infeasible</b>	<p>As applied to BMPs, refers to condition in which a BMP approach is not practicable based on technical constraints specific to the site, including by not limited to physical constraints, risks of impacts to environmental resources, risks of harm to human health, or risk of loss or damage to property. Feasibility criteria are provided in this manual.</p>
<b>Infiltration</b>	<p>In the context of LID, infiltration is defined as the percolation of water into the ground. Infiltration is often expressed as a rate (inches per hour), which is determined through an infiltration test. In the context of non-storm water, infiltration is water other than wastewater that enters a sewer system (including sewer service connections and foundation drains) from the ground through such means as defective pipes, pipe joints, connections, or manholes. Infiltration does not include, and is distinguished from, inflow [40 CFR 35.2005(20)].</p>
<b>Infiltration BMP</b>	<p>Infiltration BMPs are structural measures that capture, store and infiltrate storm water runoff. These BMPs are engineered to store a specified volume of water and have no design surface discharge (underdrain or outlet structure) until this volume is exceeded. These types of BMPs may also support evapotranspiration processes, but are characterized by having their most dominant volume losses due to infiltration. (See <b>Section 5.5.1.2</b> for illustration and additional information).</p>
<b>Jurisdiction</b>	<p>The term “jurisdiction” is used in this manual to refer to individual copermitees who have independent responsibility for implementing the requirements of the MS4 Permit.</p>
<b>LID</b>	<p>A storm water management and land development strategy that emphasizes conservation and the use of onsite natural features integrated with engineered, small-scale hydrologic controls to more closely reflect pre-development hydrologic functions. See <b>Site Design</b>.</p>
<b>Lower Flow Threshold</b>	<p>The lower limit of the range of flows to be controlled for hydromodification management. The lower flow threshold is the flow at which erosion of sediment from the stream bed or banks begins to occur. See also critical channel flow. For the San Diego region, the</p>

lower flow threshold shall be a fraction (0.1, 0.3, or 0.5) of the pre-development 2-year flow rate based on continuous simulation modeling (0.1Q2, 0.3Q2, or 0.5Q2).

**Media** Storm water runoff pollutant treatment material, typically included as a permeable constructed bed or container (cartridge) within a BMP.

**MEP** Refer to the definition in the MS4 Permit. [Appendix C, Definitions, Page C-6]

**National Pollutant Discharge Elimination System** The national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 318, 402, and 405 of the Clean Water Act.

**New Development** Land disturbing activities; structural development, including construction or installation of a building or structure, the creation of impervious surfaces; and land subdivision.

**O&M** Requirements in the MS4 Permit to inspect structural BMPs and verify the implementation of operational practices and preventative and corrective maintenance in perpetuity.

**Partial Infiltration** Infiltration of a storm water runoff volume less than the DCV.

**Partial Retention** Partial retention category is defined by structural measures that incorporate both infiltration (in the lower treatment zone) and biofiltration (in the upper treatment zone).

**PDPs** As defined by the MS4 Permit provision E.3.b, land development projects that fall under the planning and building authority of the Copermittee for which the Copermittee must impose specific requirements in addition to those required of Standard Projects. Refer to **Section 1.4** to determine if your project is a PDP.

**PDPs with only Pollutant Control Requirements** PDPs that need to meet Source Control, Site Design and Pollutant Control Requirements (but are exempt from Hydromodification Management Requirements).

**PDPs with Pollutant Control and Hydromodification** PDPs that need to meet Source Control, Site Design, Pollutant Control and Hydromodification Management Requirements.

**Management Requirements**

<b>Point of Compliance</b>	<p>1. For channel screening and determination of low flow threshold: the point at which collected storm water from a development is delivered from a constructed or modified drainage system into a natural or un-lined channel. POC for channel screening may be located onsite or offsite, depending on where runoff from the project meets a natural or un-lined channel. 2. For flow control: the point at which pre-development and post-development flow rates and durations will be compared. POC for flow control is typically onsite. A project may have a different POC for channel screening vs. POC for flow control if runoff from the project site is conveyed in hardened systems from the project site boundary to the natural or un-lined channel.</p>
<b>Pollutant Control</b>	<p>Control of pollutants via physical, chemical or biological processes</p>
<b>Pollution Prevention</b>	<p>Pollution prevention is defined as practices and processes that reduce or eliminate the generation of pollutants, in contrast to source control BMPs, treatment control BMPs, or disposal.</p>
<b>Post-Project Hydrology Flows, Volumes</b>	<p>The peak runoff flows and runoff volume anticipated after the project has been constructed taking into account all permeable and impermeable surfaces, soil and vegetation types and conditions after landscaping is complete, detention or retention basins or other water storage elements incorporated into the site design, and any other site features that would affect runoff volumes and peak flows.</p>
<b>Potential Critical Coarse Sediment Yield Area</b>	<p>A GLU with coarse-grained geologic material and high relative sediment production, as defined in the Regional WMAA. The Regional WMAA identified GLUs as potential critical coarse sediment yield areas based on slope, geology, and land cover. GLU analysis does not determine whether the sediment produced is critical to the receiving stream (a source of bed material to the receiving stream) therefore the areas are designated as potential.</p>
<b>Pre-Development Runoff Conditions</b>	<p>Approximate flow rates and durations that exist or existed onsite before land development occurs. For new development projects, this equates to runoff conditions immediately before any new project disturbance or grading. For redevelopment projects, this equates to runoff conditions from the project footprint assuming infiltration characteristics of the underlying soil, and existing grade. Runoff</p>

coefficients of concrete or asphalt must not be used. A redevelopment PDP must use available information pertaining to existing underlying soil type and onsite existing grade to estimate pre-development runoff conditions.

**Pre-Project Condition** The condition prior to any project work or the existing condition. Note that pre-project condition and pre-development condition will not be the same for redevelopment projects.

**Pretreatment** Removal of gross solids, including organic debris and coarse sediment, from runoff to minimize clogging and increase the effectiveness of BMPs.

**Project Area** All areas proposed by an applicant to be altered or developed, plus any additional areas that drain on to areas to be altered or developed. Also see **Section 1.3**.

**Project Submittal** Documents submitted to a jurisdiction or Copermittee in connection with an application for development approval and demonstrating compliance with MS4 Permit requirements for the project. Specific requirements vary from municipality to municipality.

**Proprietary BMP** BMP designed and marketed by private business for treatment of storm water. Check with City Engineer prior to proposing to use a proprietary BMP.

**Receiving Waters** See **Waters of the United States**.

**Redevelopment** The creation and/or replacement of impervious surface on an already developed site. Examples include the expansion of a building footprint, road widening, and the addition to or replacement of a structure. Replacement of impervious surfaces includes any activity where impervious material(s) are removed, exposing underlying soil during construction. Redevelopment does not include routine maintenance activities, such as trenching and resurfacing associated with utility work; pavement grinding; resurfacing existing roadways, sidewalks, pedestrian ramps, or bike lanes on existing roads; and routine replacement of damaged pavement, such as pothole repair.

**Retrofitting** Storm water management practice put into place after development has occurred in watersheds where the practices previously did not exist or are ineffective. Retrofitting of developed areas is intended to

improve water quality, protect downstream channels, reduce flooding, or meet other specific objectives. Retrofitting developed areas may include, but is not limited to replacing roofs with green roofs, disconnecting downspouts or impervious surfaces to drain to pervious surfaces, replacing impervious surfaces with pervious surfaces, installing rain barrels, installing rain gardens, and trash area enclosures.

**Regional Water Quality Control Board (SDRWQCB)** California RWQCBs are responsible for implementing pollution control provisions of the Clean Water Act and California Water Code within their jurisdiction. There are nine California RWQCBs.

**Retention (Retention BMPs)** A category of BMP that does not have any service outlets that discharge to surface water or to a conveyance system that drains to surface waters for the design event (i.e. 85<sup>th</sup> percentile 24-hour). Mechanisms used for storm water retention include infiltration, evapotranspiration, and use of retained water for non-potable or potable purposes.

**Saturated Storage** Storage that provides a permanent volume of water at the bottom of the BMP as an anaerobic zone to promote denitrification and/or thermal pollution control. Also known as internal water storage or a saturation zone.

**Self-mitigating Areas** A natural, landscaped, or turf area that does not generate significant pollutants and drains directly offsite or to the public storm drain system without being treated by a structural BMP. See **Section 5.2.1**.

**Self-retaining DMA via Qualifying Site Design BMPs** An area designed to retain runoff to fully eliminate storm water runoff from the 85<sup>th</sup> percentile 24 hours storm event; See **Section 5.2.3**.

**SIC** A Federal government system for classifying industries by 4-digit code. It is being supplanted by the North American Industrial Classification System but SIC codes are still referenced by the Regional Water Board in identifying development sites subject to regulation under the National Pollutant Discharge Elimination System permit. Information and an SIC search function are available at <https://www.osha.gov/pls/imis/sicsearch.html>

**Significant Redevelopment** Redevelopment that meets the definition of a “PDP” in this manual. See **Section 1.4**.

<b>Site Design</b>	A storm water management and land development strategy that emphasizes conservation of natural features and the use of onsite natural features integrated with engineered, small-scale hydrologic controls to more closely reflect pre-development hydrologic functions.
<b>Sizing Factor Method</b>	A method for designing flow control BMPs for hydromodification management using sizing factors developed from unit area continuous simulation models.
<b>Sorption</b>	Physical and/or chemical process where pollutants are taken out of runoff through attachment to another substance.
<b>Source Control</b>	Land use or site planning practices, or structures that aim to prevent runoff pollution by reducing the potential for contamination at the source of pollution. Source control BMPs minimizes the contact between pollutants and storm water runoff. Examples include roof structures over trash or material storage areas, and berms around fuel dispensing areas. Source control BMPs are described within this manual.
<b>Standard Project</b>	Any development project that is not defined as a PDP by the MS4 Permit.
<b>Storm Water Conveyance System</b>	A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or designated and approved management agency under section 208 of the Clean Water Act that discharges to waters of the United States; (ii) Designated or used for collecting or conveying storm water; (iii) Which is not a combined sewer; (iv) Which is not part of the Publicly Owned Treatment Works as defined at 40 CFR 122.26.
<b>Storm Water Pollutant Control BMP</b>	A category of storm water management requirements that includes treatment of storm water to remove pollutants by measures such as

retention, biofiltration, and/or flow-thru treatment control, as specified in this manual. Also called a Pollutant Control BMP.

**Structural BMP** Throughout the manual, the term "structural BMP" is a general term that encompasses the pollutant control BMPs and hydromodification BMPs required for PDPs under the MS4 Permit. A structural BMP may be a pollutant control BMP, a hydromodification management BMP, or an integrated pollutant control and hydromodification management BMP. Structural BMPs as defined in the MS4 Permit are: a subset of BMPs which detains, retains, filters, removes, or prevents the release of pollutants to surface waters from development projects in perpetuity, after construction of a project is completed.

**Subgrade** In-situ soil that lies underneath a BMP.

**Tributary Area** The total surface area of land or hardscape that contributes runoff to the BMP; including any offsite or onsite areas that comingle with project runoff and drains to the BMP. Refer to **Section 3.3.3** for additional guidance Also termed the drainage area or catchment area.

**Unified BMP Design Approach** This term refers to the standardized process for site and watershed investigation, BMP selection, BMP sizing, and BMP design that is outlined and described in this manual with associated appendices and templates. This approach is considered to be "unified" because it represents a pathway for compliance with MS4 Permit requirements that is anticipated to be reasonably consistent across the local jurisdictions in San Diego County. In contrast, applicants may choose to take an alternative approach where they demonstrate to the satisfaction of the Copermittee, in their submittal, compliance with applicable performance standards without necessarily following the process identified in this manual.

**Upper Flow Threshold** The upper limit of the range of flows to be controlled for hydromodification management. For the San Diego region, the upper flow threshold shall be the pre-development 10-year flow rate (Q10) based on continuous simulation modeling.

**Vactor** Refers to a sewer or storm drain cleaning truck equipped to remove materials from sewer or storm drain pipes or structures, including some storm water BMPs.

**Vector** An animal or insect capable of transmitting the causative agent of human disease. An example of a vector in San Diego County that is of concern in storm water management is a mosquito.

**Water Quality Improvement Plan**

Copermittees are required to develop a Water Quality Improvement Plan for each Watershed Management Area in the San Diego Region. The purpose of the Water Quality Improvement Plans is to guide the Copermittees' jurisdictional runoff management programs towards achieving the outcome of improved water quality in MS4 discharges and receiving waters. WQIPs requirements are defined in the MS4 Permit provision B.

**Waters of the United States**

Surface bodies of water, including naturally occurring wetlands, streams (perennial, intermittent, and ephemeral (exhibiting bed, bank, and ordinary high water mark)), creeks, rivers, reservoirs, lakes, lagoons, estuaries, harbors, bays and the Pacific Ocean which directly or indirectly receive discharges from storm water conveyance systems. The Copermittee shall determine the definition for wetlands and the limits thereof for the purposes of this definition, which shall be as protective as the Federal definition utilized by the United States Army Corps of Engineers and the United States Environmental Protection Agency. Constructed wetlands are not considered wetlands under this definition, unless the wetlands were constructed as mitigation for habitat loss. Other constructed BMPs are not considered receiving waters under this definition, unless the BMP was originally constructed within the boundaries of the receiving waters. Also see MS4 permit definition.

**Watershed Management Area**

The ten areas defined by the SDRWQCB in Regional MS4 Permit provision B.1, Table B-1. Each Watershed Management Area is defined by one or more Hydrologic Unit, major surface water body, and responsible Copermittee.

**Watershed Management Area Analysis**

For each Watershed Management Area, the Copermittees have the option to perform a WMAA for the purpose of developing watershed-specific requirements for structural BMP implementation. Each WMAA includes: GIS layers developed to provide physical characteristics of the watershed management area, a list of potential

## **Glossary of Key Terms**

offsite alternative compliance projects, and areas exempt from hydromodification management requirements.