EXHIBIT 7.III

TECHNICAL GUIDANCE DOCUMENT FOR THE PREPARATION OF CONCEPTUAL/PRELIMINARY AND/OR PROJECT WATER QUALITY MANAGEMENT PLANS (WQMPs)

Submittal to Santa Ana Regional Water Quality Control Board

May 24, 2010

Summary of Comments on TechnicalGuidance-edited.pdf

This page contains no comments

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Table of Acronyms

BMP – best management practice

CEQA - California Environmental Quality Act

1 CMF – cartridge media filtration

CWA – Federal Clean Water Act

DAMP – Drainage Area Management Plan

DCIA – directly connected impervious area

DEDB – dry extended detention basin

ESA – environmentally sensitive area

ET – evapotranspiration

HCOC – hydrologic condition of concern

HSC – hydrologic source control

IE – irrigation efficiency

IR – effective irrigation area ratio

IWRMP – integrated water resources management plan

LID – low impact development

LIP – Local Implementation Plan

MEP – maximum extent practicable

MS4 – municipal separate storm sewer system

NOC – North Orange County (Region 8- SARWQCB Jurisdictional Area)

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Add: WMP, HMP

NPDES – National Pollutant Discharge Elimination System

NTS – natural treatment systems

OCWD – Orange County Water District

POC – pollutant of concern

RWQCB – Regional Water Quality Control Board

SARWQCB – Santa Ana Regional Water Quality Control Board

SDRWQCB – San Diego Regional Water Quality Control Board

SOC – South Orange County (Region 9 -SDRWQCB Jurisdictional Area)

SQDF - stormwater quality design flow

SQDV – stormwater quality design volume

SSMP – Standard Stormwater Mitigation Plan

TGD – Technical Guidance Document

TMDL – Total Maximum Daily Load

WMA – Watershed Management Area

WQ – water quality

WQDF – water quality design flow

WQDV – water quality design volume

WQMP – water quality management plan

Glossary of Key Terms

2-year, 24-hour event – a 24-hour storm event expected to be equaled or exceeded, on average, every 2 years.

Agronomic demand – the amount of irrigation required to meet plant water needs, accounting for inefficiencies in irrigation.

Alternative compliance program – encompasses the elements used to satisfied remaining performance criteria after consideration of on-site LID BMPs (and in North Orange County, after consideration of both on-site and sub-regional/regional LID BMPs).

Average annual capture efficiency (a.k.a. capture efficiency) **–** the estimated percent of long term average annual runoff volume that is managed/controlled by a BMP. Target capture efficiency serves as one element of the performance criteria for LID and treatment control BMPs.

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Add definitions for: priority project, non-priority project, preliminary project WQMP, conceptual project WQMP, final project WQMP, maximized retention volume, capture efficiency, pollutant of concern, primary pollutant of concern, assessment of susceptibility, capture efficiency method, source control BMP, opportunity criteria, performance criteria, effective irrigation area ratio

Biotreatment BMP – a class of LID BMPs, biotreatment BMPs are vegetated treat-and-release BMPs that also promote infiltration and/or evapotranspiration.

Biotreatment volume – the volume of storage in biotreatment BMPs, measured from the overflow elevation of the BMP, which would be treated and discharged as the BMP drains; this volume includes surface storage and pore storage but does not include the volume that would be retained in the BMP and discharged to infiltration, ET, or uses.

Crop coefficient – a ratio used to estimate the water needs of a plant pallet in relation to a reference crop, generally defined as grass or alfalfa surfaces whose biophysical characteristics have been studied extensively.

Design capture storm depth – the 85th percentile, 24-hr storm depth as shown in Figure 6.2.

Design capture volume – the ~~runoff~~ resulting from the design capture storm depth; one component of the performance criteria for LID BMPs as well as treatment control BMPs.

Design criteria – requirements that serve as the basis for designing a BMP to meet performance criteria. Design criteria may encompass BMP sizing and other characteristics of BMP design.

Drainage Area Management Plan (DAMP) **–** The specific water pollutant control elements of the Orange County Stormwater Program are documented in the Drainage Area Management Plan (DAMP), which is the Permittees' primary policy, planning and implementation document for municipal NPDES Stormwater Permit compliance.

Drawdown – the act of discharging water from a BMP. Drawdown provides storage volume for subsequent storm events. Depending on BMP type, water may discharge to infiltration, ET, various uses, or be treated and released to the downstream system.

Drawdown rate – the rate at which water discharges from a BMP, making storage volume available for subsequent storm events. Depending on BMP type, water may discharge to infiltration, ET, various uses, or be treated and released to the downstream system.

Drawdown time – the time it takes to drain 90 percent of the water in a BMP from brim full. Drawdown time may need to be calculated separately for the retention volume of the BMP and the biotreatment volume of the BMP, in order to support design calculations if both types of volume exist. These separate measures are referred to as the "retention drawdown time" and the "biotreatment drawdown time".

Evapotranspiration (ET) - the loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues). As used in this TGD, evapotranspiration refers to one or both of these processes.

Evapotranspiration BMP (aka ET BMP) **–** a class of retention BMPs that discharges stored volume predominantly to evapotranspiration; some infiltration may occur. Evapotranspiration

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outlet

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volume of storm water

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volume-based

includes both evaporation and transpiration, and ET BMPs may incorporate one or more of these processes.

Fluvial geomorphology - the scientific study of the formation of fluvial landforms (rivers, streams, etc.) and the processes that shape them.

Harvest and Use – The act of capturing stormwater, storing it, and making it available for subsequent use. This act is performed by Harvest and Use BMPs.

Harvest and Use BMP (aka Rainwater Harvesting BMP) **–** a class of retention BMPs that captures stormwater runoff and stores it for subsequent use.

Hydrocollapse - a sudden collapse of granular soils cause by a rise in groundwater dissolving or deteriorating the inter-granular contacts between the sand particles

Hydrologic condition of concern – A land condition (or change in land conditions) that is anticipated to cause hydromodification impact.

Hydrologic source control (HSC) - a class of LID BMPs integrated with site design that retain stormwater runoff and reduce the volume (and potentially rate) of stormwater discharge to the downstream system. HSCs are differentiated from retention and biotreatment classes of LID BMPs by their higher level of integration with a site and by less strict engineering design criteria. An example includes routing roof runoff into adjacent landscaped areas.

Hydromodification – Changes in runoff and sediment yield caused by land use modifications.

Hydromodification control – Management techniques which reduce the potential for hydromodification impact.

Hydromodification impact – The physical response of stream channels to changes in runoff and sediment yield caused by land use modifications

Infiltration BMP – a class of retention BMPs that discharges stored volume predominantly to deeper infiltration; some evapotranspiration may also occur.

In-stream control *(in hydromodification control context)* **–** Modification of a receiving channel to reduce the potential for hydromodification impacts.

Irrigation Area Ratio – a ratio describing the agronomic irrigation demand for harvested stormwater as a fraction of the tributary area to the stormwater storage device (unitless, see Section 6.4.2.5)

Irrigation Efficiency – the ratio of plant irrigation needs met to the amount of irrigation water applied. A value of 0.75 implies that 1 inch of irrigation water must be applied to satisfy 0.75 inches of plant water needs.

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LID BMP – a BMP that provides retention or biotreatment as part of an LID strategy – these may include hydrologic source controls, retention, and biotreatment, and may be located either on-site or off-site. Examples include bioretention systems (introduced runoff into planter areas for infiltration with no underdrains), filtration thru planter media with underdrains, harvest and use systems, and green roofs

LID site design – the component of LID that relates to the way in which a site is laid out to achieve ~~strategic stormwater management and resource management objectives.~~ Site design practices ~~work synergistically with~~ LID BMPs, treatment control, and hydromodification control strategies. Example practices include minimizing impervious areas and locating pervious areas such that impervious areas can drain to pervious areas.

Liquefaction - a seismically-induced phenomenon in which saturated granular materials, typically possessing low to medium density, undergo matrix rearrangement, develop high pore water pressure, and lose shear strength due to cyclic ground motions induced by earthquakes. This rearrangement and strength loss is followed by a reduction in bulk volume.

Local Implementation Plan (LIP) - The Local Implementation Plan (LIP) describes how the DAMP is being implemented on a local level. The DAMP provides a foundation for the description and detail of how the Orange County Stormwater Permittees implement model programs designed to prevent pollutants from entering receiving waters to the maximum extent practicable (MEP). The LIP is designed to work in conjunction with the DAMP and each city and the County have developed a comprehensive LIP that is specific to their jurisdiction.

Natural treatment systems (NTS) – refers to systems such as those proposed by the San Diego Creek NTS Master Plan (www.naturaltreatmentsystem.org)

On-site LID practices – LID practices that are implemented within the project boundary; encompasses site design practices, hydrologic source controls, on-site retention BMPs, and on-site biotreatment BMPs.

Performance criteria –permit-based requirements against which the performance of a system is compared to assess compliance. There are three separate types of performance criteria: 1) LID, 2) treatment control, and 3) hydromodification control. These performance criteria are evaluated individually although they can be interrelated. It is possible to meet one and not meet the others, ~~or vice versa.~~ This is synonymous with "performance standard" as used by other guidance documents, but only "performance criteria" is used in this document.

Project Water Quality Management Plan (Project WQMP) - a project submittal that describes the Best Management Practices (BMPs) that will be implemented and maintained throughout the life of a project. This term is used in this TGD to describe Conceptual/Preliminary and final Project WQMPs.

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provide a definition for this term

Number: 2 Author: staff Subject: Underline Date: 6/24/2010 3:02:32 PM
If this is intended to refer to a rain garden or biofilter, please state so.

Number: 3 Author: staff Subject: Highlight Date: 6/24/2010 3:00:11 PM
This is inconsistent with the definition given on p 7.II C-1. Consider changing references to "bioretention" in Appendix C to "biodetention".

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Vague. Replace with direct language.

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compliment

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This definition is so technical that it's practical significance is lost: it is a geological hazard that can result in damage to structures.

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A more complete definition is needed for the reader who is new to this term.

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Retention BMP – a class of LID BMPs including infiltration BMPs, evapotranspiration BMPs, and harvest and use BMPs whose design does not allow ~~surface discharges to occur below the design storm volume;~~ These BMPs either infiltration, evapotranspire, or allow for use of the retention volume.

Retention volume – the volume of storage in retention and biotreatment BMPs, measured from the overflow elevation of the BMP, which would be retained and discharged to infiltration, ET, or uses as the BMP drains. All storage volume is retention volume in retention BMPs.

Sizing criteria – specific design criteria related to BMP size that serve as a basis for meeting performance criteria.

Standard Stormwater Mitigation Plan (SSMP) – see Project WQMP

Susceptibility (*in hydromodification context*) **–** a channel's lack of ability to resist physical response due to hydromodification

Treatment control BMP – ~~a treat and release BMP~~ that addresses pollutants of concern, but is not a biotreatment BMP. Examples include sand filters and cartridge media filters.

Waiver - process by which project proponents must document and submit a request to implement alternative requirements if it is determined to be infeasible to fulfill the on-site LID performance requirements.

Water quality credit system – the system by which certain project types are granted reduction in the criteria for determining treatment control and/or offsite mitigation requirements for alternative program requirements.

Watershed-based plan – refers to a RWQCB Executive Officer-approved Watershed Master Plan (WMP), Hydromodification Management Plan (HMP), or other RWQCB Executive Officer-approved watershed-based plan developed with consideration for water quality, hydrologic, fluvial, water supply, and/or habitat, consistent with the LID and hydromodification principles and criteria described in the North County and/or South County permit. Watershed-based plans may include specific guidance and support for applying LID feasibility criteria, but may not substantively alter LID performance criteria. Approved WMPs and HMPs may substantively alter hydromodification performance criteria.

Watershed Management Area (WMA) - Watershed Management Areas (WMAs) are used in the countywide Water Quality Strategic Plan as the structure for water resource management. The eleven watersheds in Orange County are grouped by similar characteristics into three Watershed Management Areas: North, Central, and South County.

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the discharge of the design capture volume to the storm drainage system or surface water.

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a structure designed to treat pollutants in storm water runoff and release the treated runoff to surface waters or a storm drain system

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This also includes the process for documenting, substantiating and submitting a request to not employ treatment control BMPs for a project if the cost of implementing BMPs greatly outweighs the pollution control benefits.

Section 1. Background

This Technical Guidance Document (TGD) has been developed by the County of Orange in cooperation with the incorporated Cities of Orange County to aid agency staff and project proponents with addressing post-construction urban runoff and stormwater pollution from new development and significant redevelopment projects in the County of Orange. The ~~role~~ [1]f this document is to serve as the technical resource companion to the Model Water Quality Management Plan (Model WQMP). The Model WQMP provides a framework for developing a Conceptual/Preliminary and/or Project WQMP that minimizes the negative impacts of urbanization on site hydrology, urban runoff flow rates or velocities, and pollutant loads.

A Conceptual/Preliminary and/or Project WQMP describes the Best Management Practices (BMPs) that will be implemented and maintained throughout the life of a project. Conceptual and Preliminary WQMPs are fundamentally identical and the preferred nomenclature depends on the reviewing jurisdiction. Conceptual/Preliminary WQMPs are required to be prepared at the planning phase of projects subject to discretionary approval and are ~~recommended~~ [2]r all [3] projects. The Conceptual/Preliminary WQMP is intended to describe, at the earliest possibly phase in the development process, the BMPs that will be implemented and maintained throughout the project. The level of detail in a Preliminary/Conceptual WQMP submitted during the land use entitlement process will depend upon the level of detail known about the overall project design at the time project approval is sought. For projects with ministerial approval, a Conceptual/Preliminary WQMP may not be required, but is encouraged.

A final Project WQMP is required for all [4]Priority Projects at the ministerial approval phase prior to final approval of a grading or building permit. Priority Projects may submit the final Project WQMP documentation in the format approved by the relevant permittee prior to obtaining ministerial permit(s). The final Project WQMP is expected to have to reflect the detail available at the time of project ministerial-level approval.

The San Diego Regional Water Quality Control Board (San Diego Regional Board) uses the term Standard Stormwater Mitigation Plan (SSMP) to refer to the same fundamental process described above for WQMPs. These terms are functionally very similar. The County of Orange uses the term WQMP solely, and WQMP is used throughout this TGD.

Th~~is~~ [5]GD provides additional detail on requirements and explains the analyses necessary for preparing the Conceptual/Preliminary and/or Project WQMP. In this document the general term "Project WQMP" is used to refer to Conceptual/Preliminary and Final Project WQMPs.

1.1. [6]Regulatory Background

Within the Santa Ana Regional Water Quality Control Board (Santa Ana Regional Board) jurisdiction, the Fourth Term MS4 Permit (Order R8-2009-0030) ("North County Permit") has been adopted with specific requirements for new development and significant redevelopment stormwater control.

Within the San Diego Regional Water Quality Control Board (San Diego Regional Board) jurisdiction, the Fourth Term MS4 Permit Order (R9-2009-0002) ("South County Permit) has

Page: 14

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purpose

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required

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such

Number: 4 Author: staff Subject: Underline Date: 7/12/2010 11:10:56 AM
Provide a summary for what happens for non-Priority Projects.

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e

Number: 6 Author: staff Subject: Underline Date: 6/25/2010 12:08:57 PM
Add some language that describes who the permitees are and explains that this document describes how the permittees will comply with requirements for new development and significant redevelopment. Also add language that describes the obligation of the project proponent and successors to fully implement the approved final project WQMP and note applicable ordinances, conditions of approval, and other enforcemetn mechanisms.

been adopted with similar but somewhat differing requirements for new development and significant redevelopment stormwater control.

The North County Permit requires the development of this TGD. Although the South County Permit does not require the preparation of a guidance document, this document has been developed to serve as a technical resource for developing Conceptual/Preliminary and/or Project WQMPs in both the Santa Ana and San Diego Regional Board permit areas.

1.2. Role of Technical Guidance Document (TGD)

This TGD is a technical resource for implementing the requirements of both the North County and South County Permits within the framework of the Conceptual/Preliminary and/or Project WQMP development, review, and approval process governed by the Drainage Area Management Plan (DAMP) and Model WQMP. [1] The Cities and County of Orange may adapt this guidance as appropriate for their jurisdiction in their Local Implementation Plans (LIPs).

This TGD is applicable to all projects determined to be Priority Projects, as defined within the Model WQMP, and also assists in selecting BMPs and other site elements for Non-Priority Projects. [2] This TGD does not describe the requirements for Non-Priority Projects.

1.3. Stormwater Management Principals for New Development/ Significant Redevelopment Projects

[3] ~~New development and significant redevelopment projects are required to develop and implement a Conceptual/Preliminary and/or Project WQMP that includes site design features and stormwater management BMPs.~~ This document will describes the methods by which low impact development (LID), hydromodification control, and treatment control requirements are [4] met. [5]

LID is a stormwater management strategy that emphasizes conservation and use of existing site features integrated with distributed stormwater controls that are designed to more closely mimic natural hydrologic patterns of un-developed sites than traditional stormwater management controls. LID includes both site design and structural measures, as described below. Components of LID are considered to be "preventative" in that they prevent runoff from occurring by reducing the elements of development that produce runoff. These are referred to in this TGD as "LID Site Design Practices" or simply "Site Design Practices." Other elements of LID are considered to be "mitigative" in that they are used to manage runoff that is generated. These are referred to in this TGD as "LID BMPs." Hydrologic source controls (HSCs) are a group of site design practices for which this TGD provides a method of quantitatively estimating benefits. Therefore, these practices are considered separately from other site design practices described in this TGD.

Hydromodification control includes measures to minimize the potential for hydromodification impacts to streams as a result of land changes. Hydromodification is the physical response of

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Number: 1 Author: staff Subject: Underline Date: 7/12/2010 11:13:53 AM

This is an inadequate description of how the local jurisdictions will implement the MWQMP and it's related Technical Guidance Document. Provide additional detail here or reference an appropriate section in the MWQMP itself.

Number: 2 Author: staff Subject: Highlight Date: 6/24/2010 4:16:24 PM

Then what will describe the requirements for non-priority projects?

Number: 3 Author: staff Subject: Cross-Out Date: 7/12/2010 11:15:28 AM

This is incorrect. Priority projects are a subset of new development and significant redevelopment projects. Only priority projects require WQMPs and treatment control BMPs. Non-priority projects must still document their BMPs, but the documentation does not necessarily need to be a WQMP and the BMPs do not need to include treatment control BMPs. Consequently, this highlights a gap in the permittees' program: if not with WQMPs, how will BMPs for non-priority projects be documented?

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by the Permittees and project proponents.

stream channels to changes in catchment runoff and sediment yield caused by land use. Controls include site design, hydrologic controls, and in-stream controls

Treatment control refers to structural non-LID measures which are used to remove pollutants from stormwater. Controls may be on-site or regional.

Depending upon the project size and characteristics, the Conceptual/Preliminary and/or Project WQMP may include combinations of:

- **LID Site Design Practices:** components of an overall LID strategy that relate to the way in which a site is laid out to achieve stormwater management and resource management objectives. Site design practices work synergistically with LID BMPs, treatment control, and hydromodification control strategies. Example practices include minimizing impervious areas and locating pervious areas such that impervious areas can drain to pervious areas.
- **On-site, Sub-regional , or Regional LID BMPs:** structural measures that provide retention or biotreatment of stormwater as part of an LID strategy – these may be located either on-site or off-site as dictated by LID performance criteria. Examples include bioretention systems (introduced runoff into planter areas for infiltration with no underdrains), filtration thru planter media with underdrains, harvest and use systems, green roofs, and regional natural treatment systems (NTS).
- **Hydromodification Control BMPs:** on-site, regional, or in-stream measures uses as part of an overall strategy to reduce the potential for hydromodification impact.
- **Treatment Control BMPs:** structural measures designed to remove pollutants of concern from stormwater, but which do not meet criteria to be categorized as biotreatment systems.
- **Source Control BMPs:** non-structural and structural practices intended to prevent the introduction of pollutants into stormwater.

New development and significant redevelopment projects are required to identify existing or potential hydrologic conditions of concern (HCOCs). An HCOC exists when the hydrologic regime of a site is altered or may be altered and there is potential for impacts on downstream channels and aquatic habitat, alone or in conjunction with impacts of other projects. New development and significant redevelopment projects are required to perform this assessment and incorporate appropriate hydromodification controls to ensure that HCOCs are mitigated.

1.4. Use and Organization of the Technical Guidance Document

This TGD is intended to be used in conjunction with the Model WQMP to develop Conceptual/Preliminary and/or Project WQMPs that meet the requirements of the County's stormwater program.

- Section 1 provides an introduction to the ~~role~~ of the document and its use.

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Number: 1 Author: staff Subject: Underline Date: 6/25/2010 10:55:48 AM

Note here that treatment control commonly refers to all structural measures but, for the purposes of this Document, you're excluding non-LID measures.

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Treatment controls are required for Priority Projects but are not for Non-Priority Projects. Permittees may grant a project a Waiver from treatment controls after undergoing rigorous feasibility analyses described in the Model WQMP and in this supporting document.

Number: 3 Author: staff Subject: Underline Date: 6/25/2010 11:06:09 AM

Provide examples.

Number: 4 Author: staff Subject: Underline Date: 6/25/2010 12:14:16 PM

The purpose and utility of this entire section is not evident. If the purpose is to provide a ready reference for the user to locate specific information, this section is a poor mechanism. That should be accomplished through the Table of Contents and the Table should be structured and labeled for this purpose, anticipating the user's needs.

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Number: 6 Author: staff Subject: Inserted Text Date: 6/25/2010 11:06:54 AM

purpose

- Section 2 contains stormwater management design standards, performance criteria, and recommended hydrologic methods. This Section supports the remainder of this TGD and the Conceptual/Preliminary and/or Project WQMP preparation process described in Section 7.II-2.2 of the Model WQMP.
- Section 3 provides guidance for site planning and Conceptual/Preliminary and/or Project WQMP preparation, including assessing site conditions and ~~other~~ constraints, addressing pollutants of concern, ~~evaluating receiving water applicability~~ and ~~susceptibility related to hydromodification control~~, preliminary BMP selection and site design, and BMP configuration and feasibility. This section expands on the site assessment and Conceptual/Preliminary and/or Project WQMP preparation process described in Section II-2.1 and 2.2 of the Model WQMP, respectively.
- Section 4 provides guidance for site design principles and practices, including site planning and layout, vegetative protection, revegetation, and maintenance, slopes and channel buffers, techniques to minimize land disturbance, LID BMPs at scales from single parcels to watershed, and integrated water resource management practices. This section supports the Conceptual/Preliminary and/or Project WQMP preparation process by reference from Section 3.
- Section 5 provides guidance for the type, functionality, and selection of Source Control Measures, both structural and non-structural. This section supports the Conceptual/Preliminary and/or Project WQMP preparation process by reference from Section 3 and expands on Section 7.II-3.0 of the Model WQMP.
- Section 6 provides guidance for LID BMPs and treatment control design, including selection, configuration, feasibility, calculating design criteria, infiltration BMPs, harvest and use BMPs, evapotranspiration BMPs, biotreatment BMPs, treatment control BMPs, and pretreatment/gross solids removal. This section supports the Conceptual/ Preliminary and/or Project WQMP preparation process by reference from Section 3.
- Section 7 provides guidance for design approaches for hydromodification control BMPs, including calculating design criteria, on-site / distributed controls, regional controls, and in-stream controls. This section supports the Conceptual/Preliminary and/or Project WQMP preparation process by reference from Section 3 and expands on Section 7.II-2.3 of the Model WQMP.
- Section 8 describes alternative compliance approaches and waivers, with specific project considerations. This section expands on the alternative compliance program develop process described in the Model WQMP (Section 7.II-2.4)
- Section 9 provides general considerations and information on operation and maintenance planning, maintenance plans, and agreements. This section expands on the alternative compliance program develop process described in the Model WQMP (Section 7.II-2.4)

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Number: 1 Author: staff Subject: Underline Date: 6/25/2010 11:08:31 AM
Its unclear what this means. Restate for clarity.

Number: 2 Author: staff Subject: Replacement Text Date: 6/25/2010 11:56:47 AM
identifying

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identify receiving waters and related priority pollutants of concern

Number: 4 Author: staff Subject: Highlight Date: 6/25/2010 11:59:42 AM

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hydraulic conditions of concern

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s

Section 2. Stormwater Management Performance Criteria and Hydrologic Methods

2.1. Introduction

Priority Projects are required to implement LID, treatment control, and hydromodification control BMPs which meet numeric sizing criteria. Source control BMPs are also required for Priority Projects, but numeric performance criteria do not apply. This section provides guidance on performance criteria for LID, treatment control, and hydromodification control BMPs as well as the hydrologic calculation methods used to assess compliance with the performance criteria. Performance criteria for source control BMPs are contained in the Model WQMP.

While Priority Projects must demonstrate compliance with LID, treatment control, and hydromodification control requirements separately, these provisions overlap significantly and some BMPs may fulfill or partially fulfill a portion of one or more of these requirements. The LID and treatment control requirements are especially interrelated because compliance with LID requirements inherently results in compliance with treatment control requirements. LID and hydromodification control requirements are also interrelated as both are based on reduction of runoff volume as their first priority.

Section 2.2 describes the performance criteria for LID, treatment control, and hydromodification control, and Section 2.3 describes the recommended hydrologic calculation methods that are common to the development of sizing criteria to meet these performance criteria.

2.2. Performance Criteria

Performance criteria include narrative and numeric requirements that underlie ~~stormwater management design standards.~~

2.2.1. Site Design Practices Performance Criteria

Site design practices include a wide range of potential practices that can be implemented to reduce the volume of stormwater runoff generated on a Priority Project site as well as improving the quality of runoff that leaves the site. Site design practices are predominantly "preventative" in nature as they reduce the amount of runoff and other impacts before, or immediately after, they occur. Examples of "preventative" aspects of site design practices include reduction of impervious area, preservation of drainage courses, and restoration of impacted soils. Descriptions of the most common site design practices are provided in Section 4.

There are no numeric performance criteria for site design practices, however, site design practices should be considered as the first priority in the hierarchy of LID implementation, beginning with the earliest phases of a project. The use of effective site design practices can result in smaller LID, treatment control, and hydromodification control BMPs than if site design practices are not used. Including space for BMPs in the site design at the earliest phases of the project planning process allows Priority Projects to more easily satisfy numeric performance criteria.

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Number: 1 Author: staff Subject: Underline Date: 7/12/2010 11:31:12 AM

There's generally two types of sizing criteria: those specified in the Permit, and those derived from meeting design parameters of a particular BMP to meet the sizing criteria in the Permit (e.g. factors of safety, contact times, etc.). It's not clear if this term is intended to address all of these criteria or just the first type. Further explanation is needed.

Number: 2 Author: staff Subject: Underline Date: 6/25/2010 12:22:19 PM

If this is intended to be equal to "numeric sizing criteria", select a term and use it consistently.

Number: 3 Author: staff Subject: Underline Date: 6/25/2010 12:24:09 PM

Explain why.

Number: 4 Author: staff Subject: Underline Date: 6/25/2010 12:25:26 PM

Include specific section references for ease of use.

Number: 5 Author: staff Subject: Replacement Text Date: 6/25/2010 12:24:32 PM

Narrative p

Number: 6 Author: staff Subject: Cross-Out Date: 7/12/2010 11:33:31 AM

There is only one other instance of this term in this entire document. It sounds important, but is evidently not. It should be deleted because it invites the reader to think that there are "stormwater management design standards" that are separate from performance criteria. If the reader attempted to find them, they would be unsuccessful.

Number: 7 Author: staff Subject: Highlight Date: 6/25/2010 3:02:54 PM

"Practices" and "BMPs" are used throughout this document as though they are different concepts at times, interchangeably at others. This is confusing. If they are intended to be different concepts, provide a definition that distinguishes the two and use the terms consistent with the definitions. If they are the same, then select one term and use it consistently.

Number: 8 Author: staff Subject: Sticky Note Date: 8/5/2010 3:33:07 PM

This section does not provide much useful information. It is appropriate to organize specific performance criteria for particular methods by each method. But this section's sub-heading suggests organization of performance criteria by categories of methods. At least, performance criteria applicable to the broader category of methods should be described here as indicated. However, the needed information that the reader is led to believe is here, is not.

In the context of this TGD, some site design practices are categorized specifically as hydrologic source controls (HSCs, Section 6.5). Hydrologic source controls are integrated and distributed micro-scale stormwater infiltration and evapotranspiration systems that are an integral part of LID site design. These practices are distinguished from "preventative" site design, such as minimization impervious area, because they address runoff that has already been generated instead of avoiding the construction of runoff-generating surfaces. These systems are distinguished from LID BMPs discussed in Section 2.2.2 below because they are highly integrated with LID site designs, they are generally applied opportunistically, they are not governed by fixed sizing criteria, and they are less stringently engineered than the LID BMPs. This TGD allows projects to calculate the benefits of HSCs when determining the amount of remaining requirements that must be met in downstream BMPs.

HSCs are listed first throughout this document because they are generally applied at the site design phase of the Project WQMP development process. If the benefits of HSCs are accounted for in the system design process, these benefits should be calculated before determining sizing criteria for downstream BMPs.

2.2.2. Low Impact Development BMP Performance Criteria

LID BMPs shall be implemented to the extent feasible to control runoff volumes that are generated on a Priority Project site. ~~These practices are inherently "mitigative" in that they control stormwater runoff after it has been initially generated.~~ LID BMPs refers to a broad class of practices that includes:

- **Infiltration BMPs** (Section 6.6): Infiltration BMPs are LID BMPs that capture, store and infiltrate stormwater runoff. These BMPs are engineered to store a specified volume of water and ~~have no design surface discharge~~ (underdrain or outlet structure) ~~until the storage volume is exceeded.~~ These types of BMPs may also discharge some water to evapotranspiration, but are characterized by having their most dominant discharge to infiltration.

- **Harvest and Use BMPs** (Section 6.7): Harvest and use BMPs are LID BMPs that capture and store stormwater 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. The use of captured water should comply with health and building codes, sanitary sewer discharge requirements, and other regulations, where applicable. ~~The use of harvested water should not result in runoff to storm drains or receiving waters (except indirectly via the sanitary sewer/municipal wastewater treatment system). Uses of captured water potentially include irrigation demand, indoor non-potable demand, industrial process water demand, or other allowed uses.~~

- **Evapotranspiration BMPs** (ET BMPs, Section 6.8): ET BMPs are LID BMPs that capture stormwater runoff and "discharge" primarily to evapotranspiration. These BMPs are engineered to store a specified volume of water and have no design surface discharge until this volume is exceeded. These BMPs are generally vegetated and exposed to the atmosphere and are either lined to prevent infiltration or have very low underlying

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Number: 1 Author: staff Subject: Underline Date: 8/5/2010 3:33:53 PM

The subheading title misleads the reader to believe that the performance criteria can be found here. But this paragraph indicates that the performance criteria is scattered throughout this document. This causes the reader to read through this only to discover that they're reading the wrong section; that the information is elsewhere; but there is no comprehensive reference in the section to its locations. The performance criteria and technical methods need to be organized for easy reference.

Number: 2 Author: staff Subject: Underline Date: 8/5/2010 3:34:10 PM

This sentence needs to be modified and a better explanation of the organization of this document needs to be provided in order to help the reader find information that they're looking for.

Number: 3 Author: staff Subject: Underline Date: 8/5/2010 3:34:33 PM

This statement has serveral new or vague terms (system design process, benefits, downstream BMPs) that are not defined, are indirect references to other concepts, or have no context. The ideas need to be separated out and explained clearly.

Number: 4 Author: staff Subject: Underline Date: 7/12/2010 11:40:38 AM

This subheading misleads the reader to believe that performance criteria follows. Re-title to accurately describe the subsequent content.

Number: 5 Author: staff Subject: Cross-Out Date: 6/25/2010 3:39:18 PM

Number: 6 Author: staff Subject: Cross-Out Date: 7/12/2010 11:42:37 AM

Number: 7 Author: staff Subject: Replacement Text Date: 7/12/2010 11:42:30 AM

except in the case of overflow, are not designed to discharge to storm drain systems or surface water bodies

Number: 8 Author: staff Subject: Sticky Note Date: 6/28/2010 10:18:15 AM

General descriptions of BMPs should be placed elsewhere in order to condense this section down to the subject of the subheading: performance criteria.

Number: 9 Author: staff Subject: Cross-Out Date: 6/28/2010 12:57:53 PM

This is a narrative performance criteria that should be consolidated elsewhere with other relevant criteria.

Number: 10 Author: staff Subject: Replacement Text Date: 7/12/2010 11:45:54 AM

Captured storm water is typically used for non-potable purposes such as landscape irrigation, indoor uses such as toilet flushing, industrial processes, or other allowable uses.

Number: 11 Author: staff Subject: Inserted Text Date: 6/28/2010 12:58:19 PM

and the BMP overflows

infiltration rates (such that infiltration does not dominate the discharge). Most commonly, ET BMPs are designed to store water in soil pores and plant tissue.

- **Biotreatment BMPs** (Section 6.9): Biotreatment BMPs are a broad class of BMPs that treat stormwater using ~~a suite of treatment mechanisms characteristic of biologically active systems~~ [1]nd discharge water to the downstream storm drain system or directly to receiving waters. Treatment mechanisms include media filtration (through biologically-active media), vegetative filtration (straining, sedimentation, interception, and stabilization of particles result from shallow flow through vegetation), general sorption processes (i.e., absorption, adsorption, ion-exchange, precipitation, surface complexation), biologically-mediated transformations, and other processes to address both suspended and dissolved constituents. Biotreatment BMPs include both flow-based and volume-based BMPs. Biotreatment BMPs may reduce the volume of stormwater via incidental infiltration and evapotranspiration.

Proprietary BMPs may [2]~~potentially~~ be categorized as LID BMPs if they are functionally equivalent to the LID BMPs categories described above.

The numeric performance for overall LID implementation may be met by combining the types of LID BMPs described above according to the hierarchy stated in below.

2.2.2.1. [3]~~*Regulatory Criteria*~~

The [4]performance criteria for LID implementation are as follows:

- Priority Projects shall infiltrate, harvest and use, evapotranspire, or biotreat, the 85th percentile, 24-hour storm event ("design capture volume") to the extent feasible.

- A properly designed biotreatment system may only be considered if infiltration, harvest and use, and ET cannot be feasibly implemented for the full design capture volume. In this case, infiltration, harvest and use, and ET practices shall be implemented to the maximum extent practicable (MEP) and biotreatment shall be provided for the remaining design capture volume to the MEP.

[5]~~**Special Considerations**~~

Site design practices (including HSCs) ~~are the first priority, however, these practices are not required to meet numeric criteria and are optional for Priority Projects that meet the LID performance criteria through other measures.~~ [6]~~For Priority Projects which cannot feasibly meet numeric performance criteria with other LID BMPs, it is mandatory to select HSCs to the MEP~~ [7] [8]and account for their effects in developing system designs to demonstrate the maximum feasible amount of the performance standard that can be met. These practices can reduce the size of downstream BMPs. In some projects with a high ratio of pervious area to impervious area, where it can be demonstrated that the design capture volume is completely retained, the use of effective HSCs could completely supplant the use of other LID BMPs. For example, paved bike trails through a park could readily be designed to drain to adjacent landscaping and produce no runoff during the design capture storm event. Likewise, landscape can be designed

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Number: 1 Author: staff Subject: Replacement Text Date: 6/25/2010 4:22:52 PM

the biological activity of soil microbes and plants

Number: 2 Author: staff Subject: Cross-Out Date: 6/28/2010 9:19:00 AM

Number: 3 Author: staff Subject: Cross-Out Date: 6/28/2010 10:26:10 AM

What follows is not a complete accounting of the permit requirements and the subheading used could mislead the reader. Change this subheading to accurately reflect the subject.

Number: 4 Author: staff Subject: Underline Date: 6/28/2010 10:19:05 AM

Explain the relationship between regulatory criteria and performance criteria.

Number: 5 Author: staff Subject: Cross-Out Date: 6/28/2010 10:23:22 AM

For ease of use, retitle to be more specific to the subject of the following paragraph.

Number: 6 Author: staff Subject: Replacement Text Date: 6/28/2010 9:35:24 AM

should be considered early in the design of a project. Site design practices may reduce the design capture volume but are not subject to numeric sizing criteria. Site design practices are not necessary if LID BMPs are applied which can infiltrate, harvest and re-use, or evapotranspirate (but not biotreat) the design capture volume.

Number: 7 Author: staff Subject: Replacement Text Date: 6/28/2010 9:54:38 AM

Priority Projects must infiltrate as much of the design capture volume as practicable using the appropriate site design and LID BMPs.

Number: 8 Author: staff Subject: Highlight Date: 8/5/2010 3:37:07 PM

This phrase raises the issue of what methods will be used to calculate reductions in the design capture volume achieved through site design. Provide a reference for the reader to the appropriate sections where the methods can be found.

to be self-retaining. Guidance on accounting for the effects of HSCs in numeric performance criteria calculations is provided in Section 2.3.4.

2.2.2.2. *Implementation*

This section describes two alternative pathways a Priority Project would follow to demonstrate compliance with ~~regulatory performance criteria (Section 2.2.2.1).~~ Instructions for sizing BMPs to meet these criteria consistent with the MEP standard are provided in Section 6.3.

Priority Projects shall implement LID BMPs to the extent feasible to achieve the following:

1) LID BMPs shall to the extent feasible be designed to retain on-site (infiltrate, harvest and use, or evapotranspire) 80 percent of average annual stormwater runoff.

OR

2) Projects shall to the extent feasible implement a combination of BMPs designed to:

   a. Retain (infiltrate, harvest and use, or evapotranspire) stormwater runoff on-site, as feasible up to the "design capture volume",

      AND

   b. ~~Recover (i.e., draw down) the storage volume as soon as possible after a storm event (see criteria for maximizing drawdown rate in Section 6.3.5)~~ ,

      AND (if necessary)

   c. Biotreat the remaining ~~runoff~~ volume on-site, if any[1], ~~as feasible to achieve 80 percent average annual capture efficiency~~ (cumulative, retention plus biotreatment),

      AND (if necessary)

   d. [North Orange County Only] retain or biotreat, in a regional facility, the remaining ~~runoff volume to achieve 80 percent average annual capture efficiency~~ (cumulative, retention plus biotreatment),

      AND (if necessary)

   e. Fulfill alternative compliance obligations for runoff volume not retained or biotreated up to a target average annual capture efficiency of 80 percent (cumulative).

Section 3.6 and 3.7 describe a method of configuring and sizing LID BMPs to meet these criteria consistent with the MEP standard.

[1] If remaining volume = 0 after any step, then subsequent steps are not necessary.

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Number: 1 Author: staff Subject: Underline Date: 6/28/2010 11:27:25 AM

The general organization of this section represents a good outline of the process described in the Permit but it needs to be the whole process, not just the alternatives to full on-site treatment using LID. For both ease of reference and clarity for the reader, the entire process should be summarized and the subheading titled accordingly.

Number: 2 Author: staff Subject: Underline Date: 7/12/2010 11:47:49 AM

The principal pathways must be described first before describing alternatives.

Number: 3 Author: staff Subject: Cross-Out Date: 6/28/2010 11:19:35 AM

It is misleading to suggest that the contents of the referenced section represent the full "regulatory performance criteria". To be accurate, you would have to describe the entire hierarchy and related process. Alternative language is needed. The design capture volume is the criteria set in the Permit for the volume of runoff that a project should treat using LID BMPs. A companion requirement is that LID BMPs (except biotreatment) should be used to treat as much of this volume as possible first, before considering biotreatment, then other structural treatment controls.

Number: 4 Author: staff Subject: Highlight Date: 6/28/2010 9:09:38 AM

You have not adequately documented a case supporting the use of this method over the method prescribed in the Permit. You must explain how this satisfies the permit sizing criteria.

Number: 5 Author: staff Subject: Cross-Out Date: 6/28/2010 11:03:00 AM

This criteria ignores the highly relevant 48-hour drawdown criteria shown elsewhere in this document. This criteria seems more relevant than maximizing drawdown rate. You need to elaborate on under what circumstances either criteria would apply and explain the rationale.

Number: 6 Author: staff Subject: Cross-Out Date: 6/28/2010 11:23:04 AM

Number: 7 Author: staff Subject: Replacement Text Date: 6/28/2010 11:22:40 AM

design capture

Number: 8 Author: staff Subject: Replacement Text Date: 6/28/2010 11:23:54 AM

design capture volume

Number: 9 Author: staff Subject: Underline Date: 6/28/2010 1:00:53 PM

The relationship between Permit requirements for sizing treatment control BMPs needs to be explained somewhere earlier in this document.

Special Considerations for North Orange County

~~Feasibility analyses are based on the MEP[2] standard and should take into account considerations of synergistic, additive, and competing factors, including, but not limited to, technical feasibility, fiscal feasibility, public health risks, societal concerns, and social benefits.~~

Narrative feasibility criteria are described in Section 7.II-2.2.5 of the Model WQMP and details for evaluating these criteria are contained in Section 6.2 and 6.3 of this TGD. Conceptually, the feasibility criteria contained in this TGD ~~include:~~

- ~~Provisions to~~ prevent significant risks to human health and environmental degradation as a result of compliance activities; and
- ~~Provisions to ensure that~~ Regional and watershed-based strategies may be selected when they are consistent with the MEP standard considering such factors as technical feasibility, fiscal feasibility, societal concerns, and social benefits; and
- ~~Provisions to~~ Ensure that compliance does not result in undue fiscal or societal burdens, including such considerations as:
    - Cost-effectiveness of on-site stormwater management versus off-site stormwater management, including capital costs and maintenance cost and considerations, and
    - Incremental cost-benefit of additional BMPs in stormwater management systems, including capital costs and maintenance costs and considerations.

Special Considerations for South Orange County

In South Orange County, the volume provided in the pre-filter detention volume (surface storage) and media pores in biotreatment BMPs may not be less than 75 percent of the design capture volume, regardless of the average annual capture efficiency achieved by the BMP.

Feasibility should be based on technical feasibility considerations. Feasibility criteria are described in Section 7.II-2.2.5 of the Model WQMP and Section 6.2 and 6.3 of this TGD. These criteria are developed with consideration for the technical feasibility requirements described in Section F.1(7) of Order No. R9-2009-0002 and include:

- Provisions to prevent significant risks to human health and environmental degradation as a result of compliance activities;
- Provisions to ensure that SmartGrowth, infill, and redevelopment are not unduly burdened by on-site retention of stormwater; and

[2] Footnote 2 of Order R8-2009-0030 (North County Permit) describes MEP as follows: "MEP is not defined in the Clean Water Act; it refers to management practices, control techniques, and system, design and engineering methods for the control of pollutants taking into account considerations of synergistic, additive, and competing factors, including, but not limited to, gravity of the problem, technical feasibility, fiscal feasibility, public health risks, societal concerns, and social benefits."

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are intended to

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Number: 4 Author: staff Subject: Replacement Text Date: 6/28/2010 11:37:01 AM
describe circumstances under which

Number: 5 Author: staff Subject: Replacement Text Date: 6/28/2010 11:42:59 AM
define performance criteria to

- Provisions to ensure that compliance does not result in undue fiscal burdens, including such considerations as:
    - Cost-effectiveness of on-site stormwater management versus off-site stormwater management including capital costs and maintenance cost and considerations, and
    - Incremental cost-benefit of additional BMPs in stormwater management systems including capital costs and maintenance costs and considerations.

Alternative Performance Criteria for Watershed-based Projects in South Orange County

In South Orange County, development projects greater than 100 acres in total project size, or smaller than 100 acres in size yet part of a larger common plan of development that is over 100 acres, that have been prepared using watershed and/or sub-watershed-based water quality, hydrologic, and fluvial geomorphologic planning principles that implement regional LID BMPs in accordance with the sizing and location criteria of the South Orange County Permit and acceptable to the Regional Board, are deemed to satisfy the South County Permit's requirements for new development and do not have to conduct an on-site feasibility analysis. Regional BMPs in such plans should clearly exhibit that they will not result in a net impact from pollutant loadings over and above the impact caused by capture and retention of the design storm with on-site LID BMPs.

2.2.3. Treatment Control BMP Performance Criteria

This section contains performance criteria for treatment control BMPs. Note that retention and biotreatment BMPs fully satisfy treatment control performance criteria for the volume of stormwater runoff which they manage. ~~Also note, fulfillment of LID sizing criteria implies fulfillment of treatment control sizing criteria.~~ Therefore ~~fulfillment for LID requirements~~ inherently fulfills treatment control requirements. ~~Where required,~~ treatment control BMPs should be selected and designed to ~~address pollutants of concern.~~.

North Orange County

If LID performance criteria have not been met through retention and biotreatment, then treatment control BMPs may be used as an alternative compliance approach or as part of an alternative compliance approach (See Section 8). Sizing of treatment control BMP(s) would be provided based on the unmet volume as calculated in Section 8.

South Orange County

If LID performance criteria have not been met through retention and biotreatment, then treatment control BMPs should be provided to address the remaining treatment control performance criteria. Two potential cases could arise with respect to performance criteria of treatment control BMPs:

1) LID performance criteria can be partially, but not fully met with LID BMPs.

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Common usage of this term means that LID BMPs are a subset of this BMP category. Remind the reader that, for purpose of this document, Treatment Control BMPs exclude LID BMPs.

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the use of LID BMPs to treat the design capture volume

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Where LID BMPs can be used to treat the design capture volume, no additional volume of storm water is required to be treated.

Number: 4 Author: staff Subject: Replacement Text Date: 6/28/2010 12:42:51 PM

If LID BMPs cannot be used to treat the full design capture volume

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treat any remaining untreated volume.

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onsite and, secondarily offsite,

Number: 7 Author: staff Subject: Underline Date: 7/12/2010 11:51:30 AM

Verify that this is a correct statement.

Number: 8 Author: staff Subject: Underline Date: 6/28/2010 12:46:54 PM

Specify and jump to specific section.

- Sizing of treatment control BMP(s) would be based on the unmet volume to achieve cumulative 80 percent average annual capture efficiency as calculated in Section 8.

2) The project or a drainage area cannot feasibly incorporate any LID BMPs.

- Sizing of treatment control BMP(s) would be based one of the following criteria:
  - Capture and infiltrate or treat 80 percent of average annual runoff volume,

    OR

  - Capture and infiltrate or treat the runoff from the 24-hour, 85th percentile storm event, as determined from the County of Orange's 85th Percentile Precipitation Isopluvial Map and draw down the stored volume in no more than 48 hours following the end of precipitation,

    OR

  - Treat the maximum flow rate of runoff produced by the 85th percentile hourly rainfall intensity, as determined from the local historical rainfall record, multiplied by a factor of two, or

    OR

  - 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.

2.2.4. Hydromodification Control Performance Criteria

The hydromodification control performance criteria for North and South Orange County differ significantly. Performance criteria in North Orange County are based ~~on a single design event and~~ the difference between pre-developed and post-developed project conditions. Predevelopment conditions in North Orange County are defined as the conditions of the project immediately prior to project submittal (i.e., the existing conditions). Performance criteria in South Orange County are based on the difference between predevelopment and post-development over a broad range of events. In South Orange County, predevelopment is defined as the naturally occurring (pre-modern human disturbance) conditions.

2.2.4.1. North Orange County Hydromodification Performance Criteria

~~As specified in the Model WQMP, Priority Projects shall identify and mitigate any HCOCs.~~

HCOCs are considered to exist if streams are determined to be potentially susceptible to hydromodification impacts and either of the following conditions exists:

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for a single design event

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Overly broad and not instructive to the reader.

Number: 4 Author: staff Subject: Underline Date: 6/28/2010 1:28:49 PM
It would be helpful to remind the reader what an HCOC is.

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any

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located downstream from the project

- Post-development runoff volume for the 2-yr, 24-hr storm exceeds that of the pre-development[3] condition by more than 5 percent

  OR

- Time of concentration of post-development runoff for the 2-yr, 24-hr storm event is less than the time of concentration of the pre-development condition by more than 5 percent[4].

If these conditions to not exist or streams are not potentially susceptible to hydromodification impacts, an HCOC does not exist and hydromodification does not need to be considered further. ~~This is inherently true for redevelopment projects which reduce impervious area~~

Streams susceptibility should be determined as described in Section 3.3, which ~~requires~~ methods of determining susceptibility based on either mapping or site specific engineering analysis.

Priority Projects where there is an HCOC shall, as the first priority, implement on-site or regional hydromodification controls such that:

- Post-development runoff volume for the 2-yr, 24-hr storm event is no greater than 105 percent of that for the pre-development condition.

  AND

- Time of concentration of post-development runoff for the 2-yr, 24-hr storm event is at least 95 percent of that for the pre-development condition (see footnote 4).

A project may implement a combination of additional site design practices, LID controls, structural treatment controls, sub-regional/regional controls, and/or in-stream controls to meet the hydromodification performance criteria stated above. In this case, the Project WQMP should include a project-specific evaluation with the pre- and post-development runoff volume and time of concentration for the 2-yr, 24-hr storm event. The Project WQMP ~~should~~ consider site design practices and on-site controls prior to proposing in-stream controls. If in-stream controls are selected, the Project WQMP should include a project-specific evaluation to demonstrate that the project will not adversely impact beneficial uses or result in sustained degradation of water quality of the receiving waters.

[3] In North Orange County (Order R8-2009-0030), predevelopment is defined as the existing conditions immediately prior to Project WQMP submittal.

[4] The North County Permit (Order R8-2009-0030), requires that T_c not increase by greater than 5 percent as a result of the project. However, a lower T_c would in fact represent a greater concern for hydromodification impacts. This TGD corrects this provision to reflect its assumed intent of not reducing T_c by more than 5 percent.

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Explain how the 2-year, 24-hour storm is to be calculated or cite the appropriate section.

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[not entirely true] Redevelopment projects that result in a net reduction of impervious area may be deemed to not increase runoff. Therefore, the project would not be subject to HCOC-related performance criteria.

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This implies that other methods can be allowed. All methods must be described here.

Number: 4 Author: staff Subject: Underline Date: 6/28/2010 1:31:43 PM

Cite the specific section. Suggest adding a hyperlink as done above.

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describes

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must

Where the Project WQMP documents that the excess runoff volume from the 2-yr, 24-hr runoff event cannot feasibly be retained (infiltrated, harvested and used, or evapotranspired), the project shall:

- Retain the excess volume from the 2-yr, 24-hr runoff event in on-site or regional controls to the MEP,

  AND

- Implement on-site or regional hydromodification controls such that the post-development runoff 2-yr, 24-hr peak flow rate is no greater than 110 percent of the pre-development runoff 2-yr, 24-hr peak flow rate.

~~A~~ [1]WQCB Executive Officer-approved Watershed Master Plan (WMP) ~~or equivalent~~ [2]may supersede these criteria for the area that the plan covers.

[3]~~Projects that claim water quality credits may choose to adjust the 2-yr, 24-hr storm depth based on the number of water quality credits claimed (see Section 8.2).~~

2.2.4.2. *South Orange County Hydromodification Performance Criteria*

As stated in the Model WQMP, Priority Projects shall identify and mitigate HCOCs.

Interim Criteria

HCOCs are not considered to exist if the downstream conveyance network is not susceptible to hydromodification impacts. Streams susceptibility should be determined as described in Section 3.3, which requires methods of determining susceptibility based on either mapping or site specific engineering analysis.

For projects discharging to a downstream conveyance network that is susceptible to hydromodification impacts, an HCOC is assumed to exist, and projects shall as required by the Model WQMPmitigate this HCOC. An HCOC is considered to be mitigated when on-site or regional hydromodification controls are provided such that such that:

- For flow rates from 10 percent of the 2-year storm event to the 5-year storm event, the post-project flows do not exceed pre-development (naturally occurring) peak flows.

- For flow rates from the 5-year storm event to the 10-year storm event the post-project peak flows may exceed pre-development (naturally occurring) flows by up to 10 percent for a 1-year frequency interval.

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Alternative performance criteria found within an

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All alternatives must be identified.

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The credit system in Section 8.2 is inappropriate for hydromodification. The volume reductions allowed in Section 8.2 have a logical relationship with reductions in pervious cover and densification. However, volume reductions are already built into the method for calculating the 2-yr, 24-hour storm. Any further reductions by the proposed credit system are arbitrary. A different credit system (or no credit system) is needed.

Final Criteria

If a Hydromodification Management Plan (HMP) has been approved by the Regional Board and the project is located within a copermittee's jurisdiction that has incorporated the HMP into the LIP, then the project shall implement the criteria that have been incorporated into the HMP.

2.2.5. Performance Criteria for Special Projects

2.2.5.1. Roadway and Similar Constrained Right of Way and Drainage Projects

Performance criteria for roadway and similar constrained right of way and drainage projects are contained in Section 7.II - 2.1.5.1 of the Model WQMP. These projects are required to follow guidelines contained in the USEPA guidance *Managing Wet Weather with Green Infrastructure: Green Streets* and the interpretation of the Green Streets guidance reflected in the requirements of this TGD. These performance criteria apply to roadways (and associated infrastructure such as bike lanes and sidewalks), linear drainage facilities, and associated access roads, and other similar projects such as sea walls/break waters, bridges, and dams where ~~multiple~~ constraining factors limit the ability to apply the same LID performance criteria that apply to other new development and significant redevelopment projects. This category include off-site improvements to existing infrastructure proposed by a larger development, such as the widening of an off-site channel or the addition of a turn lane from an existing roadway in an off-site location to accommodate the larger plan of development. This category does not include roadways and similar right of way and drainage projects that are constructed as part of and within a larger plan of development.

Projects falling in ~~this category~~ are required to consider LID and treatment control BMPs based on project opportunities and are required to attempt to design these BMPs to achieve target design volumes/flowrates. However, these projects are not subject to the standard hierarchy of controls stated in Section 2.2.2.2 (i.e., consideration of retention BMPs before biotreatment or treatment control BMPs) and do not have alternative compliance obligations if BMPs cannot be designed to meet the target performance criteria. ~~These projects are not subject to a rigorous feasibility analysis in order to demonstrate that the MEP standard has been met.~~ Vehicular and pedestrian safety ~~should be~~ overriding considerations in defining MEP for these types of projects.

The recommended method for developing a Project WQMP for roadway and similar constrained right of way and drainage projects to meet these criteria is provided in Section 3.9. It is noted that many routine maintenance activities will not be characterized as Priority Projects, therefore would not be covered by the requirements of this TGD.

2.2.5.2. Projects Claiming Water Quality Credits

~~Performance criteria for LID and hydromodification depend on the number of water quality credits claimed by the Project. Section 8.2 provides criteria for claiming water quality credits and provides guidance on adjustments to performance criteria resulting from water quality credits. Water quality credits may be applied to fulfill or partially fulfill alternative compliance requirements if LID and/or hydromodification requirements are not met on-site or in regional BMPs.~~

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limited right-of-way, easements, and other

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First sentence in a new paragraph should be unambiguous in the topic. Explain what "this" is specifically referring to.

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There is nothing in the Permit to support this assertion; there are no expressed or implied exceptions to the scope of projects to be included in the LID BMP feasibility criteria. It would be reasonable to assert that a different analysis should be done, but not that no analysis should be done. The MWQMP is the vehicle for this alternative approach and an analysis needs to be provided.

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will often

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The proposed credit system has no logical relationship with the impact.

2.2.5.3. *Performance Criteria for Projects with Approved Watershed Master Plans or Hydromodification Management Plans*

Approved WMPs and HMPs may specify alternative performance criteria for hydromodification control that supersede the criteria contained in this section.

Approved WMPs, HMPs, or other RWQCB Executive Officer-approved ~~watershed-based plans~~ [1] may provide additional guidance and support for evaluating LID feasibility and meeting LID requirements; [2] however, these documents do not have the authority to substantively change the intent of feasibility criteria and performance criteria. [3] Examples of additional guidance that could be provided by an approved WMP, HMP, or other RWQCB Executive Officer-approved watershed-based plan may [4] ~~potentially~~ include, but are not limited to: 1) refinements to regional infiltration feasibility maps allowing for increased ~~ability to rely~~ [5] on regional mapping in assessing feasibility, and 2) identification of regional LID opportunities determined to be consistent with the MEP standard considering such factors as technical feasibility, fiscal feasibility, societal concerns, and social benefits.

2.3. ~~Recommended~~ [6] Hydrologic Methods

Each of the sizing methods described in this document requires hydrologic calculations to establish BMP infrastructure requirements. This section describes the ~~recommended~~ [7] hydrologic methods that should be used to perform these calculations. [8] ~~The use of alternative methods may be accepted by the local jurisdiction with technical justification.~~

All hydrologic methods rely on simplifications to actual hydrologic processes. Those methods commonly used for urban BMP design include significant simplifications that are widely accepted for engineering purposes. Acceptable simplifications to calculation methodologies differ depending on the size of the storms being considered. For example, storms in the range of the LID design capture storm depth and the water quality design volume (WQDV) design storm depth are generally less than one inch and are expected to produce little runoff from most pervious areas, while storms in the range of the 2-yr, 24-hr event tend to exceed two inches and may result in significant pervious area runoff volume. Therefore, hydrologic calculation methods must be selected depending on the application. Further, the use of hydrologic source controls may alter the hydrologic response of a drainage area; adjustments to hydrologic methods to account for these effects are described in Section 2.3.4.

2.3.1. Hydrologic Methods for LID Design Capture Volume Calculations

[9] ~~Runoff volumes for purposes of sizing volume-based BMPs should be calculated as:~~

$$\cancel{V = C \times d \times A \times 43560\ sf/ac \times 1/12\ in/ft} \qquad \cancel{\text{Equation 2.1}}$$

~~Where:~~

~~V = runoff volume during the design storm event, cu-ft~~

~~C = runoff coefficient = $(0.75 \times imp + 0.15)$~~

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Watershed Management Plans

Number: 2 Author: staff Subject: Inserted Text Date: 7/12/2010 11:57:32 AM

within specific watersheds

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for projects within their planning areas

Number: 4 Author: staff Subject: Cross-Out Date: 6/28/2010 2:18:53 PM

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reliability

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Required

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required

Number: 8 Author: staff Subject: Cross-Out Date: 6/28/2010 2:45:02 PM

All methods must be described.

Number: 9 Author: staff Subject: Cross-Out Date: 6/25/2010 1:24:11 PM

This is not correct. For LID BMPs, you are not calculating the runoff from the 85th percentile storm event. You are calculating the entire storm volume falling on the project area. This would be inches of rainfall multiplied by the project area. The method shown is correct for non-LID volume-based treatment control BMPs.

imp = impervious fraction of drainage area (ranges from 0 to 1)

d = storm depth (inches)

A = tributary area (acres)

In some calculations that follow in this TGD, it is necessary to "back-calculate" the design storm depth based on the runoff volume. The design storm depth can be calculated by rearranging Equation 2.1 above:

$$d = V \times 12\ in/ft / [C \times A \times 43560\ sf/ac] \qquad \text{Equation 2.2}$$

Any subtraction from the designs storm depth claimed in Section 2.3.4 to account for HSCs should be added to the back-computed design storm depth after this calculation. Example 2.1 illustrates how a given volume of stormwater would be translated to an equivalent storm depth.

Example 2.1: Back-computing Storm Depth from Runoff Volume
Given:
• A drainage area consists of a 1 acre building roof surrounded by 0.25 acres of landscaping (80 percent composite imperviousness)
• An LID BMP with 1,200 cu ft of storage is provided.
Required:
• What is the equivalent design storm corresponding to this BMP volume?
Result:
1) From Equation 2.2: d = V × 12 in/ft/[C × A × 43560 sf/ac]
2) V = 1,200 cu ft (given)
3) C = (0.8×0.75 + 0.15) = 0.75
4) A = 1.25 ac
5) d = 1,200 cu ft × 12 in/ft / [0.75 × 1.25 ac × 43560 sf/ac] = **0.35 inches**

2.3.2. Hydrologic Methods for Design Flow Calculations

Design flow calculations for flow-based BMPs should be calculated as:

$$Q = C \times i \times A \qquad \text{Equation 2.3}$$

Where:

Q = design flowrate, cfs

C = runoff coefficient = $(0.75 \times imp + 0.15)$

imp = impervious fraction of drainage area (ranges from 0 to 1)

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Calculating Design Flow for Flow-based Treatment Controls [this title is more instructive]

i = design intensity (inches)

A = tributary area (acres)

The same hydrologic calculation method ~~would~~ be used if the BMP is stand-alone or if some capture has already been achieved upstream of the BMP. If the BMP is stand-alone, the performance criteria in Section 2.2.3 would be used to select the design intensity. If a flow-based BMPs is used to meet the remaining performance criteria (after another BMP is applied), the design intensity would be reduced by the method described in Section 6.4.2.3.

2.3.3. Hydrologic Methods for Hydromodification Design Calculations

As mentioned in Section 2.2.4, the hydromodification control performance criteria for North and South Orange County differ significantly. While North Orange County criteria are based on a single 2-yr, 24-hr discrete event, South Orange County criteria are based on a broad range of events. These differences require different hydrologic calculation methods, as described below.

2.3.3.1. Hydrologic Methods for North Orange County

Hydromodification design criteria for North Orange County are based on the 2-yr, 24-hr storm event runoff volume, time of concentration, and peak flowrate. The governing document for discrete hydrologic analysis in North Orange County is the *Orange County Hydrology Manual* (OCEMA 1986). The methods described in the *Orange County Hydrology Manual* are always considered to be acceptable. Technical Release 55 (TR-55): *Urban Hydrology for Small Watersheds* (NRCS 1986) is also an acceptable calculation method. TR-55 has the capacity to model watersheds with drainage areas ranging from 0.01 acre (although results from catchments less than 1 acre should be carefully examined) to 25 square miles and time of concentrations ranging from 6 minutes to 10 hours (NRCS 2009).

Priority Projects have the option to either perform the hydrologic calculations using computer simulations or hand calculations. If the *Orange County Hydrology Manual* method is used, the Watershed Modeling System (WMS) software with the Orange County Rational Method interface or hand calculations should be used, consistent with the *Orange County Hydrology Manual*. If the TR-55 method is used, then either the WinTR-55[5] or HEC-HMS[6] programs are appropriate or hand calculations should be consistent with the TR-55 manual (NRCS 1986).

Advantages of using computer simulations is that the runoff hydrograph can be produced with relative ease, which is ideal when simulating post-project drainage conditions which route

[5] Free WinTR-55 software can be downloaded at: http://www.wsi.nrcs.usda.gov/products/w2q/h&h/tools_models/wintr55.html

[6] Free HEC-HMS software can be downloaded at: http://www.hec.usace.army.mil/software/hec-hms/download.html Loss parameters shall be set to the SCS Curve Number method, transform parameters must be set to the SCS Unit Hydrograph method, and reach routing parameters must be set to the Muskingum-Cunge method.

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Number: 1 Author: staff Subject: Underline Date: 6/25/2010 1:46:41 PM

It would be worthwhile to recommend to the designer that the project site convey off-site flows so that they do not commingle with on-site flow and by-pass the site.

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must

Number: 3 Author: staff Subject: Underline Date: 6/28/2010 2:53:09 PM

This language suggests that other methods may be used. Those methods must be described or the language modified to limit the allowable methods.

runoff through detention BMPs. Routing a hydrograph through a BMP is more arduous and time consuming if calculated by hand.

An advantage of WMS with the Orange County Rational Method interface is that it is often used for generating design flows of less frequent design storm events (i.e., 10-year, 25-year, or 100-year) required of flood control analyses, so the same WMS model could be used for both the flood and hydromodification control analyses. It is important to note that WMS is not a continuous simulation hydrologic model, and thus cannot be used to meet the South Orange County hydromodification control criteria.

Storm Depth

The 2-yr, 24-hour precipitation depth specified in the *Orange County Hydrology Manual* for drainage areas below 2,000 feet in elevation is a 2.05 storm depth. For drainage areas above 2,000 feet in elevation, a 3.81 storm depth can be used (OCEMA 1986). When using the TR-55 method to produce a hydrograph, the user should select the Type I rainfall distribution. When using the *Orange County Hydrology Manual* method, rainfall distribution is imbedded in the WMS-Orange County interface and is provided in the *Orange County Hydrology Manual* in Section B.

~~Projects that qualify for water quality credits may optionally choose to adjust the 2-yr, 24-hr storm depth based on the number of water quality credits claimed (see Section 8.2).~~

Runoff Volume

Calculating runoff volumes in the existing and proposed conditions can be done by hand using Section C of the *Orange County Hydrology Manual* or Chapter 2 of the TR-55 manual, which have the same basic methodology. Where inconsistencies (e.g., selection of curve numbers) exist between the two documents, the *Orange County Hydrology Manual* should take precedence. Runoff volume is computed as an output of the WMS-Orange County, WinTR-55, and HEC-HMS programs, although input selection for these models will require reference to the manuals.

As a preliminary estimate, the difference between runoff volumes in existing and proposed conditions may optionally be calculated using the rational method (Section 2.3.1). This method tends to under-predict runoff that would occur from pervious areas during a relatively large design storm (pervious runoff coefficient = 0.15) and is likely fairly accurate for runoff from impervious areas (impervious runoff coefficient = 0.90). Therefore, this method tends to result in a larger difference between pre- and post-developed runoff coefficient than would be calculated using a more sophisticated model, resulting in more stringent hydromodification performance criteria. The rational method does not account for soil type.

When evaluating the effect of retention BMPs on proposed condition runoff volume, volume reduction should be calculated as the volume that is infiltrated, evapotranspired, or used (i.e., drawn down) over a period of 48 hours, starting at the BMP brim full capacity. Volume treated

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Describe what circumstances other Types of distributions will be allowed in order to narrow the permissiveness of this sentence.

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The proposed credit system has no apparent nexus with hydromodification that allows one to believe that HCOC's are being mitigated.

and discharged to surface water should not be considered in this calculation. The volume reduction should not be greater than the total retention volume in the BMP.

Time of Concentration

Time of concentration (T_c) can be calculated by hand using the methods described in Section D of the *Orange County Hydrology Manual* or the TR-55 manual. The Orange County method entails summing the initial time of concentration, based on a nomograph, with the subsequent time it takes to pass flow through downstream conveyances. The TR-55 method sums the travel times for sheet flow, shallow concentrated flow, and channel flow for a given flow path. WMS-Orange County will help the user estimate the Tc of a subarea when using the GIS interface or it can be entered manually. WinTR-55 also assists the user in calculating Tc through its Time of Concentration Details window. HEC-HMS does not assist the user in estimating Tc and its transform input parameter is actually lag time, which is 0.6 times the Tc, according to an empirical relationship developed by the Natural Resource Conservation Service (NRCS).

When evaluating the effect of BMPs on proposed condition time of concentration, the BMP should be represented in one of the aforementioned modeling programs because hand calculations are not ideal for the routing analyses required. The BMP component of T_c can be estimated as the time required for the BMP to reach capacity during in the design storm simulation.

Insert example calculation

Peak Runoff Flowrate

Peak runoff flowrate may be calculated using the Rational Method described in Section D of the *Orange County Hydrology Manual* for drainage areas less than 1 square mile (640 acres) or using the Unit Hydrograph Method described in Section E for drainage areas greater than or equal to 1 square mile. Alternatively, peak flowrate may be calculated using the Graphical Peak Discharge Method described in Chapter 4 of the TR-55 manual or the Tabular Hydrograph Method described in Chapter 5 of the same document. The user should select the Type 1 rainfall distribution and use the 2-yr, 24-hour precipitation depth specified in the *Orange County Hydrology Manual*.

When evaluating the effect of BMPs on the proposed condition peak runoff flowrate, the effect of the BMP should be estimated using one of the aforementioned modeling programs because hand calculations are not ideal for the routing analyses required.

2.3.3.2. Hydrologic Methods for South Orange County

Projects in South Orange County should use an approved continuous simulation model such as EPA Stormwater Management Model (SWMM) or EPA Hydrologic Simulation Program – FORTRAN (HSPF), to evaluate compliance with flow-duration-based performance criteria.

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Number: 1 Author: staff Subject: Underline Date: 6/28/2010 3:05:04 PM

Describe circumstances under which deviations will be allowed.

Number: 2 Author: staff Subject: Sticky Note Date: 6/28/2010 3:11:08 PM

Generally, there needs to be a better effort in these sections to assure that all projects use standard methods.

Number: 3 Author: staff Subject: Highlight Date: 8/5/2010 3:39:40 PM

Number: 4 Author: staff Subject: Highlight Date: 6/28/2010 3:13:05 PM

Number: 5 Author: staff Subject: Highlight Date: 6/28/2010 3:15:05 PM

"Should" and "may" are too permissive. If other methods will be allowed, they should be described, otherwise, these methods should be required in order to assure that all projects are subject to the same appropriate standards.

Number: 6 Author: staff Subject: Highlight Date: 6/28/2010 3:15:47 PM

2.3.4. Accounting for Hydrologic Source Controls in Hydrologic Calculations

The effects of HSCs are accounted for in hydrologic calculations as an adjustment to the storm depth used in the calculations described above. Runoff volume calculations are performed exactly as described in Section 2.3.1, with the exception that the storm depth used in the calculation is adjusted prior to the calculation. Adjustments are based on the type and magnitude of HSCs employed for the drainage area per guidance contained in Section 6.5.2.

Example 2.2: Accounting for HSCs in Hydrologic Calculations

Given:

- A drainage area consists of a 1 acre building roof surrounded by 0.25 acres of landscaping (80 percent composite imperviousness)
- The drainage from the roof is spread uniformly over the entire pervious area via splash pads and level spreaders
- Soils are moderately well drained and have a shallow slope
- For the purpose of this example, assume the hydrologic source control adjustment for this configuration of disconnected downspouts is 0.3 inches. For an actual project, hydrologic source control adjustment would be calculated based on instructions in Section 6.5.2.
- The unadjusted design storm depth at the project site is 0.85 inches.

Result:

1) The designer uses 0.85 inches – 0.3 inches = 0.55 inches in the calculation of runoff from the design storm depth
2) Design capture volume (with downspout disconnect) =
   1.25 ac × 0.55 inches × (0.8×0.75 + 0.15) × 43560 sf/ac × 1/12 in/ft = 1,870 cu-ft
3) Design capture volume (without downspout disconnect) = 1.25 ac × 0.85 inches × (0.8*0.75 + 0.15) × 43560 sf/ac × 1/12 in/ft = 2,890 cu-ft

This example illustrates the effect that HSCs can have on reducing the required volume of downstream BMPs.

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Number: 1 Author: staff Subject: Underline Date: 6/28/2010 3:20:47 PM

This example would be more helpful if all steps are shown. It may be better to explain how adjusting the storm depth reduces the design capture volume in a narrative. A detailed example would be shown later and cited here.

Section 3. Site Planning and Project WQMP Preparation

This section provides guidance to support the process of site planning and Project WQMP preparation. The essential requirements of the Project WQMP preparation process are described in the Model WQMP. This section describes the ~~recommended~~ methods for preparing Conceptual, Preliminary, and Project WQMPs.

An overview of the Project WQMP preparation process for typical projects is provided in Table 3.1. Roadway and similar constrained right of way and drainage projects should follow a modified process described in Section 3.9.

Table 3.1
Overview of WQMP Preparation Process

Step	Scale of Calculation	Intended Outcome	Technical Guidance Document Reference
1) Assess site conditions and other constraints	Project	Acquire data to support project planning, system design, and feasibility screening	Section 3.1
2) ~~Evaluate~~ pollutants of concern	Project	Determine which treatment control BMPs may be used if needed	Section 3.2
3) ~~Evaluate~~ hydrologic conditions of concern	Project	Determine whether HCOCs exist and whether HCOCs may control stormwater system design	Section 3.3
4) ~~Establish~~ project planning criteria	Project	Combine results of Steps 1-3 with site location and project characteristics to determine what requirements apply to project	Section 3.4
5) Develop site design and conceptual drainage management plan	Project	Select site design practices and identify conceptual drainage patterns congruous with site design, or vice versa.	Section 3.5
6) Select BMPs	Roughly homogenous subareas of the project	Select BMP(s) that are potentially feasible and are well suited to the characteristics of the drainage area(s)	Section 3.5
7) Prepare system design	Roughly homogenous subareas of the project	Configure and size system based on selected BMPs to meets the LID and hydromodification performance standard	Section 3.6 or Section 3.7 (if LID not fully feasible)
8) Participate in alternative LID and/or treatment control	Project	If necessary, fulfill any remaining LID and treatment control requirements in off-site LID, treatment control BMPs, and/or waiver program/runoff fund	Section 8
9) Provide additional hydromodification controls	Project	If necessary, fulfill remaining hydromodification requirements through additional on-site controls, regional controls, and/or in-stream controls	Section 7

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If the intent is for the MWQMP to provide a description of the development process and the Technical Guidance Document to provide a detailed description of the methods to be used for each step of the process, please state so. The reader should be given a clear idea of what the limitations are of each document so that they are not misled into believing that either document is suitable by themselves to preparing the WQMP.

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of the TGD

Number: 3 Author: staff Subject: Replacement Text Date: 6/28/2010 3:39:07 PM

technical

Number: 4 Author: staff Subject: Underline Date: 6/28/2010 3:47:07 PM

The reader should be reminded to review the MWQMP for detailed descriptions of each step in the process.

Number: 5 Author: staff Subject: Sticky Note Date: 6/28/2010 3:47:55 PM

Suggest that the appropriate sections of the MWQMP also be cited for reference.

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identify

Number: 7 Author: staff Subject: Replacement Text Date: 6/28/2010 3:39:40 PM

identify

Number: 8 Author: staff Subject: Replacement Text Date: 6/28/2010 3:40:01 PM

Identify applicable

3.1. Assessing Site Conditions and Other Constraints

Assessing a site's potential for implementation of LID, treatment control, and hydromodification control BMPs requires both the review of existing information and the collection of site-specific measurements. Available information regarding site layout and slope, soil type, geotechnical conditions, and local groundwater conditions should be reviewed as discussed below. In addition, soil and infiltration testing should be conducted to determine if stormwater infiltration is feasible and to determine the appropriate design infiltration rates for infiltration-based BMPs.

Section 3.1.1 describes mandatory site assessment requirements, where applicable, for Priority Projects. The following subsections are intended to provide recommendations for meeting these requirements. The specific recommendations contained in this section are not intended to prevent the consideration of site-specific factors or eliminate the need to exercise sound engineering judgment.

3.1.1. Requirements for Documenting in Site Assessment and Constraints

This section describes the mandatory documentation requirements related to site conditions and constraints contained in the Model WQMP that, where applicable, must be included in the Project WQMP. [1] These mandatory requirements for all Priority Projects, where applicable, include:

1. The Project WQMP shall describe the existing site conditions and constraints.
2. The Project WQMP exhibit(s) shall describe the location of the project.
3. The Project WQMP exhibit(s) shall depict project boundaries.
4. The Project WQMP exhibit(s) shall depict existing site topography such as existing condition impervious area, slopes, drainage patterns, interface with topography of adjacent parcels/right of ways, and any other topographic features of interest to site layout and/or stormwater management.
5. The Project WQMP shall document composite imperviousness of the existing condition of the site.
6. The Project WQMP and exhibit(s) shall document locations of drainage entering the site from off-site areas, including estimated tributary area and composite imperviousness of drainage areas tributary to these points.
7. The Project WQMP exhibit(s) shall depict locations of existing storm drains that could potentially receive runoff from the project site.

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These mandatory elements do not match the elements described in the MWQMP. Both lists need to be reconciled along with the strength of the requirement: the MWQMP says "should" whereas the TGD says "mandatory".

8. The Project WQMP exhibit(s) shall depict locations of existing underground infrastructure.

9. The Project WQMP and exhibit(s) shall depict the conditions and locations of environmentally sensitive areas (ESAs).

10. The Project WQMP and exhibit(s) shall describe/depict the conditions/uses of adjacent parcels/right of ways to the extent this information is available.

11. The Project WQMP and exhibit(s) shall describe/depict soil type and geologic information, including NRCS hydrologic soil groups, locations of borings, and any other geologic/geotechnical information collected.

12. The Project WQMP exhibit(s) shall depict any data obtained from regional maps relevant to the determination of feasibility of infiltration, ET, or harvest and use.

13. The Project shall document the presence of any downstream regional stormwater management system if this system is considered in the feasibility process.

14. Spatial data supporting site assessment should be submitted in graphical information system (GIS) format.

Each of the following elements are required if the project employs infiltration-based BMPs. However, if as part of Level 1 Feasibility Screening (Section 6.2.1.2 and 6.2.1.3) any one of the studies described in this section finds that that infiltration shall not be conducted, or that infiltration [1] ~~is optional~~ and is not selected, the remaining elements in the list below are not required to be documented. For example, if [2] it is determined that infiltration would mobilize pollutants in contaminated soils and therefore shall not be done, it is then not necessary to evaluate the potential for infiltration of stormwater to cause geotechnical hazards.

15. The Project WQMP and exhibit(s) shall document results of [3] infiltration tests, including location of tests and measured vertical infiltration rates. Complete documentation of infiltration testing shall be attached to the Project WQMP.

16. The Project WQMP and exhibit(s) shall document depth to seasonally high groundwater in the form of contours of depth to seasonally high groundwater ([4] minimum resolution = 5-ft). [5] Where depth to seasonally high groundwater is consistent across the project site, a single depth may be documented.

17. The Project WQMP and exhibit(s) shall [6] document the presence of soil and/or groundwater contamination on or immediately adjacent to the site. If found to be present, the potential impacts of infiltration of stormwater on mobilization of soil pollutants and/or movement groundwater plumes shall be described in a report prepared by a qualified groundwater quality professional or determined from a previously prepared report that is applicable to the project site. The Project WQMP and

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The Permit does not allow infiltration to be optional if it is practicable and is needed to treat the design capture volume. This statement needs to be reworded.

Number: 2 Author: staff Subject: Underline Date: 6/28/2010 3:58:44 PM

Identify who is responsible for making this determination and what the basis for this determination will be.

Number: 3 Author: staff Subject: Underline Date: 7/12/2010 12:01:13 PM

Describe all acceptable methods for performing these tests or cite the appropriate Section where the acceptable methods can be found.

Number: 4 Author: staff Subject: Underline Date: 6/28/2010 4:14:09 PM

Clarify that this resolution is contour spacing and not depth. Provide sources of information if widely available. Indicate if extrapolation is allow and to what extent.

Number: 5 Author: staff Subject: Underline Date: 8/5/2010 3:42:34 PM

Some additional information is needed here so that the project proponent and reviewer fully understands the nature of the data needed and borings aren't being done unnecessarily. Consider specifying circumstances under which on-site boring is needed and under which more regional data can be used (i.e. nearest well <X-feet and documented depth >Y-feet).

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Identify potential sources of this data, such as the Phase 1.

exhibits(s) shall describe areas of the project site where infiltration is not advisable for these reasons. The Project WQMP shall describe the amount of stormwater infiltration that is allowed in affected areas (if greater than zero).

18. The Project WQMP and exhibit(s) shall document the results of geotechnical studies and recommendations by identifying areas where infiltration would result in an unacceptable risk of landslide, liquefaction, hydrocollapse, soil expansion, or other significant risks to human health or property resulting from infiltration of stormwater that cannot be reasonably and technically mitigated. Documentation shall include:

    a. Mapped areas of the project site where infiltration is not advisable for one of the reasons above, including individual documentation of the justification for each area that is identified.

    b. Recommended setbacks from slopes, foundations, underground infrastructure, etc.

    c. Optionally, recommendations regarding maximum amounts of infiltration that are acceptable (if greater than zero).

19. If the project is located adjacent to an intermittent or ephemeral natural drainage course, the Project WQMP shall document, through an assessment of groundwater/surface water interactions, that the potential for change of seasonality of downstream drainage courses has been considered. Where potential for an adverse change to seasonality exists, a report shall be prepared and attached to the Project WQMP describing the potential adverse impacts and the amount of stormwater infiltration allowed at the project site.

The following sections provide guidance on preparing these elements of the Project WQMP. This guidance is not intended to supplant the need for sound professional judgment.

3.1.2. Topography

The site's topography should be assessed to evaluate surface drainage, topographic high and low points, and to identify the presence of steep slopes that qualify as hillside locations, all of which have an impact on what type of LID and treatment control BMPs will be most beneficial for a given project site. Stormwater infiltration is more effective on level or gently sloping sites. Flows applied to slopes steeper than 15% may runoff as surface flows, rather than soak into the ground. On hillsides, infiltrated runoff may daylight a short distance down slope, which could cause slope instability depending on the soil or geologic conditions. See the Geotechnical Considerations section below.

Topographic assessment and mapping should also document existing condition impervious area, drainage patterns, the interface of site topography with adjacent parcels/right of ways

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subsequent

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It's unclear what this means.

(i.e., manufactured slopes), and any other topographic features of interest to site layout and/or stormwater management.

3.1.3. Soil Type and Geology

The site's soil types and geologic conditions should be determined to evaluate the site's ability to infiltrate stormwater and to identify suitable, as well as unsuitable locations for siting infiltration-based BMPs (e.g., infiltration basins and trenches, bioretention without an underdrain, permeable pavement, and drywells). The Orange County Soil Survey (NRCS, CA678, 1978) identifies soils as Hydrologic Soil Groups (HSG) A, B, C and D [for further information, see http://soils.usda.gov/]. These soil groups are mapped in Appendix II.

- Group A soils are typically sands, loamy sands, or sandy loams. Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep and well to excessively drained sands or gravels and have a high rate of water transmission.

- Group B soils are typically silt loams or loams. They have a moderate infiltration rate when thoroughly wetted and consist chiefly of moderately deep to deep and moderately well to well drained soils with moderately fine to moderately coarse texture.

- Group C soils are typically sandy clay loams. They have low infiltration rates when thoroughly wetted, consist chiefly of soils with a layer that impedes downward movement of water, and/or have moderately fine to fine soil structure.

- Group D soils are typically clay loams, silty clay loams, sandy clays, silty clays, or clays. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with high swelling potential, permanent high water table, claypan or clay layer at or near the surface, and/or shallow soils over nearly impervious material.

Soils in Group A and B tend to have higher potential for infiltration based on likely infiltration rates and distance to a limiting horizon. Soils in Group C and D are less likely to have sufficient infiltration rate and distance to a limiting horizon to support stormwater infiltration.

Early identification of soil types throughout the project footprint can reduce the number of test pit investigations and infiltration tests needed by narrowing potential test sites to locations that are most likely to be amenable to infiltration. Guidance for conducting test pit investigations and infiltration tests is provided in Appendix III.

In addition, available geologic or geotechnical reports on local geology should be reviewed to identify relevant features such as depth to bedrock, rock type, lithology, faults, and hydrostratigraphic or confining units. These geologic investigations may also identify shallow water tables and past groundwater or soil contamination issues that are important for BMP design (see below). Geologic investigations may provide an assessment of whether soil infiltration properties are likely to be uniform or variable across the project site.

This page contains no comments

Soil classification and testing data are used to inform site design, Level 1 Feasibility Screening and BMP prioritization (see Section 3.5), and support stormwater system design and Level 2 feasibility screening (see Section 3.7) for projects demonstrating infeasibility.

3.1.4. Groundwater Considerations

Site groundwater conditions should be considered prior to LID BMP and treatment control BMP siting, selection, sizing, and design.

3.1.4.1. Groundwater Levels

The depth to seasonal high groundwater table (normal high depth during the wet season) beneath the project may preclude infiltration. Depth to seasonal high groundwater level should be estimated as the average of the annual minima (i.e., the shallowest recorded measurements in each water year, defined as October 1 through September 30) for all years on record. If groundwater level data are not available or not considered to be representative, seasonal high groundwater depth can be determined by redoximorphic analytical methods combined with temporary groundwater monitoring for November 1 through April 1 at the proposed Project site. [1] Depth to first groundwater level is depicted on maps in Appendix II.

3.1.4.2. Groundwater and Soil Contamination

In areas with known groundwater and soil pollution, infiltration may need to be avoided, ~~as~~ [2] could contribute to the movement or dispersion of soil or groundwater contamination. [3] Areas with known soil or groundwater impacts include sites listed by the Santa Ana and San Diego Regional Water Quality Control Boards' Leaking Underground Storage Tanks (LUST) program and Site Cleanup Program (SCP). The California Water Resources Control Board maintains a database of registered contaminated sites through their 'Geotracker' Program. Registered contaminated sites can be identified in the project vicinity when the site address is typed into the "map cleanup sites" field. Mobilization of groundwater contaminants may also be of concern where contamination from natural sources is prevalent (e.g., marine sediments, selenium rich groundwater, to the extent that data is available). If infiltration is used, a site-specific analysis must be conducted where soil or groundwater pollutant mobilization is a concern to determine where infiltration-based BMPs are allowed. It may be found that a certain amount of stormwater infiltration would not be detrimental, or could be beneficial. [4] Known groundwater plumes are depicted on maps in Appendix II.

3.1.4.3. Protection of Groundwater Quality

Research conducted on the effects on groundwater from stormwater infiltration by Pitt et al. (1994) indicate that the potential for contamination due to infiltration is dependent on a number of factors including the local hydrogeology and the chemical characteristics of the pollutants of concern. Chemical characteristics that influence the potential for groundwater impacts include high mobility (low absorption potential), high solubility fractions, and abundance of pollutants in urban runoff. As a class of constituents, trace metals tend to adsorb onto soil particles and are filtered out by the soils. This has been confirmed by extensive data collected beneath

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Need to explain to what extent (of even if) this map can be relied upon solely and when additional site-specific information is needed.

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if

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or adversely affect ongoing clean-up efforts.

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The user needs to be advised that both Geotracker and the maps are to be used for site evaluation.

stormwater detention/retention ponds in Fresno (conducted as part of the Nationwide Urban Runoff Program (Brown & Caldwell, 1984)) that showed that trace metals tended to be adsorbed in the upper few feet in the bottom sediments. Bacteria are also filtered out by soils. More mobile and soluble pollutants, such as chloride and nitrate, have a greater potential for impacting groundwater.

Where soils have very high infiltration rates and/or low organic content, pollutants may not be adequately removed from stormwater and groundwater quality may be impacted by infiltration BMPs. Where soil infiltration rates exceed 2.4 inches per hour and infiltration is selected, soils should be characterized and amended if necessary to provide a treatment layer to minimize the potential for groundwater contamination. The treatment layer should meet the following criteria or other criteria deemed by the project engineer to be protective of groundwater quality:

- Minimum two-foot depth of treatment layer, and
- Cation exchange capacity (CEC) of the treatment layer ≥5 milliequivalents CEC/100 g dry soil (USEPA Method 9081), and
- Minimum organic content of 1% on a dry weight basis using ASTM D2974.

Some land uses are recognized to pose significant risk of groundwater contamination if stormwater runoff is infiltrated without adequate pretreatment:

- Industrial or light industrial activity;
- Areas subject to high vehicular traffic (25,000 or greater average daily traffic on main roadway or 15,000 or more average daily traffic on any intersecting roadway);
- Automotive repair shops;
- Car washes;
- Fleet storage areas (bus, truck, etc.);
- Nurseries;
- Any other high threat to water quality land uses or activities.

In North Orange County, runoff from these areas should not be infiltration, except where sources can be reasonably and technically isolated. In South Orange County, infiltration may be conducted where pretreatment can reliably prevent significant risk of groundwater contamination or where sources can be reasonably and technically isolated.

Prior to the use of infiltration basins and subsurface infiltration BMPs, the project proponent should consult with the local groundwater management agency to identify if unconfined water

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mobile pollutant

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Provide some examples of methods.

supply aquifers are located beneath the project to determine the appropriateness and/or pre-treatment design of infiltration-based BMPs. The Orange County Water District is responsible for managing the northern Orange County groundwater basin. If a project is proposed that includes the construction of infiltration facilities within the boundaries of the north Orange County groundwater basin or areas with groundwater connectivity to this basin, the project proponent should have the facility plans reviewed by the Orange County Water District to ensure that they appropriately located and designed such that groundwater is protected (as per Orange County Drainage Area Management Plan, 2003).

LID infiltration facilities may potentially be categorized as "Class V Injection Wells" under the federal Underground Injection Control (UIC) Program, which is regulated in California by U.S. EPA Region 9. A UIC permit may be required for such a facility (for details see http://www.epa.gov/region9/water/groundwater/uic-classv.html).

Infiltration BMP Fact Sheets (Section 6.6.2) identify BMPs which may potentially be categorized as Class V Injection Wells.

3.1.4.4. Groundwater Recharge

Infiltration of stormwater can provide the benefit of recharging groundwater. However, [1] connectivity between the ground surface and managed aquifers is highly variable and is a critical factor in determining what level of benefit in this respect can be expected from stormwater infiltration. Infiltration in some areas may be much more effective than others at recharging groundwater. If infiltration BMPs are selected, site assessment should attempt to identify areas where infiltration would be most beneficial for groundwater recharge.

Approved WMPs, HMPS, or other RWQCB Executive Officer-approved watershed-based plans may identify areas where a downstream, off-site infiltration basin would result in more effective groundwater recharge than infiltration on the project site; in the areas tributary to these basins, [2] infiltration of stormwater on-site in areas less effective for groundwater recharge could be deemed inconsistent with watershed management strategies. Potential regional opportunities are discussed in Section 3.8.2.

3.1.4.5. Groundwater/Surface Water Interactions

Groundwater discharge to surface water is generally a primary source of base flows in perennial stream systems. Intermittent and ephemeral systems are often characterized by groundwater discharge during portions of the year and streams losing flow to groundwater during other portions of the year. These systems may be sensitive to minor changes in groundwater levels which could result from increased infiltration compared to the existing condition. In such systems, increases in groundwater level could potentially result in extended duration of flow in the channels and potential [3] ~~"type change"~~ of intermittent and ephemeral drainages. These changes may have significant impacts on habitat and geomorphology. If intermittent or ephemeral drainages are located adjacent to and down-gradient of the project and infiltration BMPs are considered, the Project WQMP should [4] address the potential for

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Simplify.

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Explain what is meant by this.

Number: 3 Author: staff Subject: Cross-Out Date: 6/30/2010 9:51:20 AM

This is unnecessary jargon. Substitute it with plain language.

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Describe the methods that will be used to address potential type changes.

infiltration BMPs to result in adverse type changes and, if present, should discuss to what extent infiltration BMPs should be implemented to prevent adverse impacts.

3.1.5. Geotechnical Considerations

Infiltration of stormwater can cause geotechnical issues, including: (1) settlement through collapsible soil, (2) expansive soil movement, (3) slope instability, and (4) an increased liquefaction hazard. Stormwater infiltration temporarily raises the groundwater level near the infiltration facility, such that the potential geotechnical conditions are likely to be of greatest significance near the area of infiltration and diminish with distance. If infiltration BMPs are considered, a geotechnical investigation should be performed for the infiltration facility to identify potential geotechnical issues and geological hazards that may result from infiltration.

Increased water pressure in soil pores reduces soil strength. Decreased soil strength can make foundations more susceptible to settlement and slopes more susceptible to failure. In general, infiltration-based BMPs must be set back from building foundations or steep slopes. Recommendations for each site should be determined by a licensed geotechnical engineer based on soils boring data, drainage patterns, and the current requirements for stormwater treatment. Implementing the geotechnical engineer's requirements is essential to prevent damage from increased subsurface water pressure to surrounding properties, public infrastructure, sloped banks, and even mudslides.

3.1.5.1. Collapsible Soil

Typically, collapsible soil is observed in sediments that are loosely deposited, separated by coatings or particles of clay or carbonate, and subject to saturation. Infiltration of stormwater may result in a temporary rise in the groundwater elevation. This rise in groundwater could change the soil structure by dissolving or deteriorating the intergranular contacts between the sand particles, resulting in a sudden collapse, referred to as hydrocollapse. This collapse phenomenon generally occurs during the first saturation episode after deposition of the soil, and repeated cycles of saturation are not likely to result in additional collapse. If infiltration is considered, it is important to evaluate the potential for hydrocollapse during the geotechnical investigation. The magnitude of hydrocollapse is proportional to the thickness of the soil column where infiltration is occurring; in most instances, the magnitude of hydrocollapse will be small. Regardless, if infiltration BMPs are considered, the geotechnical engineer should evaluate the potential effects of hydrocollapse and, if necessary, specify mitigation and monitoring measures.

3.1.5.2. Expansive Soil

Expansive soil is generally defined as soil or rock material that has a potential for shrinking or swelling under changing moisture conditions. Expansive soils contain clay minerals that expand in volume when water is introduced and shrink when the water is removed or the material is dried. When expansive soil is present near the ground surface, a rise in groundwater from infiltration activities can introduce moisture and cause these soils to swell. Conversely, as

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the groundwater surface falls after infiltration, these soils will shrink in response to the loss of moisture in the soil structure. The effects of expansive soil movement (swelling and shrinking) will be greatest on near surface structures such as shallow foundations, roadways, and concrete walks. Basements or below-grade parking structures can also be affected as additional loads are applied to the basement walls from the large swelling pressures generated by soil expansion. If infiltration BMPs are considered, the geotechnical investigation should identify if expandable materials are present near the proposed infiltration facility, and if they are, evaluate if the infiltration will result in wetting of these materials.

3.1.5.3. Slopes

Slopes near infiltration facilities can be affected by the temporary rise in groundwater. The presence of a water surface near a slope can substantially reduce the stability of the slope from a dry condition. If infiltration BMPs are is considered near a slope, groundwater mounding analysis should be performed to evaluate the rise in groundwater around the facility. If the computed rise in groundwater approaches nearby slopes, then a separate slope stability evaluation should be performed to evaluate the implications of the temporary groundwater surface. The geotechnical and groundwater mounding evaluations should identify the duration of the elevated groundwater and assign factors of safety consistent with the duration (e.g., temporary or long-term conditions).

3.1.5.4. Liquefaction

Seismically-induced soil liquefaction is a phenomenon in which saturated granular materials, typically possessing low to medium density, undergo matrix rearrangement, develop high pore water pressure, and lose shear strength due to cyclic ground motions induced by earthquakes. This rearrangement and strength loss is followed by a reduction in bulk volume. Manifestation of soil liquefaction can include loss of bearing capacity for foundations, surface settlements, and tilting in level ground. Soil liquefaction can also result in instabilities and lateral spreading in embankments and areas of sloping ground.

Saturation of the subsurface soils above the existing groundwater table may occur as a result of stormwater infiltration. If infiltration BMPs are considered, the potential for liquefaction should be assessed. If this assessment shows that potential for liquefaction exists, appropriate geotechnical analyses should be conducted to determine the level of stormwater infiltration that can be safely tolerated.

3.1.6. Managing Off-Site Drainage

Locations and sources of off-site run-on onto the site should be identified early in the design process. Off-site drainage should be considered when determining appropriate BMPs for the site so that the drainage can be managed. Concentrated flows from offsite drainage may cause extensive erosion if not properly conveyed through or around the project site or otherwise managed. By identifying the locations and sources of off-site drainage, the volume of water running onto the site may be estimated and factored into the siting and sizing of on-site BMPs.

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The complexity of this issue isn't being given proper treatment. For some BMPs, accepting off-site flow, but not sizing to accommodate the added volume, will adversely affect its performance and have other bad outcomes. For others, it could dilute the pollutant concentration and lower the mass load removed. Concrete guidance on this matter is needed to decide when the additional volume must be treated or not.

Vegetated swales or storm drains may be used to intercept, divert, and convey off-site drainage through or around a site, without treatment, to prevent flooding or erosion that might otherwise occur.

3.1.7. Existing Utilities

Existing subsurface utilities will limit the possible locations of certain BMPs and may constrain site design. If infiltration BMPs are considered, the potential impacts of stormwater infiltration on subsurface utilities should be evaluated to establish necessary setbacks from these utilities.

Potential points of connection to off-site storm drains should be evaluated as part of the site assessment phase to serve as a basis for developing conceptual stormwater management plans.

3.1.8. Environmentally Sensitive Areas (ESAs)

To assist developers in determining the presence of ESAs such as areas designated in the Ocean Plan as Areas of Special Biological Significance (ASBS) or waterbodies listed on the CWA Section 303(d) list of impaired waters, ESAs has prepared watershed maps that identify each ESA within Orange County (see OC Watersheds website: http://www.ocwatersheds.com/ESA.aspx).

Within the San Diego Region, the following constitutes an ESA for the purposes of the New Development/Significant Redevelopment Program:

- Waterbodies listed in Table A-7.VI-3 of the 2003 County of Orange Local WQMP
- Areas designated as preserves or equivalent under the Natural Community Conservation Planning Program
- Areas designated as Critical Aquatic Resources (CAR)

Within the Santa Ana Region, the following constitutes an ESA for the purposes of the New Development/Significant Redevelopment Program:

- Waterbodies listed in Table 7.II-3 and 7.II-4 of the Model WQMP

3.2. Addressing Pollutants of Concern

This section describes the identification of pollutants of concern (POCs) based on land use runoff water quality and receiving water impairments/total maximum daily loads (TMDLs)

3.2.1. Requirements for Documenting Pollutants of Concern

This section describes the mandatory documentation requirements related to POCs contained in the Model WQMP that, where applicable, must be included in the Project WQMP. These mandatory requirements for all Priority Projects, where applicable, include:

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A project proponent does not need to treat pollutants in storm water from offsite. This principle should not be understated in the way shown. It would also follow to recommend segregation and diversion of off-site flows whenever possible.

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or if the utilities need to be relocated.

Number: 3 Author: staff Subject: Underline Date: 6/30/2010 11:30:46 AM

It should be noted that the lists are subject to change, making this reference obsolete. This vulnerability should be indicated and a more direct reference should be provided.

Number: 4 Author: staff Subject: Underline Date: 7/12/2010 12:04:39 PM

Expand this to define what a pollutant of concern is vs. a primary pollutant of concern

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described (?)

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documentation

1) Proposed land use categories and anticipated pollutants present in stormwater runoff

2) Receiving water of project

3) Existing impairments, established TMDLs, and TMDLs in progress for the receiving water

4) Identified primary POCs and other POCs

3.2.2. ~~Establishing~~ Pollutants of Concern

~~Pollutants of concern should be established based on~~ the methodology and supporting information contained in Section 7.II – 2.1.4 of the Model WQMP.

Underlying data sources used to establish POCs such as 303(d) listings and TMDL applicability should be verified at the time of Project WQMP preparation to ensure that current information is used.

3.3. Receiving Water Applicability and Susceptibility Related to Hydromodification Control

This section discusses the process for identifying: the hydromodification control standards that apply for a particular project. Performance criteria for hydromodification depend on the location of the project and the susceptibility of downstream receiving waters.

3.3.1. Requirements for Documentation of Receiving Water Applicability and Susceptibility Related to Hydromodification Control

This section describes the mandatory documentation requirements related to receiving water applicability and susceptibility contained in the Model WQMP that, where applicable, must be included in the Project WQMP. These mandatory requirements for all Priority Projects, where applicable, include:

1) The Project WQMP shall identify the ~~MS4 permit~~ that is applicable to the project.

2) The Project WQMP shall identify whether an approved and adopted WMP or HMP is applicable to the watershed in which the project is located.

3) If the project has an HCOC as a result of the proposed project, the Project WQMP shall describe the project's receiving waters and determine whether the downstream receiving waters are susceptible to HCOCs.

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Number: 3 Author: staff Subject: Highlight Date: 6/30/2010 11:41:05 AM
The information in this section is important and should be placed in Section 3.2. This would make Section 3.2.2 unnecessary.

Number: 4 Author: staff Subject: Replacement Text Date: 6/30/2010 11:38:48 AM
Identifying

Number: 5 Author: staff Subject: Replacement Text Date: 7/12/2010 12:05:16 PM
The project proponent must identify pollutants of concern using

Number: 6 Author: staff Subject: Underline Date: 6/30/2010 11:38:04 AM
Strongly recommend that the listing in effect at the time be included in the final project WQMP.

Number: 7 Author: staff Subject: Inserted Text Date: 6/28/2010 1:17:24 PM
to the adverse effects of hydromodification.

Number: 8 Author: staff Subject: Cross-Out Date: 6/28/2010 1:21:33 PM
state the permits for the benefit of the reader

a. If regional susceptibility maps are used to establish susceptibility, the Project WQMP shall include an exhibit showing the location of the project on the regional susceptibility maps.

b. If determination of susceptibility is based on a site-specific investigation, the Project WQMP shall summarize the findings of the site-specific investigation and detailed information shall be attached.

c. Determination of susceptibility is only required for Priority Projects which have a HCOC; Priority Projects which do not have a HCOC as a result of the proposed project are not required to assess susceptibility.

3.3.2. Permit Applicability

The North and South County Permits have different performance criteria for hydromodification control, as described in Section 2.2.4. In order to determine which Permit applies to a particular project location, a project proponent can use Figure 3.1 and Figure 3.2, which overlay the County and City boundaries with the Regional Board (i.e., Permit) boundary. Because the Regional Boards' boundaries are defined along watershed boundaries, but city jurisdictions are not, some cities lie within both the North and South County Permit areas. Laguna Hills, Laguna Woods, Lake Forest, and Portola Hills (part of Lake Forest) have significant area in both regions, as shown in **Table 3.2**.

Number: 1 Author: staff Subject: Highlight Date: 6/30/2010 11:49:21 AM
Describe the process for determining susceptibility.

Figure 3.1
Permit Applicability: RWQCB and City Boundaries in Vicinity of RWQCB Boundary

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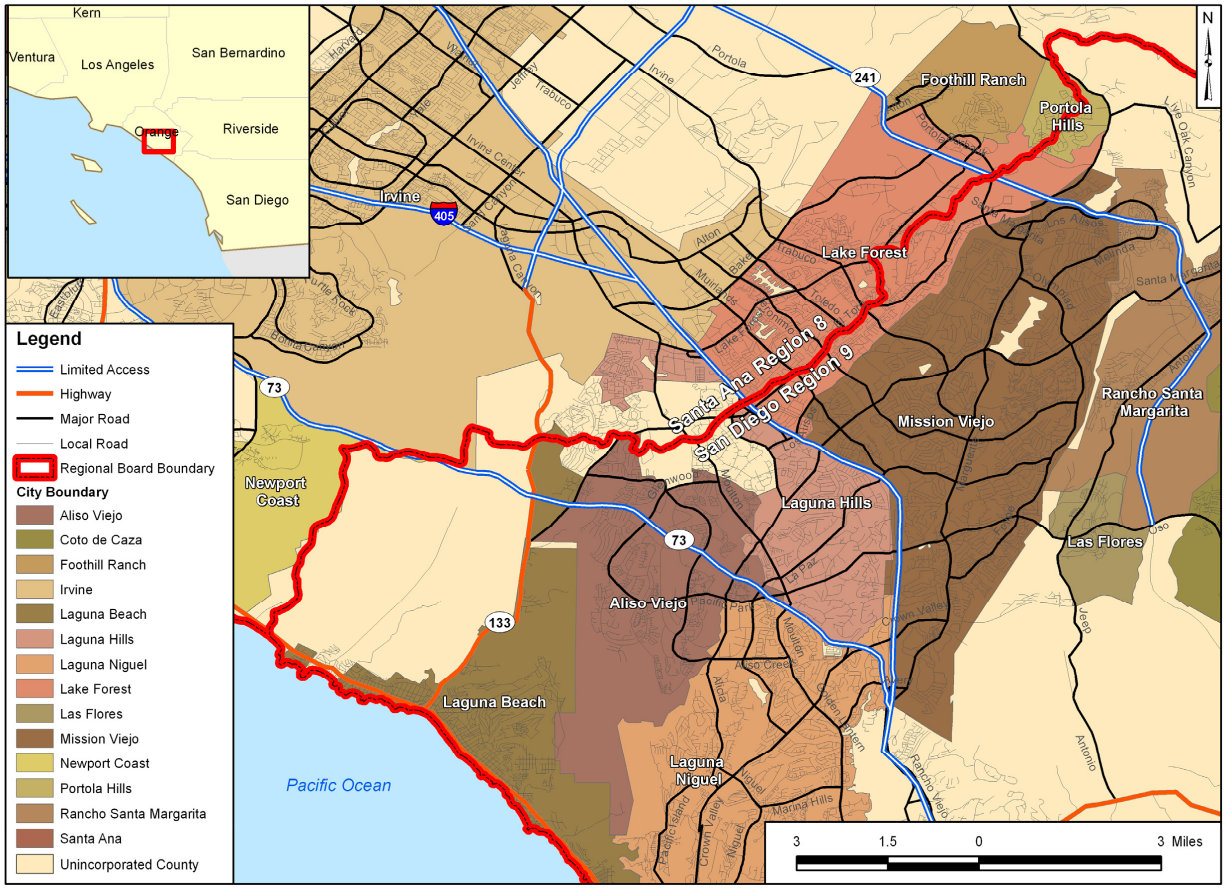
Figure 3.2
Permit Applicability: RWQCB and City Boundaries in Vicinity of RWQCB Boundary



P:\GIS\OC_DAMP\Projects\Fig3-2_OC_R8R09Bound_Urb_Area_050510.mxd, WHL, May 5, 2010

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Table 3.2 Municipalities in Orange County with Significant Land Area in both Region 8 and Region 9		
	Region 9	Region 8
	San Diego	Santa Ana
City	% of Jurisdiction	% of Jurisdiction
Laguna Hills	81.6%	18.4%
Laguna Woods	40.8%	59.2%
Lake Forest	31.8%	68.2%
Portola Hills (part of Lake Forest)	47.4%	52.6%
Unincorporated	47.2%	52.8%

3.3.3. Watershed Applicability

It is anticipated that Watershed Master Plans (North Orange County) and Hydromodification Management Plans (South Orange County) will contain watershed-based hydromodification control strategies which may supersede the hydromodification control performance criteria described in this TGD for projects in the watersheds for which a WMP or HMP is in effect. Where an approved WMP or HMP is not in effect, the criteria stated in this TGD are applicable.

3.3.4. Stream Susceptibility

Definitions of susceptibility are similar in North and South Orange County:

- In North Orange County, downstream channels are considered not susceptible to hydromodification, and therefore do not have the potential for a HCOC, if all downstream conveyance channels that will receive runoff from the project are engineered, hardened, and regularly maintained to ensure design flow capacity, and no sensitive habitat areas will be affected. The maps of such conveyance channels provided in Appendix II may be used to determine susceptibility. These maps may be updated in the WMPs.

- In South Orange County, downstream channels are considered not susceptible to hydromodification, and therefore projects do not have a potential HCOC, if (1) the project discharges stormwater runoff into underground storm drains discharging directly to bays or the ocean, or (2) storm water runoff conveyance channels whose bed and bank are concrete lined all the way from the point of discharge to ocean waters, enclosed bays, estuaries, or water storage reservoirs and lakes. Hydromodification susceptibility maps will be prepared as part of the HMP development in South Orange County.

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Number: 1 Author: staff Subject: Cross-Out Date: 6/30/2010 11:58:45 AM

This table doesn't seem useful for the purposes of the user of this document.

In North Orange County, determination of susceptibility is only required for projects which have a HCOC; projects which do not have a HCOC as a result of proposed development are not required to assess susceptibility.

Where regional maps are inconclusive, it ~~should~~ be assumed that the project's receiving waters are susceptible to hydromodification impacts unless a downstream assessment is completed by a licensed geomorphic professional.

A downstream assessment of susceptibility may be conducted by a licensed geomorphic professional for any project. This assessment should consider:

- Potential impacts on channel stability, include considerations, such as:
  - Bed and bank materials
  - Channel geometry and slope
  - Sediment supply
  - Flow regime
- Potential impacts to physical structures, such as:
  - Utility networks (e.g., sewer lines, gas lines, etc.)
  - Road crossings (culverts and bridges)
  - Storm Drains
  - Constructed channel network
  - In-stream drop structures / grade control
  - Dams and other basins
- Potential impacts to riparian and aquatic habitat, including such considerations as:
  - Longitudinal connectivity of the stream system (i.e. to allow for migration of fauna)
  - Lateral connectivity of the stream channel to its floodplain
  - Existing riparian corridors
  - Perennial and ephemeral channels
  - Channels where groundwater discharges either seasonally or year-round
  - Impaired waterbodies
  - Existing and proposed treatment BMPs
  - Channel reaches planned for enhancement or restoration
  - Water quality monitoring and bioassessment sampling locations and data

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must

Number: 2 Author: staff Subject: Underline Date: 7/12/2010 12:06:25 PM

This portion begins to explain how an assessment is to be done. It is important and should have its own subheading so that it can be referenced and quickly located. However, it is incomplete because it does not describe acceptable methods for conducting an assessment of susceptibility.

- Existing vegetation types, special habitat, locations of threatened or endangered species, and barriers restricting movement

3.4. Determining Applicable Project Planning Criteria

Applicable Priority Project performance criteria depend on the location of the project, project characteristics, the existing condition of the project site, and downstream conditions of the receiving waters. Project planning criteria are functional expressions of performance criteria that can be established at the planning phase of a project to guide project planning efforts. The following sections describe key elements of project planning criteria for Priority Projects.

3.4.1. Requirements for Documenting in Applicable Project Planning Criteria

This section describes the mandatory documentation requirements related to planning criteria contained in the Model WQMP that, where applicable, must be included in the Project WQMP. These mandatory requirements for all Priority Projects, where applicable, include:

1) The Project WQMP shall identify the applicable design capture storm depth.

2) If in North Orange County, the Project WQMP should categorize the ~~magnitude of potential HCOCs~~ as Category 1, 2 or 3.

3) The Project WQMP shall identify the hierarchy of BMPs that shall be used.

3.4.2. Design Capture Storm Depth

The design capture storm depth is defined as the 85th percentile, 24-hour storm depth. Storms are defined as days with greater than 0.1 inches of precipitation. This storm depth is used to compute the LID design capture volume per hydrologic methods provided in Section 2.3.1. Figure 6.2 provides contours of design capture storm depth for Orange County. This storm depth is also one of the sizing criteria that may be used to size BMPs to achieve treatment control performance criteria where LID BMPs are not employed.

3.4.3. Presence and Magnitude of HCOCs

At the planning level, it is necessary to develop an approximate estimate of whether HCOCs exist and the sizing criteria required to address these conditions using on-site control options. The presence or absence of potential HCOCs as a result of downstream susceptibility and the permit/watershed applicability should be determined ~~per~~ Section 3.3. The following sections describe rule of thumb methods for determining the magnitude of potential HCOCs based on preliminary project characteristics.

3.4.3.1. North Orange County

A preliminary assessment of the presence/absence and approximate magnitude of required controls can be provided through assessment of existing and proposed composite

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This wording choice is misleading. HCOC's are a presence/absence metric and there is no magnitude. The described Categories are best described as outcomes. The Category number is far less interesting to the preparer/proponent/reviewer than the outcome itself; determining the Category number seems like an unnecessary step.

Number: 3 Author: staff Subject: Underline Date: 6/30/2010 12:04:30 PM

Before introducing this term, it would be helpful to describe its meaning in a broader context. Describe all of the levels and explain all of the applicable elements of the MWQMP for each.

Number: 4 Author: staff Subject: Replacement Text Date: 6/30/2010 12:05:42 PM

using methods described in

imperviousness. Imperviousness can be estimated from proposed land use. Regardless of project size, the following rule of thumb calculations can be conducted:

$$d_{HMOD} = d_{2\text{-yr, 24-hr}} (C_{PROPOSED} - C_{EXIST})$$

Where

d_{HMOD} = the approximate design storm depth for retention BMPs to match volume of runoff in the 2-yr, 24 hour event

$d_{2\text{-yr, 24-hr}}$ = 2-yr, 24-hr storm depth

C = runoff coefficient = $(0.75 \times imp + 0.15)$

imp = impervious fraction of drainage area (ranges from 0 to 1)

~~At the preliminary planning phase,~~ it can be assumed that reduction in time of concentration is not of concern if volume-based BMPs are used. Note that these calculations are preliminary, as this methodology does not incorporate a factor related to soil type, which would significantly affect the change in hydrology for a project. Final calculations must be conducted for the Project WQMP based on the methods outlined in Section 2.3.3.1.

Channel susceptibility to hydromodification has been mapped, as described in Section 3.3.4 and shown in Appendix II. As these maps show, there are drainage areas that have been mapped as having HCOCs which are tributary to only a short segment of susceptible channel located far downstream of the drainage area. ~~If a project site is located in such a drainage area, the project proponent has the option of conducting a geomorphically-based project-specific evaluation to demonstrate that the project will not have an adverse impact on downstream channels such that a HCOC does not exist and hydromodification controls are not required.~~

3.4.3.2. South Orange County

Past studies conducted in Southern California indicate that it takes approximately 3 to 6 watershed inches of capture volume to provide flow duration control. LID requirements are not expected to fulfill hydromodification requirements in South Orange County.

3.4.3.3. Documenting ~~Magnitude~~ of HCOCs for Project Planning

Using the results of Sections 3.4.3.1 and 3.4.3.2, projects can be divided into three classes for purposes of project planning related to HCOCs. Consideration of these categories is not required, but may be helpful in determining whether LID or hydromodification control requirements are likely to control the design process.

Category 1: No HCOCs exist. Projects meeting the following criteria:

- Downstream reaches are not susceptible to hydromodification, or

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Number: 1 Author: staff Subject: Underline Date: 6/25/2010 2:33:29 PM

The loop of instruction is not closed. Instruct the reader on what to do with the resulting dHMOD.

Number: 2 Author: staff Subject: Cross-Out Date: 7/12/2010 12:07:48 PM

It needs to be clear that the assumption holds true ONLY if volume-based BMPs are used.

Number: 3 Author: staff Subject: Cross-Out Date: 6/25/2010 2:14:30 PM

Restate this in a useful plain language style. Explain what criteria will be used and describe the methods.

Number: 4 Author: staff Subject: Cross-Out Date: 8/5/2010 3:45:43 PM

The following are categories, not magnitudes. Amend this language. If there is no requirement to 'document' by using the Categories, the Categorization terminology appears to create unnecessary jargon.

- [North Orange County] d_{HMOD} is less than 5 percent of $d_{2\text{-yr, 24hr}}$ or negative, or
- The project site infiltrates at least the runoff from the 2-yr, 24-hr storm event, or
- A geomorphically-based project-specific evaluation demonstrates that the project will not have an adverse impact on downstream channels such that a hydrologic condition of concern does not exist and hydromodification controls are not needed.

Category 2: LID BMPs sized to LID performance criteria will likely address HCOCs. Projects meeting the following criteria:

- [North Orange County] d_{HMOD} is less than or equal to the design capture storm depth (see Section 3.4.2)

Category 3: LID BMPs may not meet hydromodification requirements, therefore the design process should start with hydromodification control, or hydromodification control should be evaluated after applying LID BMPs. Projects meeting the following criteria:

- All South Orange County projects.
- [North Orange County] d_{HMOD} is greater than the design capture storm depth (see Section 3.4.2)

3.4.4. Hierarchy of Controls

The default hierarchy of LID controls is described in Section 2.2.2.2. Roadway and similar constrained right of way and drainage projects are subject to alternative LID performance criteria which include suspension of the default hierarchy of controls. The recommended process for developing a Project WQMP for a roadway or similar constrained right of way or drainage project is provided in Section 3.9.

3.5. Preliminary Site Design and BMP Selection

This section describes a process for developing functional drainage plans that work with the site design/constraints and selecting BMPs based on BMP priority, site conditions/constraints, and pollutants of concern. A variety of constraints may prohibit or limit the use of certain BMP types; therefore the Level 1 Feasibility Screening process is employed, as necessary, to determine which BMPs are technically appropriate for the site. Level 1 Feasibility Screening (See Section 6.2.1) considers statutory and physical limitations as well as numerical and categorical screening criteria to determine which BMPs cannot be used for the projects and which may be used but are not mandatory. BMP prioritization is conducted by integrating the results of Level 1 Feasibility Screening with a site-specific opportunity screening. Figure 3.3 illustrates this process.

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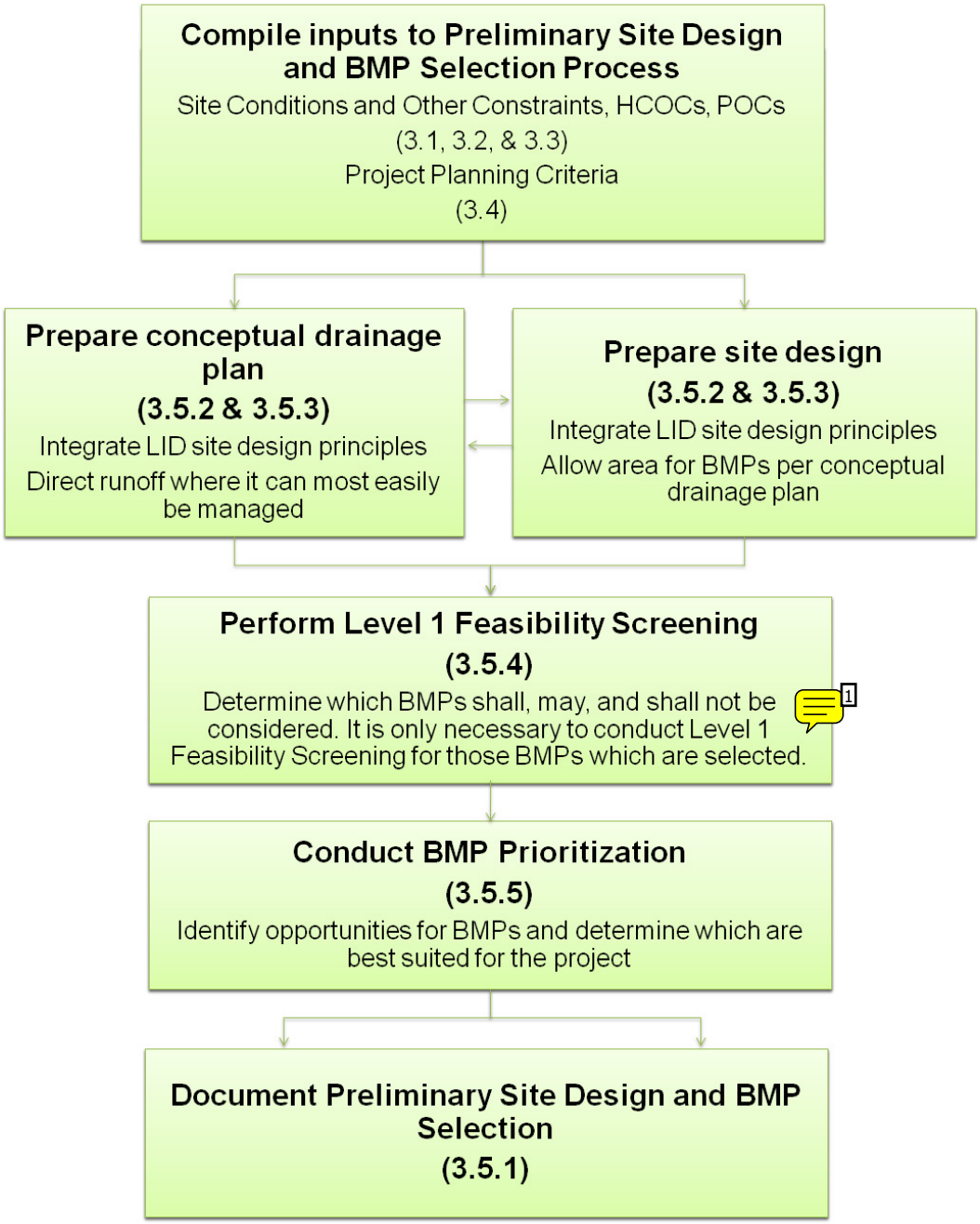
If this is simply a recommendation, you must describe all of the other acceptable processes so that they may be evaluated as well as the criteria used in the evaluation.

Number: 2 Author: staff Subject: Underline Date: 6/30/2010 12:14:42 PM

This language introduces several concepts that are not defined. If it is intended to provide an overview of the process, it is not helpful.

Figure 3.3
Site Planning and BMP Selection Process



While this process is presented in a stepwise fashion in this section, the process is inherently non-linear and iterative. Priority Projects that emphasize site design and stormwater management at the earliest phases of a project can realized benefits in the form of more efficient integration of stormwater management with site functionality and lower likelihood of invoking Level 2 feasibility analyses and alternative programs.

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If a proponent "shall" only consider BMPs shown to be feasible using the screening, but the proponent can limit the application only to those BMPs selected, the proponent is being allowed to exclude BMPs which the feasibility analysis might show are feasible. This reasoning is not acceptable.

Priority redevelopment projects and urban infill new development may have more limited opportunities to affect drainage patterns and site design than new development projects, however many of these principles may still be applicable.

3.5.1. Requirements for Documenting Preliminary Site Design and BMP Selection

This section describes the mandatory documentation requirements related to preliminary site design and BMP selection contained in the Model WQMP that, where applicable, must be included in the Project WQMP. These mandatory requirements for all Priority Projects, where applicable, include:

1) The Project WQMP and exhibit(s) shall document the use of the site design principles. A narrative discussion of non-applicability shall be included for any of the site design principles listed in Section 4 that are not included.

2) The Project WQMP exhibit(s) shall depict conceptual drainage plans. The use of drainage management areas (DMAs) is strongly encouraged.

3) The Project WQMP shall describe inputs and results of Level 1 Feasibility Screening process for all BMP types selected. Worksheet B (see Appendix V) ~~may~~ be used to meet this requirement. Supporting studies shall be referenced and submitted with the Project WQMP.

4) The Project WQMP shall include a narrative discussion of BMP selection and prioritization.

5) Spatial data depicting site design should be submitted in graphical information system (GIS) format.

If the Project WQMP finds that it is not feasible to meet the LID performance criteria on-site, the following elements are required as part of preliminary site design and BMP selection (in addition to Level 2 Feasibility Screening):

6) As required by the Model WQMP, the Project WQMP shall describe inputs and results of Level 1 Feasibility Screening for <u>all</u> BMP types. Worksheet B (see Appendix V) ~~may~~ be used to meet this requirement. Supporting studies should be referenced and submitted with the Project WQMP. *Intent: demonstrate that all BMP types have been considered before finding that it is infeasible to meet LID retention requirements on-site.*

7) As required by the Model WQMP, the Project WQMP shall document the application of a rigorous BMP prioritization process as described in Section 6.2.2. Worksheet C (see Appendix V) ~~may~~ be used to document the prioritization process described in Section 6.2.2. *Intent: demonstrate that the most appropriate BMPs are included in BMP plans before finding that it is infeasible to meet LID retention requirements on-site.*

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or other equivalent format must

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or other equivalent format must

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or other equivalent format must

3.5.2. Prepare Conceptual Drainage Plan and Site Design

LID requires an integrated approach to site design and stormwater management. Traditional approaches to stormwater management planning are not likely to be effective. The use of site planning techniques presented here will help generate a more hydrologically functional site, help to maximize the effectiveness of LID BMPs, and integrate stormwater management throughout the site.

Conceptual drainage plans are key tools in site planning. A conceptual drainage plan shows the rough delineations of the major drainage areas on the project, typically defined by the points of discharge from the site. Small projects may have only one drainage area.

The following criteria should be considered during the early site planning stages:

- LID BMPs should be considered as early as possible in the site planning process. Hydrology should be an organizing principle that is integrated into the initial site assessment planning phases. Where flexibility exists, conceptual drainage plans should attempt to route water to areas suitable for retention BMPs.

- A multidisciplinary approach is recommended that includes planners, engineers, landscape architects, and architects at the initial phases of the project.

- Individual LID BMPs should be distributed throughout the project site as feasible and may influence the configuration of roads, buildings and other infrastructure.

- Flood control should be considered early in the design stages. Even sites with LID BMPs will still have runoff that occurs during large storm events, but LID facilities can have flood control benefits. It may be possible to simultaneously address flood control requirements through an integrated water resources management approach (see Section 4.7)

Perhaps the most important aspect of site planning is allowing sufficient space for LID BMPs in areas that can physically accept runoff. Simple rules of thumb are presented in Table 3.3 to help allow sufficient space in preliminary design.

Table 3.3
Approximate Space Requirements for Structural BMPs

BMPs Selected	Percent of Tributary Impervious Area Required	
	Well Drained Soils	Moderately Drained Soils
LID Infiltration	2 to 5	5 to 10
LID Harvest and Reuse	1-2 percent of tributary area (cistern 8 feet tall, indoor or outdoor)	
LID Evapotranspiration	50 to 100 percent coverage of rooftops (with all roof area draining to green roof)	

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Site design principles presented in Section 4 should be employed at this phase in the Project WQMP preparation process.

Refer to the Bay Area Stormwater Management Agencies Association (BASMAA) Start at the Source manual for more guidance on LID site design practices.

3.5.3. Divide Site into Drainage Management Areas or Similar

Dividing the project site into DMAs is a common step in the preparation of stormwater management plans, and provides a framework for feasibility screening, BMP prioritization, and stormwater management system configuration. The use of DMAs is strongly encouraged, but is not mandatory. Similar strategies for laying out the conceptual drainage plan for the site may be used in the Project WQMP preparation process.

DMAs are defined based on the proposed drainage patterns of the site and the BMPs to which they drain. At this phase of the Project WQMP preparation process, BMPs may not have been selected. In this case, DMAs would be delineated based on site drainage patterns and possible BMP locations identified in the site planning process.

A DMA may drain to a single BMP or to a group of similar BMPs distributed throughout the DMA. For example, a drainage management area may be defined as 10 acres of mixed urban land uses draining to an infiltration basin near the lower end of the project site, or a DMA may be defined as a 2 acre parking lot with several bioretention areas distributed throughout with similar design standards. DMAs should not overlap and should be approximately homogenous with respect to BMP opportunities and feasibility constraints.

The process of defining final DMAs may require iteration through the steps described in Section 3.5.4 and 3.5.5.

3.5.4. Perform Level 1 Feasibility Screening

Level 1 Feasibility Screening includes questions to address specific statutory and physical limitations, as well as numeric and categorical screening criteria to identify conditions under which the use of a practice type "shall not", "may", or "shall" be considered further. Level 1 Feasibility Screening should be conducted and documented per the detailed instructions in Section 6.2.1. If it is feasible to meet LID performance criteria on the project site, it is only required to conduct Level 1 Feasibility Screening for those types of BMPs which are used. If it is not feasible to meet LID performance criteria on the project site, then Level 1 Feasibility Screening shall be conducted for all BMP types. The results of Level 1 Feasibility Screening ~~may~~ 1 be documented using Worksheet B (see Appendix V) or an equivalent method.

3.5.5. Conduct BMP Prioritization

BMP prioritization should be conducted for all projects. It may be a simple and informal process for those projects which can feasibly meet all LID requirements on the project site.

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must

These projects may simply document the BMPs that were selected and demonstrate that they are allowable for the project through Level 1 Feasibility Screening (see Section 3.5.4).

~~For those projects seeking~~ [1] demonstrate that LID requirements cannot be completely met on-site, a rigorous BMP prioritization process must be conducted. This process shall document that opportunities have been evaluated for all BMPs passing Level 1 Feasibility Screening, and that the selected BMPs are suited to meeting the performance criteria for the project. Section 6.2.2 describes a rigorous prioritization method used to categorize BMPs as:

- Priority 1 – BMPs which "shall" be considered based on Level 1 Feasibility Screening and which have high opportunity in the drainage area based on opportunity screening.
- Priority 2 - BMPs which "shall" be considered based on Level 1 Feasibility Screening and which have moderate opportunity in the drainage area based on opportunity screening.
- Priority 3 – BMPs which "shall" be considered based on Level 1 Feasibility Screening, but which have low opportunity in the drainage area based on opportunity screening, OR, BMPs which "may" be considered based on Level 1 Feasibility Screening and have any level of opportunity in the drainage area.
- Excluded – BMPs which "shall not" be considered based on Level 1 Feasibility Screening.

Alternative prioritization processes may be used that meet the same intent as the process described in Section 6.2.2. Worksheet C (see Appendix V) or equivalent ~~may~~ [3] be used to document the prioritization process.

3.6. BMP Sizing and Design for Typical Projects

This section describes a process for developing a comprehensive LID, treatment control, and hydromodification control plan for typical projects where it is feasible to fully meet LID requirements on-site. If the sizing requirements developed as part of this process cannot be met by the project, then the process described in Section 3.7 should be used instead.

3.6.1. Requirements for Documentation in Project WQMP

This section describes the mandatory documentation requirements related to BMP sizing and design contained in the Model WQMP that, where applicable, must be included in the Project WQMP. These mandatory requirements for all Priority Projects, where applicable, include:

1) The Project WQMP and exhibit(s) shall document the delineations and characteristics of drainage areas tributary to BMPs, including:
    - Delineation

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Number: 1 Author: staff Subject: Replacement Text Date: 6/30/2010 12:47:45 PM

In order

Number: 2 Author: staff Subject: Sticky Note Date: 6/30/2010 12:55:19 PM

A much clearer explanation of these Priority categories is needed. Explain how the BMPs get placed into each of these categories and what the Priorities mean. Do the Priorities mean that BMPs in the lower-numbered Priority must be evaluated somehow before evaluating lower Priorties?

Number: 3 Author: staff Subject: Replacement Text Date: 6/30/2010 12:55:53 PM

must

- Area
- Imperviousness

Delineations shall show how all developed areas within the project are managed.

2) The Project WQMP and exhibit(s) shall document the use of HSCs (if benefits of HSCs are quantitatively considered in meeting performance criteria) and provide calculations of performance criteria met by HSCs.
3) The Project WQMP and exhibits(s) shall document the design criteria for each LID BMP and demonstrate that these design criteria are met, including:
   - Design volume or design flowrate
   - If volume-based, the design drawdown time
4) The Project WQMP shall document that hydromodification control performance criteria have been met, including:
   - Results of susceptibility screening
   - Design calculations to demonstrate that HCOCs have been mitigated
5) If infiltration BMPs are employed, the Project WQMP shall document the design infiltration rates for each of the proposed BMPs and the source of data supporting these values.
6) Spatial data depicting the BMP locations should be submitted in graphical information system (GIS) format.

3.6.2. Select, Design, and Evaluate HSCs

HSCs should be considered based on the opportunity of the project, but are not required if LID requirements can be met in other ways. ~~The benefits of HSCs may optionally be considered in sizing of downstream BMPs.~~ Where claimed, the contribution of HSCs is ~~expressed~~ in terms of inches of the design capture storm depth and percentage of average annual runoff volume reduced. This ~~contribution~~ is deducted from sizing criteria for downstream BMPs.

If the ~~total contribution of~~ HSCs in a drainage area is greater than or equal to the design capture storm depth, the drainage area is considered to be self-retaining ~~for the purpose of evaluating compliance with LID requirements. No~~ additional BMPs are required ~~for~~ the drainage area to meet LID requirements.

If ~~quantitative benefits~~ of HSCs are accounted for in downstream BMP sizing, then ~~HSCs shall be shown on Priority Project WQMP exhibits and calculations supporting claimed benefits~~ shall be prepared as described in Section 6.5.2. These calculations ~~may~~ be submitted ~~in the format provided in~~ Worksheet J (see Appendix V) (see Table 6.7 for example calculations).

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Some HSCs are also effective at removing pollutants. HSCs that effectively remove pollutants are allowed to have their captured storm water volume count towards the design capture volume, consequently reducing the size of downstream BMPs.

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quantified

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combined volume of storm water runoff retained by [?]

Number: 5 Author: staff Subject: Replacement Text Date: 6/30/2010 1:06:32 PM
and no

Number: 6 Author: staff Subject: Replacement Text Date: 6/30/2010 1:06:57 PM
to treat discharges from

Number: 7 Author: staff Subject: Cross-Out Date: 7/12/2010 12:16:40 PM

Number: 8 Author: staff Subject: Replacement Text Date: 7/12/2010 12:16:07 PM
the retained storm water volume

Number: 9 Author: staff Subject: Replacement Text Date: 6/30/2010 1:15:17 PM
supporting calculations

Number: 10 Author: staff Subject: Replacement Text Date: 6/30/2010 1:15:30 PM
must

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HSC shall be shown on site exhibits for priority project WQMPs.

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using

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or an equivalent format

3.6.3. Size and Design LID BMPs

The following steps are used to size and design LID BMPs for typical projects:

1. Look up the ~~recommended~~ sizing method(s) for LID BMP(s) selected in previous steps using **Table 3.4**. ~~Selection of BMPs considers Level 1 Feasibility Screening. If Level 1 Feasibility Screening does not require any retention BMPs to be considered for the project, then biotreatment BMPs may be selected. Otherwise, retention BMPs shall be employed to meet performance criteria to the extent feasible.~~

2. Compute sizing criteria for selected LID BMP(s) ~~(after optionally accounting for the effects of HSCs, see Section 3.6.2).~~

3. Provide LID BMPs sized to meet the sizing criteria and designed per the guidance provided in Sections 6.6 (Infiltration), 6.7 (Harvest and Use), 6.8 (Evapotranspiration), and 6.9 (Biotreatment).

4. Back-check designed LID BMPs to ensure they are consistent with computed design criteria.

Table 3.4, below, provides the ~~recommended~~ methods of ~~computing design criteria~~ for LID BMPs. Continuous simulation hydrologic analysis may be used to demonstrate 80 percent average annual capture efficiency of any of these BMP types to meet LID performance criteria. If it is not feasible to ~~meet the entire LID sizing criteria with the selected BMPs,~~ the Project WQMP shall include a Level 2 Feasibility Screening per instructions provided in Section 3.7. This includes cases where biotreatment needs to be added to retention BMPs to achieve full LID requirements. Section 3.7 provides recommendations for biotreatment BMPs which can be added as the second BMP in a treatment train and the methods that would be used to size these multi-part systems to achieve the target cumulative capture efficiency of 80 percent.

3.6.4. Meet Remaining Hydromodification Control Requirements through Additional On-site or Off-site Controls

As required by the Model QMP, the Project WQMP shall identify hydromodification control requirements that have not been met as a result of meeting LID requirements. Remaining hydromodification control requirements are calculated as described in Section 7.

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required

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that have been

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This information is not an instructive step and is out of place.

Number: 4 Author: staff Subject: Cross-Out Date: 6/30/2010 1:29:50 PM

This step is important and deserves its own step. It must be stated much more clearly though that the retention volume of an HSC may be subtracted from the design capture volume rather than vaguely referencing this step as an 'effect'. It should be made clear that the HSC and the LID BMP must be in the same drainage area of the project.

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required

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calculating the volume of storm water that must be treated

Number: 7 Author: staff Subject: Replacement Text Date: 6/30/2010 1:38:31 PM

size the LID BMP to treat the required storm water volume

Table 3.4: Selecting Appropriate Sizing Method to Meet Performance Criteria	
BMP Type	**Recommended Sizing Method(s)**
Surface and Shallow Subsurface Infiltration BMPs	Simple Sizing Method: See 6.4.2.1 Capture Efficiency Method for Volume-based BMPs: 6.4.2.2
Drywells	Sizing approach varies by design; some dry wells may be designed as volume-based BMPs, and others may be designed as flow-based. ***Volume-based Dry Well Designs:*** Simple Sizing Method: See 6.4.2.1 Capture Efficiency Method for Volume-based BMPs: 6.4.2.2 ***Flow-based Dry Well Designs:*** Capture Efficiency Method for Flow-based BMPs: 6.4.2.3
Harvest and Use BMPs with approximately constant use rate throughout year (does not vary with season)	Simple Sizing Method: See 6.4.2.1 Capture Efficiency Method for Volume-based BMPs: 6.4.2.2
Harvest and Use BMPs with seasonally-varying use rate(irrigation demand)	Analysis indicates that 80 percent capture goal cannot be achieved by capturing stormwater and using it solely to meet agronomic soil demand within reasonable storage volumes. A continuous simulation hydrologic analysis may be used to demonstrate 80 percent capture if combination of uses or irrigation in excess of agronomic demand yields 80 percent capture.
Evapotranspiration	
Green Roofs and Brown Roofs	Simple Sizing Method: See 6.4.2.1 without consideration for 48 hour drawdown requirement
Blue Roof (rooftop detention)	Simple Sizing Method: See 6.4.2.1; discharge shall be biotreated to the extent feasible. Capture Efficiency Method for Volume-based BMPs: 6.4.2.2 ; discharge shall be biotreated to the extent feasible.
Biotreatment	
Volume-Based Biotreatment (if allowed as first BMP in hierarchy)	Simple Sizing Method: See 6.4.2.1 Capture Efficiency Method for Volume-based BMPs: 6.4.2.2
Flow-Based Biotreatment (if allowed as first BMP in hierarchy)	Capture Efficiency Method for Flow-based BMPs: 6.4.2.3

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Number: 1 Author: staff Subject: Cross-Out Date: 6/30/2010 1:39:39 PM

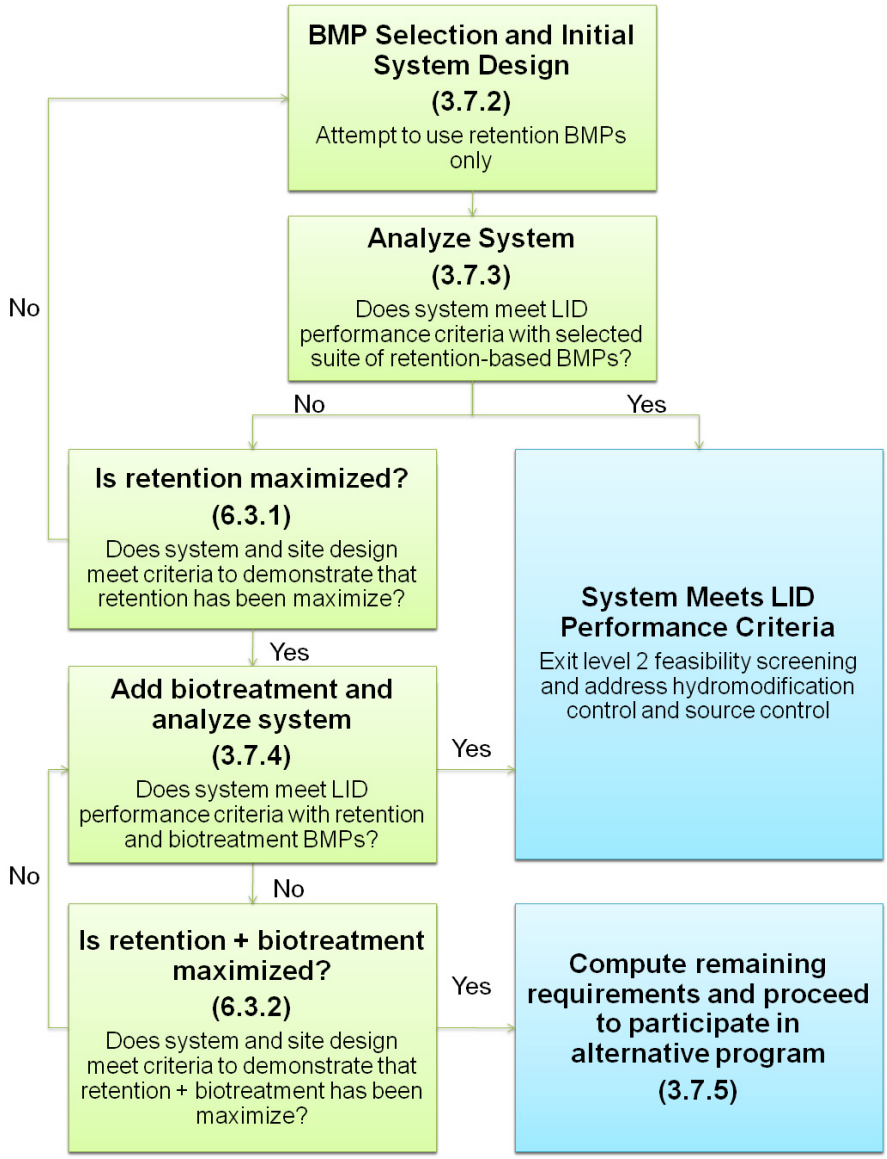
Number: 2 Author: staff Subject: Underline Date: 6/30/2010 1:56:38 PM

A drawdown standard should be included in the design standard; this would influence the surface area, but not the treatment volume. If there is no drawdown standard, what would be the rationale for its exclusion?

3.7. BMP Sizing, Configuration, and Design for Projects Demonstrating Infeasibility

This section describes a process for developing a comprehensive LID, treatment control, and hydromodification control plan where it may be infeasible to fully meet LID requirements using the specified hierarchy of LID BMPs. Level 2 Feasibility Screening criteria are used to demonstrate that the BMP plan meets the MEP standard. **Figure 3.4** illustrates the overall process of system configuration and Level 2 Feasibility Screening. The process starts with the same steps used for typical projects, but imposes additional requirements consistent with a rigorous feasibility analysis to ensure that LID requirements are met to the MEP.

Figure 3.4
BMP Sizing and Configuration for Projects Demonstrating Infeasibility
(Level 2 Feasibility Screening)



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3.7.1. Requirements for Documentation in Project WQMP

This section describes the mandatory documentation requirements for BMP sizing and design contained in the Model WQMP for projects demonstrating infeasibility. These requirements must be included in the Project WQMP where they are applicable.

1) The Project WQMP shall include all elements listed Section 3.6.1 unless redundant with the elements below.

2) The Project WQMP and exhibit(s) shall document that all HSCs suitable for the project have been utilized through a narrative discussion of non-applicability for each HSCs not utilized.

3) The Project WQMP shall document the system configuration ~~to achieve~~ [1]maximized retention" and the [2]theoretical performance achieved by this configuration. The "maximized retention volume" shall be documented (may be zero if performance does not exceed minimum cost-effectiveness threshold).

4) The Project WQMP shall document the system configuration ~~to achieve~~ [3]maximized retention plus biotreatment" and the [4]theoretical performance achieved by this configuration. The "maximized retention volume" and [5]~~"maximized biotreatment volume"~~ shall be documented and provided on the Project WQMP exhibit.

5) The Project WQMP shall document [6]~~the performance achieved by the resulting system~~ and calculate the [7]~~remaining LID requirements that remain to be addressed~~ through an alternative program.

6) ~~The Project WQMP shall document that hydromodification control requirements are addressed through project specific calculations demonstrating mitigation of HCOCs.~~ [8]

Guidance for preparing these Project WQMP elements is provided below.

3.7.2. Prepare System Design to Retain Stormwater On-Site to the MEP

The system should be configured as described in Section 3.6, with the exceptions listed below. Entering this step, it is assumed that the preferred configuration does not meet the full LID requirements.

1. HSCs should be used wherever opportunities exist and should be documented in the Project WQMP as described in Section 3.6.2. In addition, a narrative discussion of non-applicability should be prepared for any HSC not used.

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has

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These are the only two instances of this term. No technical definition is provided and it is unclear what it is referring to. Replace it with clear language.

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has

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Number: 5 Author: staff Subject: Cross-Out Date: 6/30/2010 2:12:03 PM
This is the only instance of this term in the entire document. There is no definition provided. New jargon has been created for a single use; replace it with plain language.

Number: 6 Author: staff Subject: Cross-Out Date: 6/30/2010 2:17:36 PM
be more specific

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Be more specific.

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Where HCOC's exist in the downstream receiving waters, the Project WQMP shall provide supporting calculations demonstrating that the project meets the hydromodification control requirements in Section 7.

2. BMPs should be selected based on a rigorous prioritization process, ~~such~~ as described in Section 6.2.2. ~~BMPs with the highest likelihood of achieving LID retention requirements on-site should be used.~~

3. Retention BMPs ~~should~~ be designed to meet the Level 2 Feasibility Criteria for "maximizing" retention. Criteria for maximizing retention are described in Section 6.3.1. If these criteria are not met, the system should be redesigned to meet these criteria.

If the hierarchy of LID BMPs is ~~suspended for the project~~ (i.e., biotreatment can be considered first), or no retention BMPs are feasible from Level 1 Feasibility Screening, then skip to Section 3.7.4.

3.7.3. Evaluate Performance of Maximized Retention Scenario

The performance of the maximized retention scenario should be evaluated to determine the maximum feasible ~~average annual retention~~ that can be achieved. The recommended method of computing average annual capture efficiency is described in **Table 3.7**. Alternatively, a continuous simulation hydrologic analysis may be conducted to estimate the annual average capture efficiency.

- If the capture efficiency is greater than 40% (one-half of 80% runoff retention/treatment requirement), then the maximized retention is equal to the volume provided in Section 3.7.2. When biotreatment is added to the system, retention volume should be included if ~~feasible.~~

- If the capture efficiency is less than 40% (one-half of 80% runoff retention/treatment requirement), then the maximized retention volume is zero. ~~Retention volume is encouraged to be included in biotreatment designs, but is optional.~~

If the maximum feasible capture efficiency of the system is less than 80 percent and retention has been maximized, then proceed to Section 3.7.4 and add biotreatment to reach the overall requirement.

3.7.4. Prepare System Design to Retain plus Biotreat Stormwater On-Site to the MEP

The system design should be modified from the design prepared in Section 3.7.2 by adding biotreatment volume to attempt to meet the target average annual capture efficiency of 80 percent (retained plus biotreated). The following steps describe how this can be done:

1. Add a biotreatment component to the selected retention BMP per the suggestions contained in **Table 3.5**. This may include adding underdrains to a bioretention area, adding a flow-through swale on top of an infiltration planter, adding a bioretention area downstream of a cistern, or other concepts. **Table 3.5** recommends biotreatment BMPs that are suitable to be integrated with retention BMPs to augment performance. If necessary, it is acceptable to convert some of the maximized retention volume computed

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If the intent is to leave open the possibility for other prioritization processes, these must be described.

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A point that should be made elsewhere in Section 6.2.2.

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must

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This appears to offer an option without describing the circumstances in which suspension would apply. Describe these circumstances.

Number: 5 Author: staff Subject: Underline Date: 6/30/2010 2:51:04 PM

First, explain what is meant by "maximized retention".

Number: 6 Author: staff Subject: Cross-Out Date: 6/30/2010 2:53:15 PM

This is the only instance of this term in the entire document and it is undefined. Substitute it with its own definition.

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any

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provided

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applicable

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Biotreatment BMPs MUST be designed for retention if feasible. It is not completely discretionary. An alternative suggestion would be to recommend that the invert elevation of subdrains could be set above the invert of the pervious bottom of the biotreatment BMP at a height equal to the 48-hour drawdown depth. That volume of water could then be included in the retention volume.

in Section 3.7.2 to biotreatment volume. The design criteria for the biotreatment component of a treatment train (either preceding or following retention) can be computed as directed by **Table 3.6**.

2. Evaluate system performance. **Table 3.7** provides the recommended methods to use for computing system performance when sizing criteria cannot be met. Alternatively, a continuous simulation hydrologic analysis may be conducted to estimate the annual average capture efficiency.

3. Evaluate system design and performance against criteria for maximizing retention plus biotreatment described in 6.3.2.

    a. If criteria are met and the system meets LID performance criteria, then proceed to Section 3.7.5 to fulfill remaining hydromodification control requirements.

    b. If criteria are met and the system still does not meet LID performance criteria, then proceed to Section 3.7.5 to fulfill remaining LID and hydromodification control requirements.

    c. If criteria are not met, then return to Step 1 to evaluate other options of adding biotreatment which meet the criteria.

Table 3.5: Selecting Additional Biotreatment Components Where Necessary

First BMP in Treatment Train	Suggested Additional Biotreatment Component
Infiltration	
Infiltration BMPs with potential for integrated biotreatment component: ➢ Bioretention without Underdrains ➢ Rain Gardens ➢ Infiltration Planters ➢ Other	Add underdrains plus biotreatment volume; include gravel layer below underdrains to meet retention requirements Design a swale above the retention component to provide flow-through biotreatment treatment of volume that overflows retention component
Infiltration BMPs without potential for integrated biotreatment component: ➢ Infiltration Trenches ➢ Infiltration Basins (unvegetated) ➢ Subsurface Infiltration Galleries ➢ Permeable Pavement/Asphalt/Pavers ➢ Dry wells	Biotreatment of inflow or overflow (higher level of treatment than minimum pre-treatment)
Harvest and Use	
Harvest and Use BMPs with underground cistern, receiving ground-level runoff.	Biotreatment of inflow or overflow (higher level than minimum pre-treatment)
Harvest and Use BMPs with above ground cistern, receiving roof-level runoff	Biotreatment of overflow

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Table 3.5: Selecting Additional Biotreatment Components Where Necessary	
First BMP in Treatment Train	**Suggested Additional Biotreatment Component**
Evapotranspiration	
Green Roofs and Brown Roofs	None required; biotreatment is provided by filtration through roof
Blue Roof	Biotreatment of overflow

Table 3.6: Calculating Additional Biotreatment Requirements	
Treatment Train Configuration	**Recommended Method**
Volume-based biotreatment BMP treating overflow from retention BMP (includes configurations where biotreatment is located on top of retention storage)	Use the recommended method in **Table 3.7** (based on BMP type) to calculate the percent capture provided by the retention volume. Then use the Capture Efficiency Method for Volume-based BMPs (6.4.2.2) to compute design criteria to achieve 80 percent capture starting with the capture efficiency already achieved by the retention BMP.
Flow-based biotreatment BMP treating overflow from retention BMP (includes configurations where biotreatment is located on top of retention storage)	Use the recommended method in **Table 3.7** (based on BMP type) to calculate the percent capture provided by the retention volume. Then use the Capture Efficiency Method for Volume-based BMPs (6.4.2.3) to compute design criteria to achieve 80 percent capture starting with the capture efficiency already achieved by the retention BMP.
Volume-based biotreatment BMP providing treatment for inflow to retention BMP	Use the Capture Efficiency Method for Volume-based BMPs (6.4.2.2) to compute design criteria to achieve 80 percent capture.
Flow-base biotreatment BMP providing treatment for inflow to retention BMP	Use the Capture Efficiency Method for Flow-based BMPs (6.4.2.3) to compute design criteria to achieve 80 percent capture.

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Table 3.7: Recommended Methods of Calculating System Performance for Systems Not Meeting Full Performance Criteria	
BMP Type	**Recommended method contained in:**
Infiltration (including volume-based dry wells)	Section 6.4.2.4
Flow-based Dry Wells	Section 6.4.2.6
Harvest and Use with Non-seasonally-varying demand (no irrigation)	Section 6.4.2.4
Harvest and Use with Seasonally-varying demand (irrigation)	Section 6.4.2.5
Green roofs/ Brown roofs	NA. All volume discharged from green roof or brown roof that passes through substrate is considered biotreated.
Stand-alone volume-based Biotreatment	Section 6.4.2.4
Stand-alone flow-based Biotreatment	Section 6.4.2.6
Combined system (treatment train of multiple BMPs or multiple BMP components)	Section 6.4.2.7

3.7.5. Meet Remaining Requirements through Alternative Programs

As required by the Model WQMP, the Project WQMP shall describe how remaining LID, treatment control, and hydromodification control requirements are met.

Remaining LID requirements are calculated per Section 8.1.1. Remaining LID requirements are expressed as the additional required volume to result in cumulative system capture efficiency of 80 percent, expressed in cubic feet. Meeting the remaining LID requirements achieves treatment control requirements.

Regional LID alternatives are available in North Orange County ~~without a waiver~~, and are described in Section 3.8.

Other alternative programs for meeting remaining requirements in North Orange County and South Orange County are described in Section 8.

Remaining hydromodification control requirements are calculated as described in Section 7.

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, do not require a waiver from the local jurisdiction

3.8. Regional or Sub-Regional LID Practices

3.8.1. Approach and Requirements

As described within the Model WQMP, it may be appropriate or desirable to consider implementing LID practices on a broader regional or sub-regional basis for certain development conditions, rather than at a single site or individual project level. Regional retention/infiltration basins, community and neighborhood parks, golf courses, or other large, open landscape areas are some examples of places where a regional or sub-regional level approach to LID could be implemented. Regional LID approaches may have multiple benefits over individual on-site LID controls, for example, providing water quality improvement while enhancing regional flood control and groundwater recharge goals. As such, regional options are encouraged and should be considered at the onset of the development planning process. If development of the project would also result in potential hydromodification impacts to receiving waters, using a regional or sub-regional LID approach may also satisfy hydromodification requirements.

Regional and sub-regional approaches will likely require the involvement of multiple agencies and project proponents within a common watershed to develop a watershed-based plan. These approaches may include both private proponent developments and public agency owned projects, providing greater opportunities for regional benefits, and requiring additional levels of coordination. The timing of development stages for proposed projects, land acquisition, etc. will play a role in the feasibility of regional and sub-regional LID implementation. Note that in watersheds with a RWQCB Executive Officer-approved watershed-based plan that includes specific guidance and support for LID feasibility criteria that allows for off-site measures to be used, a full on-site LID feasibility analysis may not be required to access regional solutions.

As an example of implementing LID on a regional basis, several individual developments potentially in conjunction with public agencies could propose a regional system to address storm water runoff from all the developments collectively. Use of a regional infiltration basin, regional wetland, or groundwater injection facility with distributed swales and bioretention areas could achieve LID requirements on a regional basis. The LID BMPs selected and designed in a regional LID approach should have the capacity to infiltrate, harvest and use, evapotranspire and/or biotreat the design capture volume from the entire regional tributary area.

On a sub-regional basis, multi-use areas could meet LID requirements for several projects with conditions that make on-site implementation impractical. Using a neighborhood wet detention basin BMP, along with other common areas used for runoff capture and infiltration could achieve LID requirements. As another example of sub-regional implementation, a high density housing unit development with a small strip mall and a school could connect all roof drains to vegetated areas and construct a storm water infiltration gallery below the school playground. Another may be using vegetated or biofiltration swales instead of curb and gutter drainage ways throughout an entire neighborhood. The LID BMPs selected and designed in a sub-regional LID approach should have the capacity to infiltrate, harvest and use, evapotranspire and/or biotreat at least the design capture volume from the entire sub-regional tributary area.

The approach described above is based on the ability to direct runoff from one or multiple Priority Project(s) that has not met the design volume through on-site LID practices to a

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regional BMP without first discharging to receiving waters (recognized Waters of the US). However, stormwater runoff from an individual project may be conveyed to a regional treatment system via a receiving water if the pollutants in the runoff have been controlled on-site using LID techniques to the MEP and beneficial uses of the receiving water have not been impacted.

If a project involving constructing or participating in an off-site regional LID-based approach is proposed to satisfy the remaining LID and hydromodification requirements, full details of the proposed approach must be developed and documented in the Project WQMP. Any agreements and/funding arrangements must be in place at the time of project approval and any infrastructure must be constructed and operational by the time the project is completed.

3.8.2. Potential Opportunities

Regional or sub-regional project concepts should be consistent with watershed plans already in existence or under development within the County of Orange. A countywide Water Quality Strategic Plan was initiated in 2003, and as a result a structure for water resource management was developed based upon Watershed Management Areas (WMAs). The eleven watersheds in Orange County are grouped by similar characteristics into three WMAs: North, Central, and South County.

The Orange County Water District has developed plans for increasing runoff capture and groundwater recharge in a number of basins in the northeastern portion of the County over the forebay area of the Orange County groundwater basin. Projects proposed in this part of the County could consider participating in development of expanded recharge projects.

Integrated Regional Water Management Plans (IWRMP) have been completed for all three WMAs. The IRWMPs provide information for identifying opportunities for regional implementation of LID requirements as well as potential constraints for certain project elements. For example, watersheds having goals for increasing groundwater infiltration for water supply purposes could be ideal candidates for a Project WQMP containing regional or sub-regional stormwater capture and infiltration to meet LID requirements. The IRWMPs also identify certain pollutants of concern and water quality initiatives that could affect the selection of proposed project features and / or the BMPs selected for the project.

Project proponents considering regional or sub-regional implementation of LID requirements for a project should consult the appropriate IRWMP and develop project elements that are in line with, complement, or enhance already established regional goals.

3.9. Project WQMP Preparation for Roadway and Similar Constrained Right of Way and Drainage Projects

This section describes a Project WQMP preparation process for roadway and similar constrained right of way and drainage projects meeting the criteria described in Section 7.II - 2.1.5.1 of the Model WQMP. This section is applicable to roadways (and associated

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infrastructure such as bike lanes and sidewalks), linear drainage facilities (and associated access roads), and other similar projects such as sea walls/break waters, bridges, etc. Project WQMP preparation for these projects refers to USEPA guidance *Managing Wet Weather with Green Infrastructure: Green Streets*.

3.9.1. Site Assessment for Roadway and Similar Constrained Right of Way and Drainage Projects

Site assessment of roadway and similar constrained right of way and drainage projects includes many of the same considerations as described in Sections 3.1, 3.2, and 3.3. Site assessment ~~should~~ be documented as described in these sections, as appropriate, ~~at the discretion of the project designer~~ and should meet the minimum requirements of Section 7.II-4.0 of the Model WQMP. In addition to those elements described in Section 3.1, specific elements which should be given special consideration in the site assessment process for roadway and similar constrained right of way and drainage projects include:

- **Ownership of land adjacent to right of ways.** The opportunity to provide stormwater treatment may depend on the ownership of land adjacent to the right-of-way. Acquisition of additional right-of-way and/or access easements may be more feasible if land bordering the project is owned by relatively few land owners.

- **Location of existing utilities.** The location of existing storm drainage utilities can influence the opportunities for Green Streets infrastructure. For example, stormwater planters can be designed to overflow along the curb-line to an existing storm drain inlet, thereby avoiding the infrastructure costs associated with an additional inlet. The location of other utilities will influence the ability plumb BMPs to storm drains, therefore, may limit the allowable placement of BMPs to only those areas where a clear pathway to the storm drain exists.

- **Grade differential between road surface and storm drain system.** Some BMPs require more head from inlet to outlet than others; therefore, allowable head drop may be an important consideration in BMP selection. Storm drain elevations may be constrained by a variety of factors in a roadway project (utility crossings, outfall elevations, etc.) which may override stormwater management considerations.

- **Longitudinal slope.** The suite of LID BMPs which may be installed on steeper road sections is more limited. Specifically, permeable pavement and swales are more suitable for gentle grades. Other BMPs may be more readily terraced to be used on steeper slopes.

- **Potential access opportunities.** A significant concern with installation of BMPs in major right of ways is the ability to safely access the BMPs for maintenance considering traffic hazards. The site assessment should identify vehicle travel lanes and areas of specific

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safety hazards for maintenance crews and subsequent steps of the Project WQMP preparation process should attempt avoid placing BMPs in these areas.

Infiltration may be considered for roadway and similar constrained right of way and drainage projects provided that Level 1 Feasibility Screening criteria are observed, with specific attention to protection of groundwater quality as discussed in Section 3.1.4.3 and the structural integrity of adjacent road bed. ~~However, infiltration is not required to be considered to meet the performance criteria for roadway and similar constrained right of way and drainage projects; therefore infiltration-related elements of site assessment are not required unless the proponent chooses to use infiltration BMPs.~~

POCs and HCOCs ~~should~~ be ~~determined~~ as described in Sections 3.2, and 3.3.

3.9.2. BMP Selection and Preliminary Site Design for Roadway and Similar Constrained Right of Way and Drainage Projects

The fundamental tenants of the approach described by the USEPA Green Streets guidance include:

- Selecting LID BMPs to the opportunities of the site,
- Developing innovative stormwater management configurations integrating "green" with "grey" infrastructure,
- Sizing BMPs opportunistically to provide stormwater pollution reduction to the MEP, accounting for the many competing considerations in right of ways.

Projects should apply the following LID site design measures to the MEP and as specified in the local permitting agency's codes:

- Minimize street width to the appropriate minimum width for maintaining traffic flow and public safety.
- Add tree canopy by planting or preserving trees/shrubs.
- Use porous pavement or pavers for low traffic roadways, on-street parking, shoulders or sidewalks.
- Integrate traffic calming measures in the form of bioretention curb extensions.

BMPs should be selected consistent with the Green Streets guidance. **Table 3.8**provides an inventory of LID BMPs which may be appropriate for roadway and similar constrained right of way and drainage projects. The performance criteria for roadway and similar constrained right of way and drainage projects do not require retention BMPs to be considered to the MEP before considering biotreatment and treatment control BMPs. A formal process of BMP prioritization

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This language is inconsistent with MEP. If infiltration can be done feasibly, it must be done. The language inappropriately approaches this class of projects with an automatic presumption of infeasibility, without any analysis. Suggest that you provide a general analysis and describe circumstances under which infiltration should be done, similar to the screening criteria provided for other categories of projects. The approach suggested by this language violates the first tenant in the following section; you cannot presume that there are no opportunities.

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and selection is not required for roadway and similar constrained right of way and drainage projects, however Level 1 Feasibility Screening still applies; only BMPs passing Level 1 Feasibility Screening may be selected.

BMPs should be prioritized based on a comparison of drainage area characteristics to the opportunity criteria listed in **Table 3.8**. The USEPA guidance describes how some of these BMPs may be used in combination to achieve optimal benefits in runoff reduction and water quality improvement. Specific examples and applications for residential streets, commercial streets, arterials streets, and alleys are provided in the USEPA guidance.

The drainage patterns of the project should be developed so that drainage can be routed to areas with BMP opportunities before entering storm drains. For example, if a median strip is present, a reverse crown should be considered, where allowed, so that stormwater can drain to a median swale. Likewise, standard peak-flow curb inlets should be located downstream of areas with potential for stormwater planters so that water can first flow into the planter, and then overflow to the downstream inlet if capacity of the planter is exceeded. It is more difficult to apply green infrastructure after water has entered the storm drain.

The developing of conceptual drainage plans for redevelopment projects should identify areas outside of the project which comingle with on-site runoff. The project is not required to attempt to treat off-site runoff; [1] ~~however treatment of comingled off-site runoff may be used to off-set the inability to treat areas within the project for which significant constraints prevent the ability to provide treatment.~~

Table 3.8: Potential BMPs for Roadway and Similar Constrained Right of Way and Drainage Projects

BMP Type	Opportunity Criteria for Roadway and Similar Constrained Right of Way and Drainage Projects	BMP Fact Sheet Reference
Street Trees, Canopy Interception	• Access roads, residential streets, local roads and minor arterials • Drainage infrastructure, sea walls/break waters • Effective for projects with any slope • Trees may be prohibited along high speed roads for safety reasons	Street Trees, Canopy Interception: 6.5.3.4
Stormwater Curb Extensions / Stormwater Planters Note: This class of BMPs is differentiated from bioretention areas by the use of vertical walls (concrete, block, etc.) instead of mild, vegetated side slopes	• Access roads, residential streets, and local roads with parallel or angle parking and sidewalks • Can be designed to overflow back to curbline and to standard inlet • Shape is not important and can be integrated wherever unused space exists • Can be installed on relatively steep grades with terracing	Bioretention without underdrains: 6.6.2.3), Bioretention without underdrains: 6.9.2.1

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In this case, the BMP hierarchy must be applied.

Table 3.8: Potential BMPs for Roadway and Similar Constrained Right of Way and Drainage Projects		
BMP Type	**Opportunity Criteria for Roadway and Similar Constrained Right of Way and Drainage Projects**	**BMP Fact Sheet Reference**
Bioretention Areas Note: This class of BMPs is differentiated from curb extensions and planters by the use of mild, vegetated side slopes instead of vertical walls	• Low density residential streets without sidewalks • Requires more space than curb extensions/ planters, most feasibly implemented in combination with minimized road widths	Bioretention without underdrains: 6.6.2.3), Bioretention without underdrains: 6.9.2.1
Permeable Pavement	• Parking and sidewalk areas of residential streets, and local roads • Should not receive significant run-on from major roads • Should not be subject to heavy truck/ equipment traffic • Light vehicle access roads	6.6.2.5
Permeable Friction Course Pavement	• High speed roadways unsuitable for full depth permeable pavement • Suitable for parking lots and all roadway types	
Vegetated Swales	• Roadways with low to moderate slope • Residential streets with minimal driveway access • Minor to major arterials with medians or mandatory sidewalk set- • Access roads • Swales running parallel to storm drain can have intermittent discharge points to reduce required flow capacity	Vegetated Swales: 6.9.2.2
Filter strips (amended road shoulder)	• Access roads • Major roadways with excess ROW • Not practicable in most ROWs because of excessive width requirements	Vegetated Filter Strips: 6.9.2.3
Proprietary Biotreatment	• Constrained ROWs • Typically have small footprint to tributary area ratio • Simple install and maintenance • Can be installed on roadways of any slope • Can be designed to overflow back to curb line and to standard inlet	Proprietary Biotreatment: 6.9.2.7

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Table 3.8: Potential BMPs for Roadway and Similar Constrained Right of Way and Drainage Projects		
BMP Type	**Opportunity Criteria for Roadway and Similar Constrained Right of Way and Drainage Projects**	**BMP Fact Sheet Reference**
Infiltration Trench	• Constrained ROWs • Can require small footprint where soils are suitable • Low to moderate traffic roadways • Infiltration trenches are not suitable for high traffic roadways • Requires robust pretreatment	Infiltration Trench: 6.6.2.2
Cartridge Media Filters	• Highly constrained ROW with little available surface area • Installed in underground vaults, manholes, or catch basins • Require minimum available head loss • Simple installation and maintenance	Cartridge Media Filter: 6.10.1.2

3.9.3. BMP Sizing for Roadway and Similar Constrained Right of Way and Drainage Projects

The following steps are used to size BMPs for roadway and similar constrained right of way and drainage projects:

1. Delineate drainage areas tributary to BMP locations and compute imperviousness.
2. Look up the recommended sizing method for the BMP selected in each drainage area using **Table 3.4** and calculate sizing criteria.
3. Design BMPs per the guidance provided in BMP fact sheets (see **Table 3.8** for reference to applicable fact sheets) and other references.
4. Attempt to provide the calculated sizing criteria for the selected BMPs.
5. If sizing criteria cannot be achieved, document the constraints that override the application of BMPs, and provide the largest portion of the sizing criteria that can be provided with consideration of the MEP standard.

If BMPs cannot be sized to provide the calculated volume for the tributary area, it is still essential to design the BMP inlet, energy dissipation, and overflow capacity for the full tributary area to ensure that flooding and scour is avoided. It is strongly recommended that BMPs which are designed to less than their target design volume be designed to bypass peak flows.

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3.9.4. Alternative Compliance Options for Roadway and Similar Constrained Right of Way and Drainage Projects

Roadway and similar constrained right of way and drainage projects are not required to meet alternative compliance options if stormwater management controls described in this section, or equivalent, are installed to the MEP.

Alternative compliance programs should be considered for roadway and similar constrained right of way and drainage projects if on-site green infrastructure approaches cannot practicably treat the design volume. The primary alternative compliance option for roadway and similar constrained right of way and drainage projects is the completion of off-site mitigation projects. The proponent would implement a project to reduce stormwater pollution for other portions of roadway or similar land uses to the project in the same hydrologic unit, ideally as close to the project as possible and discharging to the same outfall. Other alternative compliance options may be considered as described in Section 8, but are not required.

3.10. Maintenance Planning

As required in the Model WQMP an Operation & Maintenance (O&M) Plan shall be prepared as part of the Project WQMP. The O&M Plan should describe the designated responsible party to manage the stormwater BMP(s), employee's training program and duties, operating schedule, maintenance frequency, routine service schedule, specific maintenance activities, copies of resource agency permits, and any other necessary activities.

At a minimum, maintenance agreements should require the inspection and servicing of all structural BMPs on an annual basis.

Maintenance planning requirements are described in Section 9.

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Section 4. Site Design Principles and Techniques

4.1. Introduction

LID strategies can be broadly divided into two types:

- LID Practices that minimize the causes (or drivers) of project impacts, and
- LID BMPs that help mitigate unavoidable impacts.

This section focuses on LID practices, while LID BMPs are discussed further in Section 6.

Incorporating LID Practices at the beginning of the development planning process is the most cost effective way to implement LID successfully. When properly done, such measures can greatly reduce the extent of impacts that must be mitigated with BMPs. As such, a project proponent should exhaust all available and applicable measures to minimize impacts, before moving on to mitigating the remaining impacts. Implementation of LID practices as part of the site planning process can reduce the effective impervious area and therefore reduce the design sizing criteria for LID BMPs or alternative compliance approaches.

The simplest way to maintain the predevelopment hydrologic function of a site is to minimize the development footprint, preserving existing topography and drainage patterns. However, many development projects involve extensive landform manipulation, where the entire site is cleared and graded. On such sites, where such grading is unavoidable, changes to predevelopment hydrologic function can be minimized with a proper mix of design strategies, especially minimizing impervious area, and the use of LID BMPs to retain and/or treat excess runoff.

The descriptions below summarize concepts for incorporating LID practice approaches and techniques throughout all phases of project implementation from planning through design and construction.

4.2. Site Planning and Layout

4.2.1. Minimize Impervious Area

One of the principal causes of environmental impacts due to development is the creation of impervious surfaces. Impervious cover can be minimized through identification of the smallest possible land area that can be practically impacted or disturbed during site development. Below is a partial list of techniques that can reduce the amount of impervious area that will be created as part of a project. It is important to note that local land use ordinances and building codes may dictate minimum requirements for road widths, building setbacks and accessibility requirements which cannot be overridden. However, in certain situations, it may be possible to modify local codes and ordinances [1] promote less impervious area, such as allowing narrower road widths, sidewalks on one side of the street, and reduced building set-backs.

Limit overall coverage of paving and roofs. This can be accomplished by designing compact, taller structures, narrower and shorter streets and sidewalks, smaller parking lots (fewer stalls,

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smaller stalls, and more efficient lanes), and indoor or underground parking. Examine site layout and circulation patterns and identify areas where landscaping can be substituted for pavement.

Detain and retain runoff throughout the site. On flatter sites, it typically works best to intersperse landscaped areas and integrated small scale retention practices among the buildings and paving. On hillside sites, drainage from upper areas may be collected in conventional catch basins and piped to landscaped areas and BMPs in lower areas. Or use low retaining walls to create terraces that can accommodate BMPs.

Example Planning Phase Techniques

- Build vertically rather than horizontally - add floors to minimize building footprint.
- Cluster development to reduce requirements for roads and preserve green space.
- Minimize lot setbacks (which in turn minimize driveway lengths).
- Reduce road widths to minimum necessary for emergency vehicles.

Example Design Phase Techniques

- Install sidewalks on only one side of private roadways to the extent allowed by accessibility requirements.
- Use alternative materials such as permeable paving blocks or porous pavements on driveways, sidewalks, parking areas, etc. Practices should be selected such that they do not present health and safety hazards, such as tripping hazards.
- Create smaller parking spaces intended for compact cars.

Example Construction Phase Techniques

- Minimize unnecessary compaction where possible. The infiltrative capacity of soils can be greatly reduced when they are compacted, often to the point that they perform similarly to impervious surfaces. [1]
- Minimize construction footprint.

4.2.2. Maximize Natural Infiltration Capacity

A key component of LID is taking advantage of a site's natural infiltration and storage capacity. This will limit the amount of runoff generated, and therefore the need for mitigation BMPs. A site soils/geology assessment will help to define areas with higher potential for infiltration and surface storage.

These areas are typically characterized by:

- Principally hydrologic Soil Group A or B soils and in some cases Group C soils.
- Mild slopes or depressions.

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Where possible, remediate compacted soils.

- Historically undeveloped areas.

Example Planning Phase Techniques

- Avoid placing buildings or other impervious surfaces on highly permeable areas.
- Cluster buildings and other impervious areas onto the least permeable soils.

Example Design Phase Techniques

- Where paving of permeable soils cannot be avoided, loss of infiltration capacity can be minimized by using permeable paving materials.

Example Construction Phase Techniques

- Minimize construction footprint.
- Minimize incidental and unnecessary compaction where it is not necessary to meet the applicable grading code requirements.

4.2.3. Preserve Existing Drainage Patterns and Time of Concentration

Integrating existing drainage patterns into the site plan will help maintain a site's predevelopment hydrologic function. Preserving existing drainage paths and depressions will help maintain the time of concentration and infiltration rates of runoff, decreasing peak flows. The best way to define existing drainage patterns is to visit the site during a rain event and to directly observe runoff flowing over the site. If this is impossible, drainage patterns can be inferred from topographic data, though it should be noted that depression micro-storage features are often not accurately mapped in topographic surveys. Analysis of the existing site drainage patterns during the site assessment phase of the project can help to identify the best locations for buildings, roadways, and stormwater BMPs.

Where possible, add additional depression "micro" storage throughout the site's landscaping that mimics natural drainage patterns. Mild gradients can be used to extend the time of concentration, which reduces peak flows and increases the potential for additional infiltration. While risk of serious flooding must be minimized, the persistence of temporary "puddles" during storms is beneficial to infiltration. If a site is visited during dry weather, these areas can sometimes be identified by looking for surficial dried clay deposits.

Use drainage as a design element. Use depressed landscape areas, vegetated buffers, and bioretention areas as amenities and focal points within the site and landscape design. Bioretention areas can be almost any shape and should be located at low points. When configured as swales, bioretention areas can detain and treat low runoff flows and also convey higher flows.

Example Planning Phase Techniques

- Avoid channelization of natural streams.
- Establish set-backs and buffer areas from natural streams.

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- Where natural streams will be converted to engineered streams, provide sinuosity to increase the time of concentration.
- Develop an effective conceptual drainage plan.

Example Design Phase Techniques

- Avoid channelization of natural streams.
- When designing channels, use mild slopes and increase channel roughness to extend time of concentration.
- When possible, use pervious channel linings to maximize opportunity for infiltration.
- Use vegetated, un-hardened conveyance elements.
- Intersperse localized retention features throughout site.

Example Construction Phase Techniques

- Minimize construction footprint.

Micro-scale on-lot retention is a component of preserving existing drainage patterns and times of concentration and is characterized as a hydrologic source control (HSC) for the purpose of this TGD. A BMP fact sheet for localized on-lot retention is found in Section 6.5.3.1. The fact sheet describes recommended design criteria and methods of quantifying the performance of this practice.

4.2.4. Disconnect Impervious Areas

Runoff from 'connected' impervious surfaces commonly flows directly to a paved surface (driveway, sidewalk, or to the curb line) and from there to the stormwater collection system with no opportunity for infiltration into the soil. For example, roofs and sidewalks commonly drain onto parking lots, and the runoff is conveyed by the curb and gutter to the nearest storm inlet. Runoff from numerous impervious drainage areas may converge, combining their volumes, peak runoff rates, and pollutant loads. Disconnecting impervious areas from conventional stormwater conveyance systems allows runoff to be collected and managed at the source or redirected onto pervious surfaces such as vegetated areas. This reduces the amount of directly connected impervious area (DCIA), and will reduce the peak discharge rate by increasing the time of concentration, maximize the opportunity for infiltration by reducing the velocity of flows and providing for greater contact time with the soil, and maximize the opportunity for evapotranspiration during transport.

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. Typical receiving areas for disconnected impervious runoff include landscaped areas and/or LID BMPs (i.e. filter strips or bioretention). Runoff must not flow toward building foundations or be redirected onto adjacent private properties. Setbacks from buildings or other structures may be required to

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ensure soil stability. Consult with the project geotechnical engineer to identify areas where infiltration can be accommodated.

It is important to bear in mind that water flows down hill; therefore receiving areas must be located down gradient from runoff discharges. In a residential setting, this could mean that roof runoff discharges to either the front yard or the back yard, depending on the site configuration. As compared to conventional development, some potential techniques for redirecting flows to vegetated areas may require local design standards to be revisited.

Example Planning Phase Techniques

- Plan site layout and mass grading to allow for runoff to be directed into distributed permeable areas such as turf, recreational areas, medians, parking islands, planter boxes, etc.
- Avoid channelization of natural on-site streams.

Example Design Phase Techniques

- Provide permeable areas within medians and parkways that are designed to accept runoff from adjacent areas (i.e. via curb cuts).
- Construct roof downspouts to drain to pervious areas such as planter boxes or adjacent landscaping. This approach is further described in Section 6.
- Use permeable paving materials such as paving blocks or porous pavements on driveways, sidewalks, parking areas, etc.

To minimize stormwater-related impacts, apply the following design principles to the layout of newly developed and redeveloped sites:

- Define the development envelope and protected areas, identifying areas that are most suitable for development and areas that should be left undisturbed.
- Set back development from creeks, wetlands, and riparian habitats.
- Preserve established trees as practicable (see Section 4.3)

Impervious area disconnection is characterized as a HSC for the purpose of this TGD. BMP fact sheets for localized on-lot retention and impervious area dispersion are found in Section 6.5.3.1 and Section 6.5.3.2, respectively. These fact sheets include recommended design criteria and methods of quantifying the benefits of impervious area disconnection.

4.3. Vegetative Protection, Revegetation, and Maintenance

4.3.1. Protect Existing Vegetation and Sensitive Areas

A thorough site assessment will identify any areas containing dense vegetation or well-established trees. When planning the site, avoid disturbing these areas. Soils with thick, undisturbed vegetation have a much higher capacity to store and infiltrate runoff than do disturbed soils. Reestablishment of a mature vegetative community can take decades. Sensitive

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areas, such as wetlands, streams, floodplains, or intact forest, should also be avoided. Development in these areas is often restricted by federal, state and local laws.

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. This capacity is rarely considered, but on sites with a dense tree canopy it can provide additional volume mitigation.

Example Planning Phase Techniques

- Establish set-backs and buffer zones surrounding sensitive areas.
- Incorporate established trees into site layout.

Example Design Phase Techniques

- Design site to deter human activity within sensitive areas (i.e. fences, signs, etc).

Example Construction Phase Techniques

- Provide and maintain highly visible flagging and/or fencing around sensitive areas or vegetation that is to be protected.

Example Occupancy Phase Techniques

- Establish use/access restrictions to sensitive areas.

4.3.2. Revegetate Disturbed Areas

Maximizing plant cover protects the soil and improves ability of the site to retain stormwater, minimize runoff, and help to prevent erosion. Plants have multiple impacts on downstream water quality. First, the presence of a plant canopy (plus associated leaf litter and other organic matter that accumulates below the plants) can intercept rainfall, which reduces the erosive potential of precipitation. Section 6.5.3.4 facilitates quantification of the retention benefits of canopy cover. With less eroded material going to receiving waters, turbidity, chemical pollution, and sedimentation are reduced. Second, a healthy plant and soil community can help to trap and remediate chemical pollutants and filter particulate matter as water percolates into the soil. This occurs through the physical action of water movement through the soil, as well as through biological activity by plants and the soil microbial community that is supported by plants. Third, thick vegetative cover can maintain and even improve soil infiltration rates.

When re-vegetating areas preference should be given to native vegetation, which is uniquely suited to the local soils and climate. However, consideration of the location of the plants in the landscape with regards to wildfire safety can sometimes make the use of native species unsuitable. The Orange County Fire Authority requires “fuel modification zones” adjacent to development and restricts species of plant that may be used in these zones. Additional information can be found by contacting local Master Gardeners or seeking the advice of local plant nurseries, which will have specific knowledge of plants suitable for your particular

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application. The Las Pilitas Nursery in Santa Margarita has compiled a detailed database of California native plants which is accessible online at: http://www.laspilitas.com/comhabit/california_communities.html. The website can be used to aid in determining the correct plant communities by searching by either ZIP code or town. In cases where use of native vegetation is impractical or impossible, use of non-natives adapted to similar climate regimes, such as the Mediterranean, may be appropriate. This strategy will maximize the successful establishment of plantings, and minimize the need for supplemental irrigation.

4.3.3. Soil Stockpiling and Site Generated Organics

The regeneration of disturbed topsoil can take years under optimal conditions, and sometimes can take many decades (Brady and Weil, 2002). Proper stockpiling, storage, and reapplication of disturbed topsoil can greatly accelerate this process. Improper soil storage and restoration can significantly decrease the biological activity of the soil, decrease the successful establishment of plantings, and increase the ability of undesirable invasive species to dominate the disturbed landscape. Proper stockpiling generally includes protecting the stockpile to prevent excessive compaction and covering the stockpile to prevent significant erosion and leaching of nutrients.

Soil stockpiling and the use of in situ grubbed plant material and duff as mulch or soil amendments should be encouraged. This will reduce the need for importation of top soil to improve soil quality, and will encourage reestablishment of soil flora and fauna after site disturbance. Successful soil stockpiling and reuse begins in the early stages of project planning.

The use of topsoil harvested from the local site can improve the productivity and rate of re-vegetation of a disturbed site. In addition to stockpiled soil, vegetative material grubbed from the site and free of invasive species can be tilled back into the soil to increase organic content.

Restoration of disturbed areas using native soils which have been properly stockpiled during the construction phase of the project is the preferred method of post construction soil restoration. Proper assessment of the site during the design phase of the project is critical to maintaining soil quality, both structural and biological, during the period the soil is stockpiled. Determination of the volume of soil to be stockpiled and designating an area large enough on site to accommodate the stockpiled soil should be considered early in project design.

Consideration must be given to maintenance of the flora and fauna present in the stockpiled soil in addition to its physical condition. Improper storage such as soil that is too wet or stockpiled to deeply, can render what were active biological soil communities sterile. This will severely impact the ability of the soil to support a healthy plant community. If necessary, a local soil scientist familiar with regional soils can provide testing services to evaluate soil condition prior to and after construction and recommend appropriate remediation steps to restore the soil's predevelopment ability to infiltrate stormwater runoff and support a healthy plant community.

Additional information about the impact of soil stockpiling can be found in the following document which was prepared for the District 11 office of the California Department of Transportation.

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Restoration in the California Desert - http://www.sci.sdsu.edu/SERG/techniques/topsoil.html

4.3.4. Firescaping

Fire is a part of the ecosystems of Southern California. Over the years, wildfires have repeatedly destroyed homes and caused loss of life. In response to this natural phenomenon, extensive research has been done and, in the interest of public safety, guidelines have been codified into law. When considering any planting or re-vegetation plan consideration must be given to minimizing the risks of fire with proper plant selection and maintenance. Keep in mind that all plants are flammable given the right conditions; selection and maintenance of plants to mitigate flammability go hand in hand. A plant with a low flammability rating which is allowed to accumulate dead wood or excessive levels of duff in and around the plant will elevate the risk of flammability significantly.

California law (Public Resources Code 4291) requires a minimum 100-foot space around homes on level ground to protect the structure and provide a safe area for firefighters. If a home is located on a slope, additional distance is required and plant spacing, selection, and design must be modified to maintain proper fire safety margins.

A four zone system has been developed to create a maximum buffer around structures located in high risk wildfire zones. Each zone has very specific landscaping and management requirements to minimize flammability of the landscape.

The four zones are broken down as follows:

Zone One – The garden or clean and green zone

Zone Two – The greenbelt or reduced fuel zone

Zone Three – The transition zone

Zone Four – Native or Natural Zone / Open Space

The landscape plant selection and design for any bioretention or re-vegetation project should be compliant with the requirements of the specific zone in which it will be located. For assistance in determining the correct zone plant selection and spacing, contact your local fire department or insurance company for assistance. Additional resources are provided below for specific information about successful firescaping plant selection and design requirements.

4.3.5. Xeriscape Landscaping

As water use, the frequency of drought, and the impact of organic waste generated from landscape management increases in California, methods to deal with these problems have been developed. The concept of xeriscape was originally developed by the Denver Water Department in 1978. The word was coined by combining the Greek word xeros ("dry") with landscape. Since 1978, the xeriscape has become a widely-accepted alternative to traditional landscape design in dry areas.

Xeriscape landscaping is a landscape design and plant selection scheme that is used to minimize required resources and waste generated from a landscape. Defined as “quality landscaping that

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conserves water and protects the environment" the principles of xeriscape should be employed in any project that creates or restores the landscape. Consulting local resources, such as your local county extension agent, Master Gardeners, Landscape Architects, or local garden centers and nurseries, will help to select plant material suitable for a specific geographic location.

Xeriscape landscaping is based on seven principles:

- Soil analysis
- Planning and design
- Appropriate plant selection
- Practical turf areas
- Efficient irrigation
- Use of mulches
- Appropriate maintenance

Xeriscape landscaping has many benefits which include:

- Reduced water use
- Decreased energy use
- Reduced heating and cooling costs resulting from optimal placement of trees and plants
- Minimal runoff from both stormwater and irrigation resulting in reduction of sediment, fertilizer and pesticide transport
- Reduction in yard waste that would normally be landfilled
- Creation of habitat for wildlife
- Lower labor and maintenance costs
- Extended life of existing water resources infrastructure.

A xeriscape-type landscape can reduce outdoor water consumption by as much as 50 percent without sacrificing the quality and beauty of landscaped areas. It is also an environmentally sound landscape, requiring less fertilizer and fewer chemicals. Xeriscape-type landscape is low maintenance, saving time, effort and money.

Street trees/canopy cover are elements of vegetative protection, revegetation, and maintenance and are characterized as a HSC for the purpose of this TGD. A BMP fact sheet for street trees/canopy interception is found in Section 6.5.3.4. Fact sheets include recommended design criteria and methods of quantifying the benefits of street trees/canopy interception.

The selection and design of vegetative-based LID BMPs that are specifically sized to treat the design capture volume is discussed further in Section 6.

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4.4. Slopes and Channel Buffers

Project plans should include Source Control BMPs to decrease the potential for erosion of slopes and/or channels. The following design principles should be considered, and incorporated and implemented where determined applicable and feasible by the Permittee:

1. Convey runoff safely from the tops of slopes.
2. Avoid disturbing steep or unstable slopes.
3. Avoid disturbing natural channels.
4. Install permanent stabilization BMPs on disturbed slopes as quickly as possible.
5. Vegetate slopes with native or drought tolerant vegetation.
6. Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
7. Install permanent stabilization BMPs in channel crossings as quickly as possible, and ensure that increases in runoff velocity and frequency caused by the project do not erode the channel.
8. Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters should be installed in such a way as to minimize impacts to receiving waters.
9. On-site conveyance channels should be lined, where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. Irrigation demand of vegetated systems should be considered. If velocities in the channel are large enough to erode grass or other vegetative linings, rock, riprap, concrete soil cement or geo-grid stabilization may be substituted or used in combination with grass or other vegetation stabilization.
10. Other design principles which are comparable and equally effective.

These practices should be implemented, as feasible, consistent with local codes and ordinances. Projects involving an alteration to bed, bank, or channel of a Water of the US may require approval of regulatory agencies with jurisdiction over water bodies, (e.g., the U.S. Army Corps of Engineers, the Regional Boards and the California Department of Fish and Game).

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4.5. Techniques to Minimize Land Disturbance

Minimizing the amount of site clearing and grading can dramatically reduce the overall hydrologic impacts of site development. This applies primarily to new construction but the principles can be adapted to retrofit and infill projects as well.

Soil compaction resulting from the movement of heavy construction equipment can reduce soil infiltration rates by 70-99% (Gregory et al, 2006)[7]. Even low levels of compaction caused by light construction equipment can significantly reduce infiltration rates. In addition, compaction can destroy the complex network of biota in the soil profile that support the soil's ability to capture and mitigate pollutants. Soil compaction severely limits the establishment of healthy root systems of plants that may be used to revegetate the area. For these reasons, it is very important to avoid unnecessary damage to soils during the construction process. The use of clearly defined protection areas will help to preserve the existing capacity of the site to store, treat and infiltrate stormwater runoff.

Example Planning Phase Techniques

- Many of the planning techniques identified in the above sections will help minimize the construction footprint.

Example Construction Phase Techniques

- Minimize the size of construction easements.
- Locate material storage areas and stockpiles within the development envelope.
- Limit ground disturbance outside of areas that require grading.
- Identify and clearly delineate access routes for the movement of heavy equipment.
- Establish and delineate vegetation and soil protection areas.

Additional techniques for minimizing disturbance and protecting or restoring site conditions during construction phase include:

Establish Vegetation and Soil Protection Areas

Vegetative protection areas (e.g. stream, river, lake and other watercourse buffers, vegetation protection areas, existing trees) should be clearly delineated with highly visible fencing materials to prevent incursion of equipment or the stockpiling of materials during construction. Tree trunks should be sheathed during construction to prevent or minimize damage to the bark.

[7] Gregory, J.H.; Dukes, M.D.; Jones, P.H.; and G.L. Miller, 2006. Effect of urban soil compaction on infiltration rate. *Journal of Soil and Water Conservation 2006 61(3):117-124 Online at:* http://www.floridadep.org/water/wetlands/erp/rules/stormwater/docs/compaction.pdf

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Use of Mulch and Load Distributing Matting

Mulch blankets can be used to protect soil from compaction during construction. The use of timbers or other types of load distributing materials can also be used to limit the effect of heavy equipment movement on the site.

Pre / Post Construction Soil and Plant Treatments

Consideration should be given to pre-construction treatment of the soil to mitigate the stresses on existing shrubs and trees. This can include soil aeration and specific fertilization protocols that would encourage plant vitality. A local restoration ecologist should be engaged well in advance of the start of construction to develop a plan based on specific site conditions since some of these practices are carried out prior to construction.

Inspection Guidelines and Procedures

Management of soil, water, and vegetation protection measures during the construction process will only be effective if it is carefully implemented and meticulously policed during all phases of construction. Significant damage can be done in a short timeframe, and the cost of damage remediation tends to be far greater than the cost of avoiding it. Areas intended for infiltration should be treated especially carefully. Avoid the use of heavy machinery or discharge of sediment-laden runoff in these areas.

Techniques implemented on the construction site to minimize the construction footprint should be included in the project documentation and contractors working on the project should review and agree to comply with them while working on the jobsite. Construction site inspections should include inspection of such protocols to ensure they are maintained throughout construction.

4.6. LID BMPs at Scales from Single Parcels to Watershed

While the above techniques and approaches are primarily aimed at project-specific planning and design efforts on individual parcels or sites, they are equally applicable when planning projects or activities on a larger scale. The application of LID principles and practices on a watershed scale may be reflected in the promotion of high density development and infill, protection of drainage courses, land use planning with consideration for areas most suitable for development, preservation of native vegetation, and the implementation of LID BMPs on a sub-regional or regional basis. Such approaches and opportunities are expected to be evaluated and identified in future watershed-scale plans that integrate water quality, hydroligic, fluvial, water supply, and habitat considerations.

4.7. Integrated Water Resource Management Practices

Selection and incorporation of site design principles into new development and significant redevelopment projects, whether on-site or off-site can have significant multiple benefits on a subwatershed, watershed and county-wide basis. For example, Orange County Water District

This page contains no comments

is supportive of regional/sub-regional infiltration BMPs as an approach to retaining more urban runoff in the groundwater basin. As another example, the San Diego Creek Natural Treatment System (NTS) Master Plan (www.naturaltreatmentsystem.org) includes, among other concepts, constructed wetlands integrated with flood control facilities. These types of facilities would provide retention and biotreatment as well as treatment of dry weather flows while maintaining the original flood control functionality of the basin. Finally, LID and hydromodification control BMPs may provide significant flood control benefits, therefore the system design processes described in this TGD should be coordinated with flood control design (not covered by this TGD) to most efficiently support both functions.

This page contains no comments

Section 5. Source Control Measures

This section provides guidance on the selection and design of structural source control measures.

5.1. Introduction

Source Control BMPs reduce the potential for stormwater runoff and pollutants from coming into contact with one another. Source Control BMPs are defined as any administrative action, design of a structural facility, usage of alternative materials, and operation, maintenance, inspection, and compliance of an area to eliminate or reduce stormwater pollution. Each new development and significant redevelopment project is required to implement appropriate Source Control BMP(s).

Applicable Source Control BMPs (routine non-structural BMPs, routine structural BMPs and BMPs for individual categories/project features) are required to be incorporated into all new development and significant redevelopment projects regardless of their priority, including those identified in an applicable regional or watershed program, unless they do not apply due to the project characteristics. Most of these measures are the same as or very similar to BMPs that are currently required to be incorporated in projects under the current DAMP and Model WQMP and the numbering system reflects the system currently used. California Stormwater Quality Association (CASQA) BMP Fact Sheet numbers are included in parentheses where applicable.

5.2. Non-Structural Measures

N1 Education for Property Owners, Tenants and Occupants

For developments with no Property Owners Association (POA) or with POAs of less than fifty (50) dwelling units, practical information materials will be provided to the first residents/occupants/tenants on general housekeeping practices that contribute to the protection of stormwater quality. These materials will be initially developed and provided to first residents/occupants/tenants by the developer. Thereafter such materials will be available through the Permittees' education program. Different materials for residential, office commercial, retail commercial, vehicle-related commercial and industrial uses will be developed.

For developments with POA and residential projects of more than fifty (50) dwelling units, project conditions of approval will require that the POA periodically provide environmental awareness education materials, made available by the municipalities, to all members. Among other things, these materials will describe the use of chemicals (including household type) that should be limited to the property, with no discharge of wastes via hosing or other direct discharge to gutters, catch basins and storm drains.

N2 Activity Restrictions

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Number: 1 Author: staff Subject: Inserted Text Date: 7/1/2010 8:40:01 AM
which includes subcategories of

Number: 2 Author: staff Subject: Underline Date: 7/1/2010 8:41:43 AM
This term appears abruptly. Add some discussion explaining the system.

Number: 3 Author: staff Subject: Inserted Text Date: 7/1/2010 8:46:15 AM
of its

If a POA is formed, conditions, covenants and restrictions (CCRs) ~~should~~ be prepared by the developer for the purpose of surface water quality protection. An example would be not allowing car washing outside of established community car wash areas in multi-unit complexes. Alternatively, use restrictions may be developed by a building operator through lease terms, etc. These restrictions must be included in the Project WQMPas required by the Model WQMP.

N3 (SC-73) Common Area Landscape Management

Identify on-going landscape maintenance requirements consistent with County Water Conservation Resolution or city equivalent that include fertilizer and/or pesticide usage consistent with Management Guidelines for Use of Fertilizers (DAMP Section 5.5). Statements regarding the specific applicable guidelines must be included in the Project WQMP.

N4 BMP Maintenance

Identify responsibility for implementation of each non-structural BMP and scheduled cleaning and/or maintenance of all structural BMP facilities.

N5 Title 22 CCR Compliance

Compliance with Title 22 of the California Code of Regulations (CCR) and relevant sections of the California Health & Safety Code regarding hazardous waste management is enforced by County Environmental Health on behalf of the State. The Project WQMP must describe how the development will comply with the applicable hazardous waste management section(s) of Title 22.

N6 Local Water Quality Permit Compliance

The Permittees, under the Water Quality Ordinance, may issue permits to ensure clean stormwater discharges from fuel dispensing areas and other areas of concern to public properties.

N7 (SC-11) Spill Contingency Plan

Prepared by building operator for use by specified types of building or suite occupancies ~~and which mandates~~ stockpiling of cleanup materials, notification of responsible agencies, disposal of cleanup materials, documentation, etc.

N8 Underground Storage Tank Compliance

Compliance with State regulations dealing with underground storage tanks, enforced by County Environmental Health on behalf of State.

N9 Hazardous Materials Disclosure Compliance

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Number: 1 Author: staff Subject: Replacement Text Date: 7/1/2010 8:47:09 AM
must

Number: 2 Author: staff Subject: Underline Date: 7/1/2010 8:49:32 AM
This sentence is unclear: it is missing a subject and includes several ideas. It needs to be re-written into several sentences to separate out the ideas.

Number: 3 Author: staff Subject: Underline Date: 7/1/2010 8:51:01 AM
Who should identify the responsible parties?

Number: 4 Author: staff Subject: Underline Date: 7/1/2010 9:10:35 AM
Explain how this might materially affect the project WQMP, site design, etc.

Number: 5 Author: staff Subject: Underline Date: 7/1/2010 8:52:50 AM
It is unclear what this could be referring to. Provide clarification.

Number: 6 Author: staff Subject: Underline Date: 7/1/2010 9:00:52 AM
It needs to be explained that, under certain circumstances, Spill Contingency Plans are required by regulations. Indicate that this is the case and cite the regulations.

Number: 7 Author: staff Subject: Replacement Text Date: 7/1/2010 8:54:08 AM
A Spill Contingency Plan is

Number: 8 Author: staff Subject: Replacement Text Date: 7/1/2010 8:55:00 AM
or occupants

Number: 9 Author: staff Subject: Replacement Text Date: 7/1/2010 8:58:04 AM
. The Plan describes how the occupants will prepare for and respond to spills of hazardous materials. Plans typically describe

Number: 10 Author: staff Subject: Underline Date: 7/1/2010 9:09:19 AM
This is too brief. Explain what types of UST's are regulated and cite the regulations or sources of additional information. Explain how this might affect site design or how it is relevant to the WQMP preparer.

Compliance with Permittee ordinances typically enforced by respective fire protection agencies for the management of hazardous materials. The Orange County, health care agencies, and/or other appropriate agencies (i.e. Department of Toxics Substances Control) are typically responsible for enforcing hazardous materials and hazardous waste handling and disposal regulations.

N10 Uniform Fire Code Implementation

Compliance with Article 80 of the Uniform Fire Code enforced by fire protection agency.

N11 (SC-60) Common Area Litter Control

For industrial/commercial developments and for developments with POAs, the owner/POA should be required to implement trash management and litter control procedures in the common areas aimed at reducing pollution of drainage water. The owner/POA may contract with their landscape maintenance firms to provide this service during regularly scheduled maintenance, which should consist of litter patrol, emptying of trash receptacles in common areas, and noting trash disposal violations by tenants/homeowners or businesses and reporting the violations to the owner/POA for investigation.

N12 Employee Training

Education program (see N1) as it would apply to future employees of individual businesses. Developer either prepares manual(s) for initial purchasers of business site or for development that is constructed for an unspecified use makes commitment on behalf of POA or future business owner to prepare.

N13 (SD-31) Housekeeping of Loading Docks

Loading docks typically found at large retail and warehouse-type commercial and industrial facilities should be kept in a clean and orderly condition through a regular program of sweeping and litter control and immediate cleanup of spills and broken containers. Cleanup procedures should minimize or eliminate the use of water. If wash water is used, it must be disposed of in an approved manner and not discharged to the storm drain system. If there are no other alternatives, discharge of non-stormwater flow to the sanitary sewer may be considered only if allowed by the local sewerage agency through a permitted connection.

N14 (SC-74) Common Area Catch Basin Inspection

For industrial/commercial developments and for developments with privately maintained drainage systems, the owner is required to have at least 80 percent of drainage facilities inspected, cleaned and maintained on an annual basis with 100 percent of the facilities included in a two-year period. Cleaning should take place in the late summer/early fall prior to the start of the rainy season. Drainage facilities include catch basins (storm drain inlets) detention basins, retention basins, sediment basins, open drainage channels and lift stations.

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Number: 1 Author: staff Subject: Underline Date: 7/1/2010 9:08:12 AM

Describe who must comply. Explain how this might affect the site design. Instruct the reader where to go for more information; provide a web link if available.

Number: 2 Author: staff Subject: Underline Date: 7/1/2010 9:07:15 AM

Explain how this is relevant to the preparer. Who must comply? How might this affect site design?

Number: 3 Author: staff Subject: Underline Date: 7/1/2010 9:13:27 AM

Required under what authority?

Number: 4 Author: staff Subject: Underline Date: 7/1/2010 9:13:59 AM

Describe any record-keeping requirements, if any.

N15 (SC-43, SC-70) Street Sweeping Private Streets and Parking Lots

Streets and parking lots are required to be swept prior to the storm season, in late summer or early fall, prior to the start of the rainy season or equivalent as required by the governing jurisdiction.

N16 (SD-30, SC-20) Retail Gasoline Outlets

Retail gasoline outlets (RGOs) are required to follow the guidelines of this TGD and Model WQMP and non-structural source control operations and maintenance BMPs shown in the CASQA Structural Source Control Fact Sheet SD-30, and Non-structural Source Control Fact Sheet (SC-20).

Other Non-structural Measures for Public Agency Projects

As required by the Model WQMP other non-structural measures shall be implemented and included in the Project WQMP as applicable for new public agency Priority Projects as described in the Municipal Activity fact sheets http://www.ocwatersheds.com/MunicipalActivities.aspx. These include BMPs FF-1 through FF-13 for Fixed Facilities and DF-1 for Drainage Facilities.

5.3. Structural Measures

The following measures are applicable to all project types. CASQA BMP Fact Sheet numbers are included in parentheses where applicable.

S1 (SD-13) Provide Storm Drain System Stenciling and Signage

Storm drain stencils are highly visible source control messages, typically placed directly adjacent to storm drain inlets. The stencils contain a brief statement that prohibits the dumping of improper materials into the municipal storm drain system. Graphical icons, either illustrating anti-dumping symbols or images of receiving water fauna, are effective supplements to the anti-dumping message. Stencils and signs alert the public to the destination of pollutants discharged into stormwater. The following requirements should be included in the project design and shown on the project plans:

1. Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language (such as: "NO DUMPING-DRAINS TO OCEAN") and/or graphical icons to discourage illegal dumping.

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

3. Maintain legibility of stencils and signs.

See CASQA Stormwater Handbook BMP Fact Sheet SD-13 for additional information.

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Number: 1 Author: staff Subject: Underline Date: 7/1/2010 9:17:07 AM

If this is not required by the local jurisdiction, then it should not appear in the project WQMP, else it would be hollow language. Provide a table or list of jurisdictions that require this or provide a similar resource so that the preparer knows to include it or not.

Number: 2 Author: staff Subject: Underline Date: 8/9/2010 7:56:56 AM

This needs to be rephrased so that it is clear as to what in the Fact Sheets are mandatory and what are discretionary.

Number: 3 Author: staff Subject: Underline Date: 7/1/2010 9:22:41 AM

Explain to the reader what the purpose is of providing the Fact Sheet numbers.

Number: 4 Author: staff Subject: Underline Date: 7/1/2010 9:25:15 AM

The reader should be alerted that different jurisdictions may have different standards regarding the size, type, and language and the local jurisdiction should be consulted.

Number: 5 Author: staff Subject: Underline Date: 7/1/2010 9:25:56 AM

Explain who will be responsible for maintaining legibility.

S2 (SD-34) Design Outdoor Hazardous Material Storage Areas to Reduce Pollutant Introduction

Improper storage of materials outdoors may increase the potential for toxic compounds, oil and grease, fuels, solvents, coolants, wastes, heavy metals, nutrients, suspended solids, and other pollutants to enter the municipal storm drain system. Where the plan of development includes outdoor areas for storage of hazardous materials that may contribute pollutants to the municipal storm drain system, the following stormwater BMPs are required:

1. Hazardous materials with the potential to contaminate urban runoff shall either be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with ~~runoff~~ or spillage to the municipal storm drain system; or (2) protected by secondary containment structures (not double wall containers) such as berms, dikes, or curbs.

2. The storage area shall be paved and sufficiently impervious to contain leaks and spills.

3. The storage area shall have a roof or awning to minimize direct precipitation and collection of stormwater within the secondary containment area.

4. Any stormwater retained within the containment structure must not be discharged to the street or storm drain system.

5. Location(s) of installations of where these preventative measures will be employed must be included on the map or plans identifying BMPs.

See CASQA Stormwater Handbook Section 3.2.6 and BMP Fact Sheet SD-34 for additional information.

S3 (SD-32) Design Trash Enclosures to Reduce Pollutant Introduction

Design trash storage areas to reduce pollutant introduction. All trash container areas shall meet the following requirements (limited exclusion: detached residential homes):

1. Paved with an impervious surface, designed not to allow run-on from adjoining areas, designed to divert drainage from adjoining roofs and pavements diverted around the area, screened or walled to prevent off-site transport of trash; and

2. Provide solid roof or awning to prevent direct precipitation.

Connection of trash area drains to the municipal storm drain system is prohibited.

See CASQA Stormwater Handbook Section 3.2.9 and BMP Fact Sheet SD-32 for additional information.

S4 (SD-12) Use Efficient Irrigation Systems and Landscape Design

Projects shall design the timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the municipal storm drain system. (Limited exclusion:

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Number: 1 Author: staff Subject: Underline Date: 7/1/2010 9:34:50 AM

Explain below if this includes above-ground storage tanks.

Number: 2 Author: staff Subject: Replacement Text Date: 7/1/2010 9:26:59 AM

storm water

Number: 3 Author: staff Subject: Underline Date: 7/12/2010 12:28:28 PM

The purposes of impervious paving seem confused here. Impervious paving itself is generally for the purpose of preventing soil contamination and easing cleanup effort. It can be, but isn't always to contain larger spills, which might be better addressed with permanent dikes and/or sumps. These methods of containing spills should be discussed separately.

Number: 4 Author: staff Subject: Underline Date: 7/1/2010 9:33:39 AM

Provide performance criteria to describe how much containment capacity should be provided. Address containment for above-ground storage tanks separately.

Number: 5 Author: staff Subject: Underline Date: 7/1/2010 9:36:37 AM

If applicable, advise that additional requirements from the local hauler may apply.

Number: 6 Author: staff Subject: Underline Date: 7/1/2010 9:38:32 AM

This implies that trash areas must drain to the next logical discharge point - the sewer. Clarify if this is not the intent or state so explicitly if it is the intent.

Number: 7 Author: staff Subject: Underline Date: 7/1/2010 9:41:19 AM

Indicate if this includes the use of reclaimed water. If not, provide separate discussion of this water source. Explain how this section relates to storm water capture and use.

detached residential homes.) The following methods to reduce excessive irrigation runoff shall be considered, and incorporated on common areas of development and other areas where determined applicable and feasible by the Permittee:

1. Employing rain shutoff devices to prevent irrigation after precipitation.

2. Designing irrigation systems to each landscape area's specific water requirements.

3. Using flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.

4. Implementing landscape plan consistent with County Water Conservation Resolution or city equivalent, which may include provision of water sensors, programmable irrigation times (for short cycles), etc.

5. The timing and application methods of irrigation water shall be designed to minimize the runoff of excess irrigation water into the municipal storm drain system.

6. Employing other comparable, equally effective, methods to reduce irrigation water runoff.

7. Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider other design features, such as:

    - Use mulches (such as wood chips or shredded wood products) in planter areas without ground cover to minimize sediment in runoff.

    - Install appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant material where possible and/or as recommended by the landscape architect.

    - Leave a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible.

    - Choose plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth.

Irrigation practices shall comply with local and statewide ordinances related to irrigation efficiency.

S5 Protect Slopes and Channels

Projects shall protect slopes and channels as described in Section 4.4 of this TGD.

S6 (SD-31) Loading Dock Areas

Loading /unloading dock areas shall include the following:

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1. Cover loading dock areas, or design drainage to preclude run-on and runoff, unless the material loaded and unloaded at the docks does not have potential to contribute to stormwater pollution, and this use is ensured for the life of the facility.

2. Direct connections to the municipal storm drain system from below grade loading docks (truck wells) or similar structures are prohibited. Stormwater can be discharged through a permitted connection to the storm drain system with a treatment control BMP applicable to the use.

3. Other comparable and equally effective features that prevent unpermitted discharges to the municipal storm drain system.

4. Housekeeping of loading docks shall be consistent with N13.

See CASQA Stormwater Handbook Section 3.2.8 for additional information.

S7 (SD-31) Maintenance Bays

Maintenance bays shall include the following:

1. Repair/maintenance bays shall be indoors; or, designed to preclude urban run-on and runoff.

2. Design a repair/maintenance bay drainage system to capture all wash water, leaks and spills. Provide impermeable berms, drop inlets, trench catch basins, or overflow containment structures around repair bays to prevent spilled materials and wash-down waters from entering the storm drain system. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the municipal storm drain system is prohibited. If there are no other alternatives, discharge of non-stormwater flow to the sanitary sewer may be considered only if allowed by the local sewerage agency through permitted connection.

Other features which are comparable and equally effective that prevent discharges to the municipal storm drain system without appropriate permits.

See CASQA Stormwater Handbook Fact Sheet SD-31 for additional information.

S8 (SD-33) Vehicle Wash Areas

Projects that include areas for washing /steam cleaning of vehicles shall use the following:

1. Self-contained or covered with a roof or overhang.

2. Equipped with a wash racks, and with the prior approval of the sewerage agency (Note: Discharge monitoring may be required by the sewerage agency).

3. Equipped with a clarifier or other pretreatment facility.

4. If there are no other alternatives, discharge of non-stormwater flow to the sanitary sewer may be considered only allowed by the local sewerage agency through permitted connection.

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Number: 1 Author: staff Subject: Inserted Text Date: 7/1/2010 9:43:10 AM

in an equally effective manner

Number: 2 Author: staff Subject: Underline Date: 7/1/2010 10:19:56 AM

Include a statement that alerts the reader that this is distinct from community wash racks below.

5. Other features which are comparable and equally effective that prevent unpermitted discharges, to the municipal storm drain system.

See CASQA Stormwater Handbook Sections 3.2.7 and 3.2.10 and Fact Sheet SD-33 for additional information.

S9 (SD-36) Outdoor Processing Areas

Outdoor process equipment operations, such as rock grinding or crushing, painting or coating, grinding or sanding, degreasing or parts cleaning, landfills, waste piles, and wastewater and solid waste handling, treatment, and disposal, and other operations determined to be a potential threat to water quality by the Permittee shall adhere to the following requirements.

1. Cover or enclose areas that would be the sources of pollutants; or, slope the area toward a sump that will provide infiltration or evaporation with no discharge; or, if there are no other alternatives, discharge of non-stormwater flow to the sanitary sewer may be considered only allowed by the local sewerage agency through permitted connection.
2. Grade or berm area to prevent run-on from surrounding areas.
3. Installation of storm drains in areas of equipment repair is prohibited.
4. Other features which are comparable or equally effective that prevent unpermitted discharges to the municipal storm drain system.
5. Where wet material processing occurs (e.g. Electroplating), secondary containment structures (not double wall containers) shall be provided to hold spills resulting from accidents, leaking tanks or equipment, or any other unplanned releases (Note: If these are plumbed to the sanitary sewer, the structures and plumbing shall be in accordance with Section 7.II - 8, Attachment D, and with the prior approval of the sewerage agency). See also Section 7.II - 3.4.2, N10. Design of secondary containment structures shall be consistent with "Design of Outdoor Material Storage Areas to Reduce Pollutant Introduction".

Some of these land uses (e.g. landfills, waste piles, wastewater and solid waste handling, treatment and disposal) may be subject to other permits including Phase I Industrial Permits that may require additional BMPs.

See CASQA Stormwater Handbook Section 3.2.5 for additional information.

S10 Equipment Wash Areas

Outdoor equipment/accessory washing and steam cleaning activities shall use the following:

1. Be self-contained or covered with a roof or overhang.
2. Design an equipment wash area drainage system to capture all wash water. Provide impermeable berms, drop inlets, trench catch basins, or overflow containment structures around equipment wash areas to prevent wash -down waters from entering the storm

This page contains no comments

drain system. Connect drains to a sump for collection and disposal. Discharge from equipment wash areas to the municipal storm drain system is prohibited. If there are no other alternatives, discharge of non-stormwater flow to the sanitary sewer may be considered, but only when allowed by the local sewerage agency through a permitted connection.

3. Other comparable or equally effective features that prevent unpermitted discharges to the municipal storm drain system.

S11 (SD-30) Fueling Areas

Fuel dispensing areas shall contain the following:

1. At a minimum, the fuel dispensing area must extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.
2. The fuel dispensing area shall be paved with Portland cement concrete (or equivalent smooth impervious surface). The use of asphalt concrete shall be prohibited.
3. The fuel dispensing area shall have an appropriate slope (2% - 4%) to prevent ponding, and must be separated from the rest of the site by a grade break that prevents run-on of stormwater.
4. An overhanging roof structure or canopy shall be provided. The cover's minimum dimensions must be equal to or greater than the area of the fuel dispensing area in the first item above. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area. The fueling area shall drain to the project's Treatment Control BMP(s) prior to discharging to the municipal storm drain system.

See CASQA Stormwater Handbook Section 3.2.11 and BMP Fact Sheet SD-30 for additional information.

S12 (SD-10) Site Design and Landscape Planning (Hillside Landscaping)

Hillside areas that are disturbed by project development shall be landscaped with deep-rooted, drought tolerant plant species selected for erosion control, satisfactory to the Permittee.

S13 Wash Water Controls for Food Preparation Areas

Food establishments (per State Health & Safety Code 27520) shall have either contained areas or sinks, each with sanitary sewer connections for disposal of wash waters containing kitchen and food wastes. If located outside, the contained areas or sinks shall also be structurally covered to prevent entry of stormwater. Adequate signs shall be provided and appropriately placed stating the prohibition of discharging washwater to the storm drain system.

S14 Community Car Wash Racks

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Number: 1 Author: staff Subject: Highlight Date: 7/1/2010 9:55:53 AM

This term is used in two contexts throughout this document either to refer to the permittees under the MS4 Permit or to the project proponent. The term "Permittee" is not expressly defined and needs to be in order to make the distinction between the proponent and the local jurisdiction. Preferably, the precise terms should be used instead.

In complexes larger than 100 dwelling units where car washing is allowed, a designated car wash area that does not drain to a storm drain system shall be provided for common usage. Wash waters from this area may be directed to the sanitary sewer (with the prior approval of the sewerage agency); to an engineered infiltration system; or to an equally effective alternative. Pre-treatment may also be required.

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Section 6. LID and Treatment Control BMP Design

6.1. Introduction

LID BMPs and treatment control BMPs are required in addition to site design measures and source controls to reduce pollutants in stormwater discharges to the MEP. LID BMPs are engineered facilities that are designed to retain or biotreat runoff on the project site. HSCs are a category of LID BMPs that reduce stormwater runoff, but are less rigorously designed and maintained than the other types of LID BMPs. Treatment control BMPs are structural, engineered facilities that are designed to remove pollutants from stormwater runoff using treatment processes that do not incorporate biological methods. Both LID BMPs and treatment control BMPs can also partially or fully satisfy hydromodification performance criteria depending on their design and functions.

The type of LID BMP(s) to be implemented depends on site conditions, site opportunities, owner/builder preferences, and the feasibility criteria. The type of treatment control(s) to be implemented at a site depends on a number of factors, including: type of pollutants potentially present in the stormwater runoff, quantity of stormwater runoff to be treated, project site conditions, receiving water conditions, owner/builder preferences and state industrial permit requirements, where applicable. Land requirements and costs to design, construct, and maintain LID and treatment control BMPs vary.

6.1.1. BMP Selection and Design Philosophy

BMP selection and screening is based on a two-tiered approach: Level 1 and Level 2 Feasibility Screening. Level 1 Feasibility Screening is driven by screening questions to address specific statutory and physical limitations (i.e., Level 1 Suitability Screening Factors). Level 1 Feasibility Screening also consists of numeric and categorical screening criteria to identify conditions under which a practice may be used but is not mandatory (i.e., Level 1 Effectiveness Screening). Level 1 Feasibility Screening is intended to achieve the following goals:

- Ensure that stormwater management activities do not result in violations of statutory requirements,
- Ensure protection of groundwater and other natural resources from negative impacts as a result of stormwater management activities, and
- Prioritize on-site stormwater management options based on site constraints to maximize the overall effectiveness in reducing pollutants to MEP and reduce design/review burden.

Level 2 Feasibility Screening recognizes that a practice may, in some cases, only be feasible up to a certain extent. In order to meet the MEP standard, implementation of practices to the extent feasible is required even when they do not meet the entire performance criterion. A site-specific detailed analysis that considers site layout, site constraints, project type, design criteria and

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other factors is required to determine the maximum feasible level of implementation and fractional amount of the applicable performance criterion that is met at this level of screening. Level 2 Feasibility Screening is intended to achieve the following goals:

- Encourage a diversity of stormwater management controls;
- Account for site specific parameters, such as infiltration rate, which vary over a continuous range and which cannot be described by a single cut-off value;
- Provide incentive for improved site design and hydrologic source control; and
- Provide an objective means of documenting that the MEP standard is met for each practice type.

The North and South County Permits specifically recognize that there is a necessary economic analysis to be performed when considering LID, and a balancing of cost considerations versus the relative performance benefits of LID (versus standard BMP treatment controls) is appropriate.

6.1.2. Integrated Stormwater Design Philosophy

Unlike flood control measures that are designed to handle peak flows, stormwater LID BMPs and treatment control BMPs are designed to retain or treat the more frequent, lower-flow runoff events, or the first flush portions of runoff from larger storm events. Smaller, more frequent storm events represent most of the total average annual rainfall for the area. It is the runoff volume from such small events that is targeted for on-site retention/biotreatment in LID BMPs and for treatment by treatment control BMPs. Performance criteria for LID BMPs and treatment control BMPs are presented in Section 2.2. In addition, sites must meet performance criteria for hydromodification control (see Section 2.2), and flood control standards (see other applicable requirements). Depending on project conditions, hydromodification control performance criteria and flood control standards may either be fully satisfied through LID BMPs and treatment control BMPs or may require ~~additional~~ infrastructure. Flood control standards are not discussed in this TGD.

It may be necessary to combine LID BMPs, treatment control BMPs, and additional measures to meet all stormwater management obligations. ~~This requires a comprehensive method of calculated design criteria that considers the incremental contribution of all practices towards achieving the overall performance criteria.~~ This process can be thought of as a series of cascading glasses where the ~~maximum feasible benefit~~ achieved by the highest priority practice is first considered (i.e., the first glass is filled), and then the remaining requirements are transferred to the next practice downstream (i.e., the first glass overflows), and so on. The order of consideration of BMPs is as follows:

1) Site Design BMPs (see Section 4)

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Number: 1 Author: staff Subject: Sticky Note Date: 7/1/2010 11:03:54 AM

Somewhere in this paragraph, you must define directly what is meant by "integrated stormwater design". The concept is discussed in the paragraph, but it is not expressly related back to this phrase so that the reader can understand that, when they later see the phrase, it relates to the concept.

Number: 2 Author: staff Subject: Inserted Text Date: 7/1/2010 10:26:18 AM

that integrate these functions

Number: 3 Author: staff Subject: Replacement Text Date: 7/1/2010 10:26:34 AM

separate

Number: 4 Author: staff Subject: Cross-Out Date: 7/1/2010 10:38:09 AM

Substitute: For many projects, it may be necessary to use a combination of BMPs to treat the volume of storm water required by the Permit and the MWQMP. The Permit, and consequently, the MWQMP, requires that BMPs be considered and implemented in a hierarchical order. Some projects may be able to treat the entire storm water volume with the first order of BMPs, but many will not. Any remaining untreated volume then must be treated by subsequent orders of BMPs.

Number: 5 Author: staff Subject: Underline Date: 7/1/2010 10:29:27 AM

This is the only instance of this phrase in the document. It is undefined. It's meaning needs to be made clear or it should be substituted using a phrase whose meaning is clear.

Number: 6 Author: staff Subject: Cross-Out Date: 7/1/2010 10:35:50 AM

substitute with more specific language

2) On-site LID BMPs

   a. On-site Retention BMPs in one of the following four categories:

      i. Hydrologic Source Controls (part of LID site design)

      ii. Infiltration BMPs

      iii. Evapotranspiration BMPs

      iv. Harvest and use BMPs

   b. On-site Biotreatment LID BMPs (may include both retention and biotreatment)

3) Off-site LID BMPs

4) Additional hydromodification control measures

5) Alternative compliance measures. See Section 8 for guidance on implementation of alternative compliance measures.

Level 1 Feasibility Screening ~~determines~~ which BMPs "shall", "may", and "shall not" be considered in developing an integrated stormwater design. Level 2 Feasibility Screening is conducted in parallel with the integrated design process and helps to determine whether the performance criteria have been met or whether the ~~maximum feasible benefit~~ has been provided by a specific practice, allowing the remaining performance criteria to be met in a lower priority practice.

The scale of ~~calculations~~ an important consideration. Some elements of the overall ~~stormwater design and feasibility process~~ must be conducted at specific scales in order to yield valid results. For example, it may be feasible to infiltrate on one part of a project site but not on another. Therefore, it would be inappropriate to conduct Level 1 Feasibility Screening at the project scale unless the project site is small; for larger projects this analysis should be conducted for individual drainage areas or groups of similar, contiguous drainage areas. **Table 6.1** outlines the steps for developing an integrated stormwater design, the scale at which the steps should be performed, and the section within this document where more detailed guidance can be found.

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Number: 1 Author: staff Subject: Underline Date: 7/1/2010 10:41:23 AM

Explain first what the screening consists of.

Number: 2 Author: staff Subject: Replacement Text Date: 7/1/2010 10:43:59 AM

is an objective sytematic method for determining

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This is one of only two instances of this phrase in the entire document. It is undefined. Substitute with specific language.

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Both Level 1 and Level 2 Screening must be completed and documented for all project WQMPs. The method of analysis in both Screenings is expected to be applicable to the vast majority of projects. However, deviations are allowed under circumstances where justified by site-specific conditions.

Number: 5 Author: staff Subject: Cross-Out Date: 7/1/2010 10:56:14 AM

This is the only instance of this phrase in the entire document. Substitute it with more specific language or explain more precisely what it is alluding to. If it is intended to allude to the Feasibility Screenings, state so.

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analysis

Table 6.1 Potential Stormwater Management Design Steps and Recommended Scale of Calculations		
Step	**Scale of Calculation [1]**	**Technical Guidance Document Reference**
Determine applicable performance criteria (LID, treatment control, and hydromodification control)	Project	Section 3.4
Level 1 Feasibility Screening	Group of similar, contiguous drainage areas *OR* individual drainage areas	Section 6.2.1
LID BMP prioritization	Group of similar, contiguous drainage areas *OR* individual drainage areas	Section 6.2.2
Calculate design requirements	Individual drainage areas	Section 3.6 / 6.4
Evaluate maximum feasible LID BMP implementation and design requirements to meet MEP via Level 2 Feasibility Screening	Individual drainage areas	Section 3.7 / 6.3 / 6.4
Calculate remaining requirements not met by on-site LID BMPs	Individual drainage areas, combined to Project totals	Section 3.7 / 6.4
Evaluate regional and subregional BMPs	Project	Section 3.8
Identify acceptable treatment control BMPs to address POCs	Project	Section 8
Alternative LID and/or WQ compliance	Project	Section 8
Evaluate hydromodification performance criteria	Project	Section 7

[1] Note that small projects may consist of one drainage area.

6.1.3. Using Section 6

~~This section~~ ~~should~~ be used as referenced ~~by~~ the Project WQMP preparation process described in Section 3. Some elements of this section will not be applicable in preparing a Project WQMP for every project. Refer to Section 3 to determine which elements of this section are applicable.

For projects where hydromodification control performance criteria are expected to be the factor that controls the design (i.e., ~~sizing of~~ BMPs ~~would be larger than required~~ for POC/treatment control) the hydromodification design process described in Section 7 ~~should~~ also be used.

Section 6.2 provides guidance for completion of Level 1 Feasibility Screening to support the BMP Selection and Preliminary Site Planning step of the Project WQMP preparation process. **Section 6.2** will assist the user in developing a list of BMPs that "shall" and "may" be considered in developing an integrated stormwater management design.

Section 6.3 provides detailed information to support the Level 2 Feasibility Screening step of the Project WQMP preparation process.

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This raises again the question of how the MWQMP should be used. Is it the intent of the authors that the Technical Guidance Document be used by itself and there is no need to refer back to the MWQMP? If so, then that should be stated, if not, the reader needs clear instruction as to how to use these documents.

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Section 6

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is intended to

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during

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Permissive. If other methods will be allowed, they must be described.

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the volume of storm water addressed by

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hydromodification control

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is greater than the volume

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BMPs

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must

Section 6.4 describes methods for calculating design criteria to support Section 3.6 and 3.7. The subsections of **6.4** which are applicable in certain cases are outlined in Section 3.6 and 3.7.

Sections 6.5 through **6.9** describe LID BMPs, including design calculations, specific considerations for implementation in Orange County, and references to other documents containing design guidance.

Section 6.10 and **6.11** describe treatment control BMPs and pretreatment measures.

In addition, site design BMPs are described in Section 4, hydromodification control measures are described in Section 7, and alternative compliance measures are described in Section 8.

6.2. Level 1 Feasibility Screening and BMP Selection

~~This section describes the methodology for determining which retention BMPs "shall", "may", and "shall not" be considered in developing a system to meet stormwater management requirements.~~ This section supports Section 3.5 of this document and should be conducted for a group of similar, contiguous drainage areas or individual drainage areas.

6.2.1. Level 1 Feasibility Screening

For purposes of Level 1 Feasibility Screening, LID BMPs are divided into two classes:

1) Retention BMPs, including:
    a. Hydrologic Source Controls,
    b. Infiltration BMPs,
    c. Harvest and Use BMPs,
    d. Evapotranspiration BMPs, and
2) Biotreatment BMPs

Level 1 Feasibility Screening is a two part process where retention BMPs must be considered before biotreatment BMPs. Table 6.2 provides a categorization of the most common LID BMPs into the four retention categories and the biotreatment category. Through the two parts of Level 1 Feasibility Screening, BMP categories are classified as those that "shall", "may", and "shall not" be considered in Level 2 Feasibility Screening as described below and in Figure 6.1:

- BMP categories passing Level 1 Suitability Screening and Effectiveness Screening: "shall" be considered
- BMP categories passing Level 1 Suitability Screening but not Effectiveness Screening: "may" be considered
- BMP categories failing Level 1 Suitability Screening: "shall not" be considered

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The screening consists of a series of questions that are intended to simplify an analysis of what LID BMPs should not be used or should be used with the given restrictions on a project site.

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consisting of separate analyses based on "Suitability" and "Effectiveness,

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the feasibility of using

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onsite

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Explain how this categorization relates to the screening. If the intent is to illustrate the specific BMPs being evaluated through the screening method, state so.

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consistent with Permit requirements. Both retention and biotreatment BMPs are further divided into categories. The Level 1 Feasibility Screening analyzes BMPs based on these categories.

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A complete description of the method is lacking here. The reader has no familiarity with what "two parts" is referring to. If it is referring to Suitability and Effectiveness Screening, state so plainly.

Figure 6.1
Level 1 Feasibility Screening Process

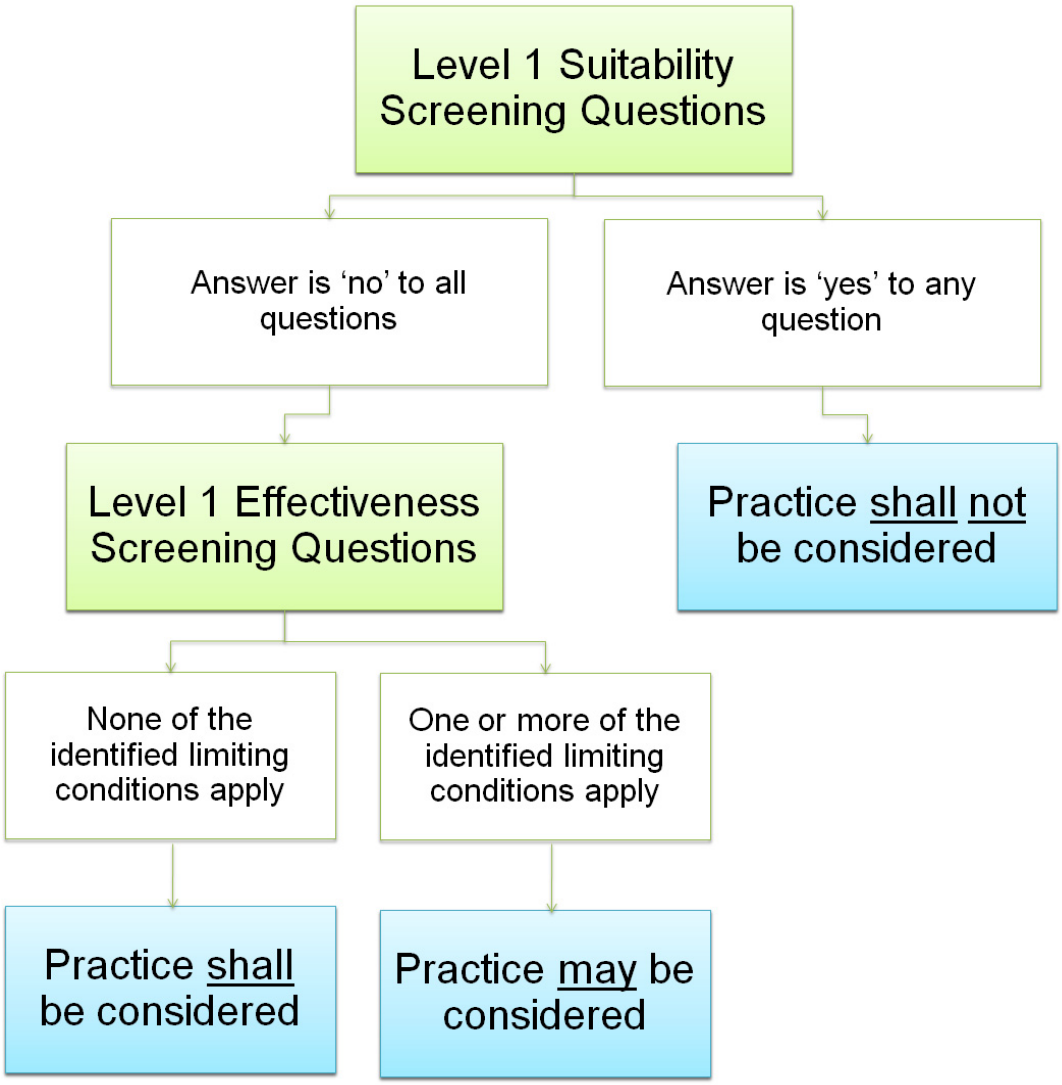

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Table 6.2
~~LID Options within Level 1 Feasibility Screening Categories~~

Hydrologic Source Controls Section 6.5	Infiltration Section 6.6	Harvest and Use Section 6.7	Evapotranspiration Section 6.8	Biotreatment Section 6.9
➢ Localized on-lot infiltration ➢ Impervious area dispersion ➢ Amended soils ➢ Street trees(canopy interception) ➢ Residential rain barrels (not actively managed) *Hydrologic source controls meeting specified criteria should be considered as infiltration, ET and/or harvest and use BMPs for purposes of Level 1 Feasibility Screening.* *These BMPs result in a reduced design storm depth for LID and/or Treatment Control BMPs.*	➢ Bioretention without underdrains ➢ Infiltration trenches ➢ Infiltration basins ➢ Drywells ➢ Underground infiltration ➢ Permeable pavement *Soil amendments may be used to improve infiltration capacity of low permeability soils where the limiting soil horizon lies within the depth that can be feasibly amended.* *Where the entire thickness of the limiting horizon cannot be amended, the use of soil amendments would increase storage volume but not increase effective infiltration rates.*	*Storage options:* ➢ Above-ground cisterns ➢ Underground detention *Potential demand:* ➢ Irrigation ➢ Toilet flushing ➢ Vehicle/ equipment washing ➢ Evaporative cooling ➢ Industrial processes ➢ Dilution water for recycled water systems ➢ Other non-potable uses	➢ Green roofs ➢ Brown roofs ➢ Blue roofs *These are BMPs that rely solely on evapotranspiration for water losses. All vegetated BMPs and permeable pavements also provide part of their volume reduction benefits through ET.*	➢ Bioretention with underdrains ➢ Constructed wetlands ➢ Wet detention basins ➢ Dry extended detention basins ➢ Vegetated swales ➢ Vegetated filter strips ➢ Proprietary biotreatment *Biotreatment BMPs may provide significant volume loss through incidental infiltration and ET or may include retention components such as additional storage volume below surface discharge.*

Note: Lists are not exhaustive; BMPs with similar unit processes may be considered.

6.2.1.1. *Categorization of Hydrologic Source Controls*

HSCs are a category of controls that reduce stormwater runoff, but are ~~less rigorously designed than the other types of LID BMPs.~~ These types of BMPs may still be subject to Level 1 Suitability Screening factors (i.e., factors which would prohibit ~~the use of a specific practice type), and~~ are classified as either infiltration, ET, and/or harvest and use BMPs for ~~this purpose~~ (**Table 6.3**).

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Categories of LID BMPs evaluated with Level 1 Feasibility Screening

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not specifically designed to treat any particular volume of storm water (i.e. design capture volume).

Number: 3 Author: staff Subject: Replacement Text Date: 6/28/2010 12:36:39 PM

or limit their use

Number: 4 Author: staff Subject: Replacement Text Date: 6/28/2010 12:37:04 PM

. HSCs

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the purposes of the screening

Table 6.3: Classification of Hydrologic Source Controls for Level 1 Suitability Screening	
Categorization for Level 1 Feasibility Screening	**Hydrologic Source Control**
HSCs Categorized as **Infiltration BMPs** for Level 1 Feasibility Screening	➢ Localized on-lot infiltration (e.g., retention grading, downspout connected to infiltration facility, etc.) (see Section 6.5.3.1) ➢ Impervious area dispersion (e.g., downspout disconnected to lawn (see Section 6.5.3.2) ➢ Any other HSC removing volume primarily through infiltration.
HSCs Categorized as **Harvest and use BMPs** for Level 1 Feasibility Screening	➢ Residential rain barrels not actively managed and used for irrigation; if discharge of barrels is predominantly to infiltration, they should be evaluated as infiltration BMPs

Note: Lists are not exhaustive; BMPs with similar unit processes should be considered with the most appropriate category.

6.2.1.2. Level 1 Infiltration Suitability Screening

A single 'yes' answer amongst the questions below indicates that infiltration shall not be used and shall not be considered further in evaluating feasibility.

- ~~Would stormwater infiltration result in significant risks to drinking water quality and groundwater quality that cannot be reasonably and technically mitigated?~~ Factors that may pose an unmitigatable risk to groundwater quality include:
  - Seasonally high groundwater is less than 10 feet below the designed bottom of the infiltration facility for aquifers managed for water quality or with significant connectivity to aquifers managed for groundwater quality. This criterion applies to all projects located over to the Orange County Groundwater Basin and in other locations where it is demonstrated that stormwater infiltration would result in a significant risk to deterioration of groundwater quality.
  - Seasonally high groundwater is less than 5 feet below the designed bottom of the infiltration facility for aquifers not managed for groundwater quality and without significant connectivity to aquifers managed for groundwater quality.
  - Horizontal distance to a water supply well is less than 100 feet.
  - Infiltration of stormwater from project land uses would result in significant risks to drinking water quality and groundwater quality that cannot be reasonably and technically mitigated through methods such isolation of sources and/or pre-treatment of runoff prior to infiltration.
- For brownfield sites or adjacent sites, would stormwater infiltration result in a significant risk of mobilizing or moving contamination that cannot be reasonably and technically avoided, as documented by a site-specific or available watershed study with

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Recommend that the questions themselves be made to stand out (in bold font, italicized, etc.) so that they can be easily found by the reader.

Number: 2 Author: staff Subject: Cross-Out Date: 7/2/2010 9:18:18 AM

This question is subjective but how it gets answered is based on the more objective criteria below. In order to be more direct, rephrase the subsequent criteria as questions.

Number: 3 Author: staff Subject: Underline Date: 7/2/2010 9:18:48 AM

Rephrase as questions.

Number: 4 Author: staff Subject: Underline Date: 7/2/2010 9:14:38 AM

This phrase needs to be explained so that the reader understands why different depth standards are being applied for managed versus un-managed aquifers. An appropriate resource also needs to be provided to the user, such as a map of the managed aquifers.

sufficient resolution to positively identify areas where stormwater infiltration should not be conducted? The documenting study shall have sufficient resolution to positively identify areas [1]here stormwater infiltration should be restricted.

- Where a groundwater pollutant plume (man-made or natural) is under the site or in close proximity, would stormwater infiltration result in a significant risk of causing or contributing to plume movement that cannot be reasonably and technically avoided, as documented by a site-specific study or available watershed study? The documenting study shall have sufficient resolution to positively identify areas where stormwater infiltration should be restricted.

- [2]Would stormwater infiltration result in significantly increased risks of geotechnical hazards such as liquefaction or landslides that cannot be reasonably and technically mitigated as documented by a geotechnical professional or available watershed study? The documenting study shall have sufficient resolution to positively identify ~~areas~~ [3] where stormwater infiltration should be restricted.

- Would infiltration of runoff violate downstream water rights? While it is not anticipated that infiltration of runoff would violate water rights in Orange County, water law in California is complex, and this TGD does not exclude the possibility that a rightful water rights claim could restrict infiltration of stormwater. The South County Permit contemplates the potential for stormwater management activities to violate water rights at F.3.d.(6)(d).

6.2.1.3. Level 1 Infiltration Effectiveness Screening

Certain factors may limit the potential benefit that infiltration BMPs can have or limit the extent to which infiltration is beneficial. While these factors eliminate the requirement to consider infiltration, these factors ~~do not prevent the ability of the project proponent to consider some level of incidental infiltration,~~ [4] desired, as part of an integrated stormwater management design.

Infiltration is not required to be considered if any of the following conditions are met:

- Project is located in HSG D soils per regional maps, the project meets criteria to use regional maps for infiltration screening per Section 6.2.1.4, and the site geotechnical investigation, if otherwise required, identifies presence of soil characteristics which support categorization as D soils. For projects ~~qualifying~~ [5] use regional maps, geotechnical investigation ~~shall not~~ [6]be required to include infiltration testing to confirm mapped categorization as HSG D soils; ~~other sources of data such as bore logs obtained for other purposes may be used.~~ [7]

- Measured infiltration rate after accounting for soil amendments is < 0.3 inches per hour in the vicinity of proposed BMPs Infiltration should be measured as described in

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Number: 1 Author: staff Subject: Inserted Text Date: 7/2/2010 9:19:57 AM
of the property where contamination is located and

Number: 2 Author: staff Subject: Underline Date: 7/2/2010 9:22:42 AM
Many jurisdictions have established thresholds for evaluating these risks in an objective way. Identify any available objective thresholds and use those.

Number: 3 Author: staff Subject: Replacement Text Date: 7/2/2010 9:23:35 AM
geotechnical hazards on a project site and the surrounding area

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should not discourage the project proponent from maximizing the available infiltration capacity of a site

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that meet the criteria

Number: 6 Author: staff Subject: Replacement Text Date: 7/2/2010 12:51:39 PM
will not

Number: 7 Author: staff Subject: Replacement Text Date: 7/2/2010 12:54:30 PM
if other site-specific information sources are otherwise available, such as bore logs, relevant information therein must be used.

Appendix III, which includes protocol that account for the effect of soil amendments. Soil amendments would not be expected to increase the effective infiltration rate of a soil if the limiting horizon for infiltration lies below the amended zone (in this case, it would increase storage, but not infiltration rate). Soil amendments would be expected to effectively increase infiltration rates if the limiting horizon for infiltration occurs near the proposed bottom of the infiltration basin and the entire depth of this layer can be amended.

- Reduction of runoff over predeveloped conditions would be partially or fully inconsistent with watershed-scale management strategies and/or would impair the beneficial uses of the receiving water. The allowable level of runoff reduction must be documented in a site-specific study or watershed plan, and it must be demonstrated that infiltration BMPs would exceed the allowable level of runoff reduction.

- Increase in infiltration over predeveloped conditions would be partially or fully inconsistent with watershed-scale management strategies and/or would cause impairments to downstream beneficial uses, such as change of seasonality of ephemeral washes. The level of allowable increase in infiltration must be documented in a site-specific study or watershed plan, and it must be demonstrated that stand-alone infiltration BMPs would exceed the allowable level of increase in infiltration or what level could be infiltrated as a partial consideration.

- A RWQCB Executive Officer-approved watershed-based plan has identified a subregional or regional BMP opportunity and demonstrated that this opportunity meets the following criteria:

    - The subregional/regional BMP is located such that the project would drain to the BMP prior to discharge to a Waters of the US, or the use of Waters of the US to convey water to the subregional/regional BMP meets the requirements of this TGD (See Section 3.8), and

    - The subregional/regional BMP is sufficiently sized to receive runoff from the project,

    - The subregional/regional BMP is sited and designed such that it will provide greater overall benefit than would be achieved by infiltration of stormwater on-site, including combined considerations of pollutant loading, hydrologic loading, groundwater recharge, potable water demand, and SmartGrowth goals.

    - The subregional/regional BMP will be adequately maintained into perpetuity.

In the event that any of these conditions apply, infiltration BMPs are not required to be considered, but may be considered as an option. Bioretreatment BMPs (where employed) should be designed to promote incidental infiltration where possible.

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This language suggests that a project proponent can set the allowable level with their own site-specific study. If this is not the intent, then the language needs to be modified. If this is the intent, it is unacceptable.

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n adopted

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that will serve the project

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Under any circumstances

6.2.1.4. *Use of Regional Maps for Level 1 Infiltration Feasibility Screening*

For certain types/scales of projects, it may not be economically feasible to evaluate each of the Level 1 Feasibility Screening criteria on a site-specific basis. Regional infiltration suitability maps generated as part of a RWQCB Executive Officer-approved watershed-based plans may be used to evaluate the Level 1 Feasibility Screening questions depending on project scale and type as defined in Table 6.4. Extensive geotechnical exploration is likely to impose a greater incremental cost for smaller projects, and requirements are therefore lessened consistent with the MEP standard.

If the resolution of regional maps is improved through more detailed studies and/or the reliability of data is demonstrated sufficiently, these criteria may be adjusted to allow larger projects to rely on regional mapping.

Table 6.4
Project Types Permitted to Use Regional Maps for Level 1 Infiltration Screening

Project Type	Project Size	OK to use Regional Maps for Level 1 Feasibility Screening?
Residential < 7 du/ac Public Facilities, FAR < 0.5 Surface Parking Lots Transit Stations	< 1 ac	Yes, if available data[1] supports mapped determination
	1 to 10 ac	Yes, if more than one identified constraint prohibits infiltration and available data[1] supports mapped constraint determinations
	> 10 ac	No
Residential > 7 du/ac Commercial/ Employment/ Mixed Use/ Institutional/ Educational/ Industrial Public Facilities, FAR > 0.5 Parking Structures	< 1 ac	Yes, if available data[1] supports mapped determination
	1 to 5 ac	Yes, if more than one identified constraint prohibits infiltration and available data[1] supports mapped constraint determinations
	> 5 ac	No

1- "available data" refers to data available through studies otherwise required to be conducted for the project or through applicable investigations of adjacent projects; it does not require additional project-specific investigations to be conducted. Examples include soil texture classes, presence of bedrock, or depth to groundwater determined from boring logs or test pits. If a project falls below review thresholds such that it is not otherwise required to collect soils data, the mapped determination can be used without support of site-specific data at the discretion of the reviewing agency. This condition is expected to apply to small, single story buildings only. Site-specific data should always be used wherever it is available.

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Number: 1 Author: staff Subject: Sticky Note Date: 7/2/2010 1:00:05 PM

The functional distinction between these two 'yes' is not clear. Restate.

Number: 2 Author: staff Subject: Sticky Note Date: 7/2/2010 1:00:42 PM

The functional distinction between these two 'yes' is not clear. Restate.

6.2.1.5. *Level 1 Harvest and Use Suitability Screening*

A single 'yes' answer to any of the following question indicates that harvest and use shall not be considered because harvest and use would conflict with codes and/or ordinances:

- Does use of harvested water for the type of demand on the project violate codes or ordinances in effect at the time of project application? An effort will be undertaken to identify and modify codes and ordinances that impede the implementation of LID. : However, this TGD does not have the authority to modify codes/ordinances in itself, and it remains a likely possibility that some forms of harvest and use will ~~be in violation of~~ codes/ordinances for at least a portion of this life of this manual.

- Would harvest and use of runoff violate downstream water rights? While it is not anticipated that infiltration of runoff would violate water rights in Orange County, water law in California is complex, and this TGD does not exclude the possibility that a rightful water rights claim could restrict infiltration of stormwater. The South County Permit contemplates the potential for stormwater management activities to violate water rights at F.3.d.(6)(d).

6.2.1.6. *Level 1 Harvest and Use Effectiveness Screening*

Certain factors may limit the potential benefit that harvest and use BMPs can have, however these factors do not prevent the project proponent from considering harvest and use BMPs. The feasibility of harvest and use BMPs should be determined by the capabilities of the end user to reasonably use the captured water on-site, considering the project type and configuration. Harvest and use systems are not required to be considered if any of the following conditions are met:

- The site is designated for reclaimed water use for irrigation and/or toilet flushing and insufficient demand is available for both reclaimed and harvested stormwater use.

- No landscape irrigation demand exists for periods of longer than 1 week following an 85th percentile, 24-hour storm event as documented by a certified landscape design professional, and the project is single family residential land use or multi-family land use with density < 7 dwellings units per acre, or commercial with FAR < 1.0. *Intent: sufficient demand for harvested rainwater would be very unlikely to be present in these land uses.*

- Reduction of runoff over predeveloped conditions would be partially or fully inconsistent with watershed-based management strategies and/or would impair beneficial uses of the receiving water. The level of allowable reduction must be documented in a site-specific study or watershed study, and it must be demonstrated that stand-alone harvest and use BMPs would exceed the allowable level of reduction.

- A technically-based ~~study of economic feasibility and/or cost-effectiveness~~ has been approved by the RWQCB Executive Officer that addresses the feasibility of harvest and

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Number: 1 Author: staff Subject: Inserted Text Date: 7/2/2010 1:02:03 PM
and a waiver cannot be obtained

Number: 2 Author: staff Subject: Replacement Text Date: 7/2/2010 1:02:55 PM
be prohibited by

Number: 3 Author: staff Subject: Underline Date: 7/2/2010 1:04:26 PM
Describe acceptable methods for calculating demand.

Number: 4 Author: staff Subject: Underline Date: 7/2/2010 1:15:00 PM
This criteria is complex and the methods for making this determination need to be explained. It is also unclear why irrigation demand and indoor use are considered separately, as opposed to the total demand of the site. This criteria seems to leave open the possibility that a site with adequate indoor use would not use capture and use BMPs.

Number: 5 Author: staff Subject: Underline Date: 7/2/2010 1:06:30 PM
The technical rationale for these thresholds needs to be provided and reviewed. These thresholds should have their own bullets.

Number: 6 Author: staff Subject: Cross-Out Date: 7/2/2010 1:15:32 PM

Number: 7 Author: staff Subject: Inserted Text Date: 7/2/2010 1:16:16 PM
methodology for evaluating economic feasibility and/or cost effectiveness

use and provides criteria for when harvest and use would be economically infeasible, and the project meets the criteria described by this ~~study.~~ [1] [2]

- A [3] ~~RWQCB Executive Officer approved~~ watershed-based plan has identified a subregional or regional BMP opportunity and demonstrated that this opportunity meets the following criteria: [4]

    - The subregional/regional BMP is located such that the project would drain to the BMP prior to discharge to a Waters of the US, or the use of Waters of the US to convey water meets the requirements of this TGD (See Section 3.8), and

    - The subregional/regional BMP is sufficiently sized to ~~receive runoff from the project,~~ [5] and

    - The subregional/regional BMP is sited and designed such that it will provide greater overall benefit than would be achieved by harvest and use BMPs on-site, including combined considerations of pollutant loading, hydrologic loading, groundwater recharge, potable water demand, and SmartGrowth goals.

    - The subregional/regional BMP will be adequately maintained into perpetuity. [6]

6.2.1.7. Level 1 Evapotranspiration Suitability Screening

In general, ET would not be expected to cause a risk that would exclude its use from any project. [7]

6.2.1.8. Level 1 Evapotranspiration Effectiveness Screening

In some cases, evaporation BMPs may have unintended consequences such as decreasing the project density or resulting in greater dry season irrigation demand. [8] ~~ET-based BMPs may always be considered but should be selected with consideration for maintaining target project density.~~ [9] ~~Low water use landscaping requirements should be granted higher priority in BMP selection than promoting stormwater ET.~~

Green roofs, brown roofs, and blue roofs may be considered wherever they are consistent with applicable codes and ordinances; however, the use of these BMPs is presently considered above and beyond the MEP, therefore these BMPs are encouraged but not required to be considered in assessing feasibility. Green roofs, brown roofs, and blue roofs are considered to be beyond the MEP for technical, economical, and societal reasons:

1) The increased use of irrigation water and plant life requiring water is inapposite to the direction of state legislation (AB1881) mandating landscaping water efficiency. [10]

2) [11] Long term data regarding maintenance of a green roof, in a Mediterranean climate prone to high winds and fire hazard is not easily available.

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Number: 1 Author: staff Subject: Cross-Out Date: 7/2/2010 1:16:19 PM

Number: 2 Author: staff Subject: Inserted Text Date: 7/2/2010 1:16:28 PM
methodology

Number: 3 Author: staff Subject: Cross-Out Date: 7/2/2010 1:16:43 PM

Number: 4 Author: staff Subject: Inserted Text Date: 7/2/2010 1:17:23 PM
, approved by the appropriate RWQCB Executive Officer,

Number: 5 Author: staff Subject: Replacement Text Date: 7/2/2010 1:19:23 PM
treat storm water runoff from its tributary area

Number: 6 Author: staff Subject: Inserted Text Date: 7/2/2010 1:23:32 PM
and the subregional/regional BMP will be constructed and operational to serve the project once the project is complete.

Number: 7 Author: staff Subject: Inserted Text Date: 7/2/2010 1:25:37 PM
ET may be used in conjunction with other detention BMPs [i.e. to control flow to the evapotranspiration BMP] and the risk of those facilities should be evaluated separately.

Number: 8 Author: staff Subject: Cross-Out Date: 7/2/2010 1:29:06 PM
This is a determination that should be left to the discretion of the project proponent. However, it would be fair for a local jurisdiction to assert that ET should not cause a project to fall below some minimum zoning density or adversely affect the jurisdiction's ability to satisfy its housing needs allocation.

Number: 9 Author: staff Subject: Cross-Out Date: 7/2/2010 1:38:00 PM
This is not sufficiently precise. ET should not be used where it would increase the demand for irrigation with potable water. Whether or not ET should be allowed to increase the use of reclaimed water during the dry season is up for discussion. The policy considerations do not appear to have been fully considered.

Number: 10 Author: staff Subject: Highlight Date: 7/2/2010 2:20:01 PM
This argument is a double-edged sword. AB1881 mandates landscaping water efficiency, it does not prohibit landscaping. You are singling out rooftop landscaping for purposes of ET, from ground-level landscaping for traditional purposes, and applying AB1881 unevenly to the first. But the argument could also apply to all landscaping. If one were to object to this second application of the argument, you would have to accept that rooftop landscaping that provides traditional landscaping services is acceptable.

Number: 11 Author: staff Subject: Underline Date: 7/2/2010 2:29:19 PM
This statement suggests that since long-term local data is not easily available for maintenance, green roofs are not practicable. The suggestion is that such roofs pose a greater risk of fire or unspecified wind-hazard. No evidence is presented to support the suggestion or that the risks cannot be mitigated. The statement does not say that long-term data is not available at all. This argument brings up ideas that do not seem fully explored.

3) The practical limitations of requiring individual homeowners and small business owners to irrigate and maintain a green roof are untested.

4) The majority of current building codes and the fire code do not specifically address green roof construction, and it is unknown how this requirement may conflict with other building code provisions or upcoming mandatory solar requirements.

5) Studies of cost-benefit and cost-effectiveness of green roofs have often not considered costs of additional structural requirements, which may comprise a large portion of green roof costs.

6) Although green roofs have been encouraged in several locations across the country, there are no known locations in the US where implementation of greenroofs has been required in an implemented permit in order to meet the MEP standard.

Where green roofs, brown roofs and blue roofs are selected as an option, consideration should be given for overall water demands which may increase as a result of an increase in the amount of area potentially requiring irrigation during the dry periods. However, for a project with very high density, green roofs could provide almost complete treatment for the water quality design storm (sidewalks and minor surface areas would also need treatment) and, for some projects, could provide a cost-saving when other benefits (heating and cooling reductions, etc.) are factored in.

6.2.1.9. Level 1 Biotreatment Suitability Screening

In general, biotreatment would not be expected to cause a risk that would exclude its use from any project. However, Biotreatment BMPs shall be designed to prevent or limit incidental infiltration where incidental infiltration would trigger Level 1 Infiltration Suitability Screening criteria as described in Section 6.2.1.2.

6.2.1.10. Level 1 Biotreatment Effectiveness Screening

If the following condition is met, biotreatment BMPs may be used but are not required to be considered on-site:

- A RWQCB Executive Officer-approved watershed-based plan has identified a subregional or regional BMP opportunity and demonstrated that this opportunity meets the following criteria:
    - The subregional/regional BMP is located such that the project would drain to the BMP prior to discharge to a Waters of the US, or the use of Waters of the US to convey water meets the requirements of this TGD (See Section 3.8), and
    - The subregional/regional BMP is sufficiently sized to receive runoff from the project, and

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Number: 1 Author: staff Subject: Underline Date: 7/2/2010 2:22:12 PM

This argument has merit. It implies that some projects should not use green roofs, but not that all projects should be precluded from using green roofs.

Number: 2 Author: staff Subject: Underline Date: 7/2/2010 1:59:03 PM

Where applicable codes preclude green/brown/blue roofs, so be it. However, the majority condition should not preclude consideration for the whole of the County. This statement also contains inadequate argument based on speculative "unknown" conflicts. The roofs should be precluded where there are actual conflicts, not conflicts based on speculation.

Number: 3 Author: staff Subject: Underline Date: 7/2/2010 1:50:59 PM

The limitations of studies on past projects is irrelevant to studies for future projects.

Number: 4 Author: staff Subject: Underline Date: 7/2/2010 1:47:55 PM

This does not explain why the purpose of the green roof is relevant to how practicable it is.

Number: 5 Author: staff Subject: Underline Date: 7/2/2010 2:27:51 PM

This statement is contradictory to the earlier assertion the green roofs are "beyond the MEP". The MWQMP needs to either front-load the feasibility analysis for project proponents and identify project types where green roofs are known to be infeasible based on an objective analysis, or exclude overly generalized and speculative arguments and require project proponents to consider green roofs based on an established method.

Number: 6 Author: staff Subject: Underline Date: 7/2/2010 3:08:01 PM

Suggest that this be qualified. One typical constraint to biotreatment are geotechnical hazards to nearby structures.

Number: 7 Author: staff Subject: Underline Date: 7/2/2010 3:09:35 PM

If the intent is to say that Level 1 Infiltration Suitability Screening criteria must be used to evaluate whether or not incidental infiltration should be precluded, state so plainly.

Number: 8 Author: staff Subject: Sticky Note Date: 7/2/2010 3:12:41 PM

See comments on previous identical statements.

- The subregional/regional BMP is sited and designed such that it will provide greater overall benefit than would be achieved by biotreatment on-site, including combined considerations of pollutant loading, hydrologic loading, groundwater recharge, potable water demand, and SmartGrowth goals.

- The subregional/regional BMP will be adequately maintained into perpetuity.

6.2.2. LID BMP Prioritization Framework

A rigorous feasibility analysis must demonstrate that BMP(s) with the greatest potential to meet the performance criteria have been selected. A rigorous BMP prioritization methodology is described in this section. ~~This methodology is strongly encouraged; however equivalent prioritization methodologies may be used.~~ Prioritization ~~is encourage but not required if~~ the selected BMP(s) ~~meets the performance criteria; it is only required if the Project WQMP seeks to establish infeasibility of fully meeting the performance criteria on-site.~~

6.2.2.1. Results of Level 1 Feasibility Screening

~~For prioritization purposes, potential LID BMPs should be divided into the following categories based on the results of Level 1 Feasibility Screening (Section 6.2.1).~~

- LID BMPs that shall be considered further,
- LID BMPs that may be considered further, but are not mandatory to be considered as stand-alone LID or in combination with other BMPs, and
- LID BMPs that shall not be considered further.

6.2.2.2. LID BMP Opportunities

LID BMP Fact Sheets presented in Sections 6.5 through 6.9 include opportunity criteria for each BMP which are expressed as characteristics of the drainage area that influence the opportunities for implementation of a specific LID BMP type. For example, a high density drainage area with gently sloping low-traffic roadways and minimal landscaping would present a high opportunity for use of porous pavement but potentially a low opportunity for bioretention. For each LID BMP that "shall" or "may" be considered further based on the results of Level 1 Feasibility Screening, the opportunity for implementation ~~should~~ evaluated for each drainage area and documented in Worksheet C.

Opportunity rankings ~~should~~ determined based on the following guidance:

X = No Opportunity. The characteristics of proposed development in the drainage area preclude the use of the LID BMP type. For example, if no landscaping exists, there is not an opportunity to use harvested water for irrigation of landscaped area. If the entire lot is underlain by subsurface parking, then there is no opportunity for surface infiltration

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Number: 1 Author: staff Subject: Sticky Note Date: 7/12/2010 12:37:29 PM
It would be helpful to instruct the reader that the methodology is designed to be general enough to be applicable to all projects. Substantial conformance to the methodology is required unless deviations are required by the particular circumstances of the project.

Number: 2 Author: staff Subject: Cross-Out Date: 7/2/2010 3:14:05 PM
All methodologies that will be used must be described.

Number: 3 Author: staff Subject: Replacement Text Date: 7/6/2010 8:09:54 AM
Substantial conformance with this methodology is required unless deviations are necessitated by the particular circumstances of a project.

Number: 4 Author: staff Subject: Replacement Text Date: 7/6/2010 8:03:35 AM
is mandatory unless

Number: 5 Author: staff Subject: Cross-Out Date: 7/6/2010 8:12:11 AM
Be more specific. If LID BMPs are able to treat the full design capture volume on site, the prioritization methodology does not need to be completed. If not, the methodology must be followed until BMPs have been identified to treat the full design capture volume on-site, off-site, or a combination thereof.

Number: 6 Author: staff Subject: Replacement Text Date: 7/12/2010 12:38:36 PM
The results of the Level 1 Feasibility Screening from Section 6.2.1. allow the preparer to classify LID BMPs into the following categories

Number: 7 Author: staff Subject: Cross-Out Date: 7/12/2010 12:38:39 PM

Number: 8 Author: staff Subject: Underline Date: 7/2/2010 3:25:39 PM
It is not clear what this means. Explain further or restate.

Number: 9 Author: staff Subject: Inserted Text Date: 7/12/2010 12:39:07 PM
are infeasible and that

Number: 10 Author: staff Subject: Underline Date: 7/12/2010 12:39:25 PM
If this is the definition of "opportunity criteria" it is important and deserves its own sentence.

Number: 11 Author: staff Subject: Replacement Text Date: 7/2/2010 3:40:55 PM
must

Number: 12 Author: staff Subject: Highlight Date: 7/2/2010 3:39:44 PM
Not found.

Number: 13 Author: staff Subject: Highlight Date: 7/2/2010 3:39:32 PM

Number: 14 Author: staff Subject: Replacement Text Date: 7/2/2010 3:55:07 PM
must

Number: 15 Author: staff Subject: Sticky Note Date: 7/2/2010 4:01:32 PM
These are descriptions of rankings, not a set of guidance. If the preparer is to use the "opportunity criteria" to evaluate opportunities for specific BMPs, state so plainly.

BMPs. If there are no lower vehicle weight paved areas in the drainage area, then there is no opportunity for porous pavement.

L = Low Opportunity. Limited opportunities appear to exist for the type of BMP, and significant design considerations may be required. The characteristics of the drainage area do not align with the opportunity criteria listed in the LID BMP fact sheet.

M = Moderate Opportunity. Opportunities appear to exist for the type of LID BMP, however some specific design considerations may be required. The characteristics of the drainage area align with at least one of the opportunity criteria listed in the LID BMP fact sheet.

H = High Opportunity. Opportunities appear to exist for the type of LID BMP without any specific design considerations. The characteristics of the drainage area align with more than one of the opportunity criteria listed in the LID BMP fact sheet.

An example LID BMP prioritization worksheet is provided for an example drainage area in **Table 6.5**.

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Number: 1 Author: staff Subject: Underline Date: 7/6/2010 8:13:18 AM

Explain the purpose of assigning a Priority Level with the worksheet. Explain the importance of this step.

Table 6.5: Example LID BMP Prioritization Worksheet (Worksheet C)			
Drainage area ID (s): *Heritage Plaza, drainage area 1-A*			
Description of drainage area (s): *Surface parking lot with restaurant; 90% impervious*			
OK to combine drainage areas with same Level 1 Feasibility Screening Results and Similar Opportunities			
Assessment	Level 1 Feasibility Screening Results	Opportunity for drainage area	Priority Level
Key to Ranking	✓ Shall ○ May x Shall Not	X = No Opportunity H, M, L = Level of Suitability	☑ + H = Priority 1 ☑ + M = Priority 2 ☑ + L = Priority 3 ○ + H,M,L = Priority 3
Hydrologic Source Controls			
Localized on-lot infiltration	○	L	3
Impervious area dispersion	○	M	3
Street trees /Canopy Cover	○	M	3
Residential rain barrels not actively managed	○	L	3
Infiltration BMPs			
Bioretention without Underdrains/ Rain Garden	☑	M	2
Infiltration Basin	☑	H	1
Infiltration Trench/French Drain	☑	H	1
Dry Well	☑	H	1
Underground Infiltration	☑	H	1
Permeable Pavement	☑	H	1
Harvest and Use BMPs			
Harvest and Use for Landscape Demand	○	L	3
Harvest and Use for Indoor Demand	x	x	X
Harvest and Use for Mixed Demand	x	x	X

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Number: 1 Author: staff Subject: Highlight Date: 7/2/2010 3:42:43 PM

If this information is expected then a separate form input needs to be present.

Number: 2 Author: staff Subject: Sticky Note Date: 7/6/2010 8:43:28 AM

The user needs to be reminded where to get these Results from.

Table 6.5: Example LID BMP Prioritization Worksheet (Worksheet C)			
Drainage area ID (s): *Heritage Plaza, drainage area 1-A*			
Description of drainage area (s): *Surface parking lot with restaurant; 90% impervious*			
OK to combine drainage areas with same Level 1 Feasibility Screening Results and Similar Opportunities			
Assessment	Level 1 Feasibility Screening Results	Opportunity for drainage area	Priority Level
Key to Ranking	✓ Shall ○ May x Shall Not	X = No Opportunity H, M, L = Level of Suitability	☑ + H = Priority 1 ☑ + M = Priority 2 ☑ + L = Priority 3 ○ + H,M,L = Priority 3
Harvest and Use for Other Demand	○	x	X
Biotreatment BMPs			
Bioretention with underdrains	☑	M	2
Vegetated Swales	☑	M	2
Vegetated Filter Strips	☑	L	3
Constructed Wetlands	☑	L	3
Proprietary Biotreatment	☑	H	1

6.3. Level 2 Feasibility Screening Criteria

This section provides Level 2 Feasibility Screening Criteria which are applied to demonstrate that the system has been designed to retain, and if necessary biotreat, stormwater to the MEP.

In the event that HSCs plus the retention BMPs cannot ~~meet the computed sizing criteria,~~ Level 2 Feasibility Screening is required to document that all options have been evaluated and that selected BMPs have been implemented to the MEP.

Section 3.7 describes the process for ~~designing a system to the MEP~~ when it is infeasible to retain ~~stormwater on-site to meet full requirements.~~ The following subsections provide criteria to support this process.

6.3.1. Criteria to Determine Maximized Retention Volume

Retention volume can be said to be "maximized" when all of the following conditions have been met:

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Number: 1 Author: staff Subject: Underline Date: 7/2/2010 3:51:57 PM

Explain how Level 2 Feasibility Screening Criteria relates to Level 1.

Number: 2 Author: staff Subject: Replacement Text Date: 7/6/2010 8:15:47 AM

contain the full design capture volume or the increased runoff from the 2-year, 24-hour storm event, whichever is greater,

Number: 3 Author: staff Subject: Underline Date: 7/6/2010 8:20:29 AM

Explain what is meant by this directly. If it is intended to state that Level 2 Screening documents that all LID BMPs have been evaluated and that, of those selected, the LID BMPs have been sized to treat as much of the treatment volume on site as possible, state so.

Number: 4 Author: staff Subject: Replacement Text Date: 7/6/2010 8:26:28 AM

documenting that the maximum storm water volume has been retained on site

Number: 5 Author: staff Subject: Replacement Text Date: 7/6/2010 8:26:55 AM

the full storm water treatment volume.

Number: 6 Author: staff Subject: Highlight Date: 7/6/2010 9:28:04 AM

Explain what the concept of "maximized retention volume" is.

For Infiltration BMPs:

- HSCs have been selected wherever opportunities exist (See Section 6.3.3 for criteria), and
- High priority infiltration BMPs have been provided (See Section 6.3.4 for criteria).
- Site design allowances for infiltration BMPs meet minimum criteria (See Section 6.3.6 for criteria) , and
- Using the infiltration area that meets the minimum site design criteria, BMP retention depth has been selected such that:
    - Storage volume provided in HSCs plus retention BMP(s) ≥ the design capture volume, or
    - Retention BMP depth is at least the depth that would draw down in 48 hours based on the design infiltration rate. (For example: if the design infiltration rate is 0.25 inches per hour, a the maximum retention depth that would be required is 12 inches)
- If at any time in this process, the design capture volume can be ~~provided~~ and drawn down in less than or equal to 48 hours, or capture efficiency is otherwise demonstrated to be 80 percent, the system meets ~~performance criteria.~~

For Harvest and Use BMPs:

- HSCs have been selected wherever opportunities exist (See Section 6.3.3 for criteria), and
- High priority harvest and use BMPs have been provided (See Section 6.3.4 for criteria).
- ~~Storage~~ provided in HSCs and harvest and use BMP(s) ≥ design capture volume, and
- Retention volume drawdown rate has been maximized given allowable BMP options and site constraints (See Section 6.3.5 for criteria).
- If at any time in this process, the design capture volume can be ~~provided~~ and drawn down in less than or equal to 48 hours, or capture efficiency is otherwise demonstrated to be 80 percent, the system meets ~~performance criteria.~~

For ET BMPs:

- ~~Level 2 feasibility screening does not apply to green roofs because they are not required to be considered to demonstrate retention volume is maximized on-site.~~

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Number: 1 Author: staff Subject: Underline Date: 7/6/2010 8:46:07 AM
The criteria are not in this Section. They are in Section 6.2.2. and elsewhere. Provide an appropriate citation.

Number: 2 Author: staff Subject: Underline Date: 7/6/2010 8:32:05 AM
The criteria are not in this Section. They are in Section 6.2.2 and are determined by completing Worksheet C. Provide a direct reference to how the priorities are determined.

Number: 3 Author: staff Subject: Underline Date: 7/6/2010 8:52:06 AM
The meaning of this is unclear. If it is intended to say that the 'combined storage volume provided by HSCs and retention BMPs equals or exceeds the design capture volume' then state so plainly.

Number: 4 Author: staff Subject: Cross-Out Date: 7/6/2010 8:54:53 AM
This use may be appropriate in less formal writing, such as text messages, but mathematical functions should be used in formulas, not in narrative portions of publications.

Number: 5 Author: staff Subject: Underline Date: 8/9/2010 8:02:22 AM
This statement is contradicted by "the maximum". In order to be consistent, the retention depth SHOULD NOT EXCEED the depth of water that would draw down in 96 hours.

Number: 6 Author: staff Subject: Underline Date: 7/6/2010 8:55:42 AM

Number: 7 Author: staff Subject: Replacement Text Date: 7/6/2010 9:13:12 AM
retained [onsite?]

Number: 8 Author: staff Subject: Underline Date: 7/6/2010 8:59:37 AM
Provide a complete reference to explain what is meant by this.

Number: 9 Author: staff Subject: Cross-Out Date: 7/12/2010 12:41:03 PM
"Performance criteria" connotes a broader set of criteria than what should be intended. It is possible for a site to meet criteria for capturing the specified storm water volume but not meet BMP-specific performance criteria. If intended to indicate that the system does not need to be sized to treat any additional storm water volume, state so directly.

Number: 10 Author: staff Subject: Underline Date: 7/6/2010 9:00:34 AM
Criteria is not found in this Section. It is found in Section 6.2.2 and elsewhere.

Number: 11 Author: staff Subject: Replacement Text Date: 7/6/2010 9:01:07 AM
The combined storage volume

Number: 12 Author: staff Subject: Replacement Text Date: 7/6/2010 9:01:21 AM
equal or exceed the

Number: 13 Author: staff Subject: Replacement Text Date: 7/6/2010 9:20:07 AM
retained [on site?]

Number: 14 Author: staff Subject: Underline Date: 7/6/2010 9:02:50 AM
Provide a complete reference to explain what this means.

Number: 15 Author: staff Subject: Cross-Out Date: 7/6/2010 9:19:48 AM
See comment above.

Number: 16 Author: staff Subject: Cross-Out Date: 7/6/2010 9:07:05 AM
A screening tool and methodology should be provided for those proponents who wish to consider green roofs. By not providing a process for reviewers and proponents for evaluating this BMP, you are discouraging its use.

6.3.2. Criteria to Determine Maximized Retention plus Biotreatment Volume

Retention plus biotreatment volume can be said to be "maximized" when all of the following conditions have been met:

- Hydrologic source controls have been selected wherever opportunities exist (See Section 6.3.3 for criteria), and
- The system achieves 80 percent capture of runoff when considering both retention and biotreatment, and
- At least half of the maximized retention volume (See Section 6.3.1) is retained.

If the system does not achieve 80 percent capture of runoff when considering both retention and biotreatment, the following criteria shall be met to determine that retention plus biotreatment have been "maximized" on-site:

- Hydrologic source controls have been selected wherever opportunities exist (See Section 6.3.3 for criteria), and
- Area provided for infiltration plus biotreatment meets minimum criteria (See Section 6.3.6 for criteria), and
- Using the area provided above, BMPs have been selected and configured such that:
  - At least half of the maximized retention volume (See Section 6.3.1) is retained, and
  - At least the other half the maximized retention volume (See Section 6.3.1) is biotreated.

6.3.3. Minimum Criteria for Selection of HSCs

In order to demonstrate that stormwater has been retained on-site to MEP, a combination of HSCs must be selected for each drainage area that provides the maximum volume reduction given the constraints of the drainage area.

All HSCs categorized as Priority 1 or 2 (Section 6.2.2) (or equivalent prioritization method) should be considered and provided consistent with the opportunities in the drainage area. Where two different HSC types are suitable to be provided in the same footprint but they are mutually exclusive (i.e., one or the other, but not both, can be selected), the HSC that achieves the greater volume reduction should be selected. The Project WQMP should provide, for each HSC that was not used, a narrative discussion of why the HSC type was not used. Rationales may include:

- HSC is not categorized as Priority 1 or 2.
- Site conditions/constraints prohibit the use of the HSC (proponent must provide details).

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Number: 1 Author: staff Subject: Underline Date: 7/6/2010 9:08:25 AM

Explain more fully what this means.

Number: 2 Author: staff Subject: Underline Date: 7/12/2010 12:41:44 PM

This appears to be an error.

Number: 3 Author: staff Subject: Underline Date: 7/6/2010 9:37:38 AM

This appears to be an error. By definition, all of the "maximized retention volume" must be retained.

Number: 4 Author: staff Subject: Underline Date: 7/6/2010 9:39:26 AM

This also appears to be an error in the use of the term "maximized retention volume". It would be helpful if a definition of this term was provided.

Number: 5 Author: staff Subject: Underline Date: 7/6/2010 9:46:44 AM

This is not necessarily true. If all sub-areas drain to the same water body with HCOC's, then only the total increased runoff from the site matters. This means that a reduction in the runoff from one sub-area can be used to off-set the increase in runoff from another sub-area. However, this approach cannot be applied to the removal of pollutants. This Section needs a discussion of the different acceptable strategies for dealing with HCOC's and how those differ from pollutant removal.

- Another HSC type achieves greater volume reduction in the same footprint and the HSCs are mutually exclusive.
- A retention BMP can be used in the same footprint to achieve greater volume reduction than an HSC.

~~Projects that meet LID performance criteria (as documented by the Project WQMP) are not required to demonstrate that they meet minimum criteria for selection of HSCs. Minimum criteria for selection of HSCs are only required to be met if the Project WQMP seeks to demonstrate that the full LID performance criteria cannot be feasibly met on-site and wishes to consider alternative programs.~~

6.3.4. Minimum Criteria for Selection of LID BMPs

In order to demonstrate that stormwater has been retained on-site to MEP, LID BMP(s) must be selected for each drainage area that provides the maximum volume reduction given the constraints of the drainage area.

All LID BMPs categorized as Priority 1 or 2 (Section 6.2.2) ~~(or equivalent prioritization method)~~ should be considered. The Project WQMP shall include a narrative discussion of why the selected BMP achieves higher performance than all other BMPs given site constraints.

~~Projects that meet LID performance criteria (as documented by the Project WQMP) are not required to demonstrate that they have conducted a rigorous BMP prioritization process. Criteria for BMP selection are only required to be met if the Project WQMP seeks to demonstrate that the full LID performance criteria cannot be feasibly met on-site and wishes to consider alternative programs.~~

6.3.5. Criteria for Maximizing Drawdown Rate

In order to demonstrate that ~~stormwater~~ has been retained, or retained plus biotreated, on-site to MEP, BMPs must be designed to draw down stored volume via infiltration, evapotranspiration, or harvested use at the maximum possible rate.

For infiltration BMPs, drawdown rate can be said to be maximized when the following conditions are met and documented in a narrative discussion and/or exhibits as part of the Project WQMP.

- BMPs have been designed with the shallowest possible depth, given site constraints. If more area could be dedicated to BMPs, then the depth has not been minimized and/or the volume has not been maximized.
- Infiltration rates have been sufficiently investigated and sufficient pretreatment is provided such that the recommended infiltration rate factor of safety is no greater than 2.5. See Appendix IV for guidance on calculating the recommended infiltration rate factor of safety. Additional investigation and provision of robust pre-treatment could allow a lower factor of safety to be used. Sufficient investigation and pretreatment

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Number: 1 Author: staff Subject: Sticky Note Date: 7/6/2010 9:56:55 AM

A discussion is needed to guide the preparer in the event of a conflict between the need for a LID BMP, with a smaller volume, for pollutant removal versus a larger HSC where, for a given drainage area, they are mutually exclusive. Pollutant removal should be given priority because the LID could be increased in size or any unmet retention volume can be off-set by increasing the size of an HSC in another drainage area. Essentially, the designer has more flexibility in addressing HCOC's across drainage areas as opposed to the design capture volume which must be addressed within each drainage area separately.

Number: 2 Author: staff Subject: Cross-Out Date: 7/6/2010 10:01:00 AM

This language appears to conflict with the Permit requirements. It needs to be substituted with clear language that does not conflict with the Permit or it needs to be deleted.

Number: 3 Author: staff Subject: Underline Date: 7/6/2010 10:17:13 AM

The context of this term has changed. Restate this in plain language to assure that its meaning has not also changed with the context.

Number: 4 Author: staff Subject: Cross-Out Date: 7/6/2010 10:19:10 AM

Number: 5 Author: staff Subject: Cross-Out Date: 7/6/2010 10:23:53 AM

This statement is repeated elsewhere and should be understood by this time.

Number: 6 Author: staff Subject: Replacement Text Date: 7/6/2010 10:26:12 AM

the design capture volume

Number: 7 Author: staff Subject: Underline Date: 7/6/2010 10:31:25 AM

Provide examples of uses of the captured volume in order to draw down.

Number: 8 Author: staff Subject: Underline Date: 6/28/2010 10:42:38 AM

Need to define what constitutes "sufficiently investigated".

should be provided so that the infiltration factor of safety can be reduced to near the minimum recommended value (2.0).

For harvest and use BMPs, drawdown rate can be said to be maximized when all potential demands for harvested water have been considered and any suitable demand that could be met with harvested water has been designated as such. Rationale for excluding a demand shall be documented in a narrative discussion. Rationales for excluding a demand may include:

- Use of harvested water conflicts with codes or ordinances in place at the time of Project WQMP submittal,
- ~~Reclaimed water is designated for use on the Project,~~
- ~~The system components required to facilitate use of harvested water are not economically feasible (supporting documentation shall be provided), or~~
- The demand cannot be reliably ensured by the Project proponent or would potentially not exist in the event of change of uses or ownership.

~~LT-based BMPs are not required to be considered to demonstrate consistency with MEP, therefore are not addressed in this section.~~

These criteria do not apply to biotreatment BMPs (if used). The drawdown rate of biotreatment BMPs is critical to treatment function and should not be increased outside of accepted design guidance in order to improve capture efficiency.

~~Projects that meet LID performance criteria (as documented in the Project WQMP) are not required to demonstrate that they meet criteria for maximizing drawdown rate. Criteria for maximizing drawdown rate are only required to be met if the Project WQMP seeks to demonstrate that the full LID performance criteria cannot be feasibly met on-site and wishes to consider alternative programs.~~

6.3.6. Criteria for Site Design to Allow LID BMPs

In order to demonstrate that stormwater has been retained, or, if necessary, retained plus biotreated, on-site to MEP, minimum criteria for site design must be met.

The site design of a Priority Project is considered to meet minimum criteria for allowing LID BMPs when the following conditions are met:

- At least the recommended portion of the site specified in Table 6.6 (or specified in an analogous table developed by local jurisdictions) is provided in the site plans for surface plus subsurface BMPs, and
- The site is configured such that runoff can be routed to ~~fully utilize the available area(s),~~ and

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Number: 1 Author: staff Subject: Underline Date: 6/14/2010 3:41:13 PM

include a list of potential water demands that need to be considered and a corresponding list of factors that create upper-limits on that demand (i.e. irrigation and water tolerance of the plant pallette). Include water demand tables for ease of reference for each potential demand.

Number: 2 Author: staff Subject: Sticky Note Date: 6/28/2010 10:49:33 AM

The criteria in this section is so specific to particular BMPs, it should placed with those BMPs.

Number: 3 Author: staff Subject: Cross-Out Date: 6/28/2010 10:45:39 AM

You have not provided evidence that the use of storm water precludes the use of reclaimed water.

Number: 4 Author: staff Subject: Cross-Out Date: 7/7/2010 2:46:33 PM

Economic feasibility should be discussed elsewhere, including a description of the methods to analyze it.

Number: 5 Author: staff Subject: Underline Date: 7/7/2010 2:47:26 PM

Provide examples of such situations. Describe methods that will be used for evaluating demand.

Number: 6 Author: staff Subject: Cross-Out Date: 7/7/2010 2:48:35 PM

The practical significance and meaning of this statement is not evident. The statement needs to be reworded to be more direct.

Number: 7 Author: staff Subject: Cross-Out Date: 7/7/2010 2:49:24 PM

LID performance criteria is made up of criteria in the Permit and criteria developed by the permittees. The intent behind this paragraph is not clear because its not clear what the full suite of unmet LID performance criteria is.

Number: 8 Author: staff Subject: Underline Date: 7/6/2010 10:50:46 AM

There needs to be an explanation describing the circumstances where an analogous table is desirable and how that table would be developed and approved by the Executive Officer for use. If no alternative table is developed Table 6.6 should be the default.

Number: 9 Author: staff Subject: Cross-Out Date: 7/6/2010 10:51:44 AM

This could be interpreted is several ways. Explain directly what is meant by this phrase.

- The site is laid out such that infiltration BMPs (if required to be considered) are located over infiltrative soils as practicable given the constraints of the site, and
- Satisfaction of these criteria has been documented in exhibits or narrative descriptions.

OR

- The site cannot be designed to allow more area for BMPs as documented by a site-specific study. The study may consider:
    - Site conditions/constraints (e.g., depth to groundwater, topography, existing utilities)
    - Zoning/code requirements (e.g., target density, accessibility, traffic circulation, health and safety, setbacks, etc.)
    - Economic feasibility

Table 6.6 provides the recommended maximum percentage of a project site that is required to be made available for infiltration in order to demonstrate that retention has been maximized on the project site. The project may provide more area. These values constitute recommendations and may be revised by adopting jurisdictions upon further analysis. Projects that ~~meet LID performance criteria~~ (as documented by the Project WQMP) are not required to demonstrate that they meet criteria for site design. Criteria for site design are only required to be met if the Project WQMP seeks to demonstrate that the full LID performance criteria cannot be feasibly met on-site and seeks to consider alternative programs.

Table 6.6
Recommended Minimum Criteria for Site Design

Project Type		Maximum effective area[1] required to be made available for LID BMPs (surface + subsurface facilities) to meet site design criteria[2] (percent of site)
New Development	SF/MF Residential < 7 du/ac	10
	SF/MF Residential 7 – 18 du/ac	7
	SF/MF Residential > 18 du/ac	5
	Mixed Use, Commercial, Institutional/Industrial w/ FAR < 1.0	10
	Mixed Use, Commercial, Institutional/Industrial w/ FAR 1.0 – 2.0	7
	Mixed Use, Commercial, Institutional/Industrial w/ FAR > 2.0	5
	Podium (parking under > 75% of project)	3
	Projects with zoning allowing development to lot lines	2
	Transit Oriented Development[3]	5
	Parking	5

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Number: 1 Author: staff Subject: Underline Date: 7/6/2010 10:57:36 AM

Explain why this is characterized as a "maximum" instead of a "minimum".

Number: 2 Author: staff Subject: Underline Date: 8/9/2010 8:03:02 AM

This goal is vague, so that it's unclear what is meant by this phrase. If the table is intended to indicate the minimum amount of project area needed to infiltrate the design capture volume within 48 hours, state so plainly. It seems that a site could have less area available but still be considered to have "maximized" retention if all available area has been used.

Number: 3 Author: staff Subject: Replacement Text Date: 7/6/2010 11:02:25 AM

employ LID BMPs to retain the full design capture volume

Number: 4 Author: staff Subject: Underline Date: 7/6/2010 11:11:53 AM

This statement suggests that Table 6.6 serves some purpose in the process, but that purpose is not clear. For example, if a SF residential project has 12% of its area available for LID BMPs, but the proponent want to pursue off-site LID BMPs or biotreatment, will the Table be used to deny that request? Alternately, will the table be used to evaluate and modify zoning standards to require that specific percentages of area be made available to accomodate LID BMPs?

Table 6.6 Recommended Minimum Criteria for Site Design		
Project Type		Maximum effective area[1] required to be made available for LID BMPs (surface + subsurface facilities) to meet site design criteria[2] (percent of site)
Redevelopment	SF/MF Residential < 7 du/ac	5
	SF/MF Residential 7 – 18 du/ac	4
	SF/MF Residential > 18 du/ac	3
	Mixed Use, Commercial, Institutional/Industrial w/ FAR < 1.0	5
	Mixed Use, Commercial, Institutional/Industrial w/ FAR 1.0 – 2.0	4
	Mixed Use, Commercial, Institutional/Industrial w/ FAR > 2.0	3
	Podium (parking under > 75% of project)	2
	Projects with zoning allowing development to lot lines	1
	Transit Oriented Development[3]	3
	Projects in Historic Districts	3

[1] "Effective area" is defined as area which 1) is suitable for a BMP (for example, if an infiltration BMP must be considered, infiltration must be allowed over this area) and 2) receives ~~impervious area runoff (i.e., is downgradient of impervious area)~~; 1

[2]Criteria for site design are only required to be met if the Project WQMP seeks to demonstrate that the full 2 ~~LID performance criteria~~ cannot be feasibly met on-site and wishes to consider alternative programs.

[3] Transit oriented development is defined as a development with development center within one half mile of a mass transit center.

Key: du/ac = dwelling units per acre, FAR = Floor Area Ratio = ratio of gross floor area of building to gross lot area
MF = Multi Family, SF = Single Family

6.4. Calculating LID Design Criteria

3 ~~The following subsections are intended to be employed as guided by **Table 3.4**. They are not intended to be stand-alone protocol for designing stormwater management systems, and in fact, they may make little sense to the user who attempts to use them as stand-alone sections.~~

6.4.1. Exhibits Used for Design Criteria Calculations

This section contains exhibits that are used throughout the design criteria calculations.

Figure 6.2 depicts the Design Capture Storm Depth[8] for Orange County. A higher resolution version of this figure is provided in Appendix I.

Figure 6.3 presents a relationship between unit storage volume, drawdown time (assuming constant drawdown rate regardless of season), and capture efficiency. The relationships are

[8] The Design Capture Storm Depth is calculated as the 85th percentile, 24 hour precipitation depth, determined from historic precipitation records, excluding days with less than or equal to 0.1 inches of precipitation.

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Number: 1 Author: staff Subject: Replacement Text Date: 7/6/2010 10:56:22 AM

runoff from impervious areas.

Number: 2 Author: staff Subject: Cross-Out Date: 7/6/2010 10:54:45 AM

If this is intended to refer to the design capture volume, state so plainly.

Number: 3 Author: staff Subject: Cross-Out Date: 7/6/2010 11:26:16 AM

The meaning of these statements is unclear. If the subsections provide detailed instructions for the sizing methods described in Table 3.4, state so plainly. Provide clear instruction to the reader as to how the information in the subsections is to be used.

developed based on continuous simulation of hourly precipitation data and can be used in a variety of ways for design calculations as described in the following sections.

Figure 6.4 presents a relationship between unit storage volume, unit demand (assuming drawdown rate varies with evapotranspiration rate), and capture efficiency. The relationships are developed based on continuous simulation of hourly precipitation data and daily ET data and can be used in a variety of ways for design calculations of harvest and use systems as described in the following sections. The effective irrigation area ratio of the system (*IR*) is calculated as follows:

$$IR = IA \times Kc/[IE \times \text{Tributary Impervious Area}]$$

Where:

IR = effective irrigated area ratio (ac/ac)

IA = area irrigated with harvested water, ac

Kc = Crop coefficient = ratio of actual evapotranspiration rate to reference evapotranspiration (ETo) when water is present. Account for low water use landscaping requirement when selecting this value.

IE = irrigation efficiency = depth of agronomic demand applied for each unit depth of irrigation supplied. Default is 0.75 inches/inch.

Figure 6.5 presents a relationship between design intensity, catchment time of concentration, and capture efficiency for off-line, flow-based BMPs. The relationships are developed based on analysis of hourly and 5-minute precipitation data and can be used in a variety of ways for design calculations as described in the following sections.

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Number: 1 Author: staff Subject: Sticky Note Date: 7/7/2010 2:56:30 PM

If this relationship holds only for Orange County, state so. If the relationship assumes that ET is the only demand, state so. Explain what ET rates were used from what months (e.g. actual daily ET or derivatives of average annual, average seasonal, monthly, etc.).

Figure 6.2
Design Capture Storm Depth for Orange County (85th percentile, 24 hour Isopluvials)
Click Here for Higher Resolution Figure

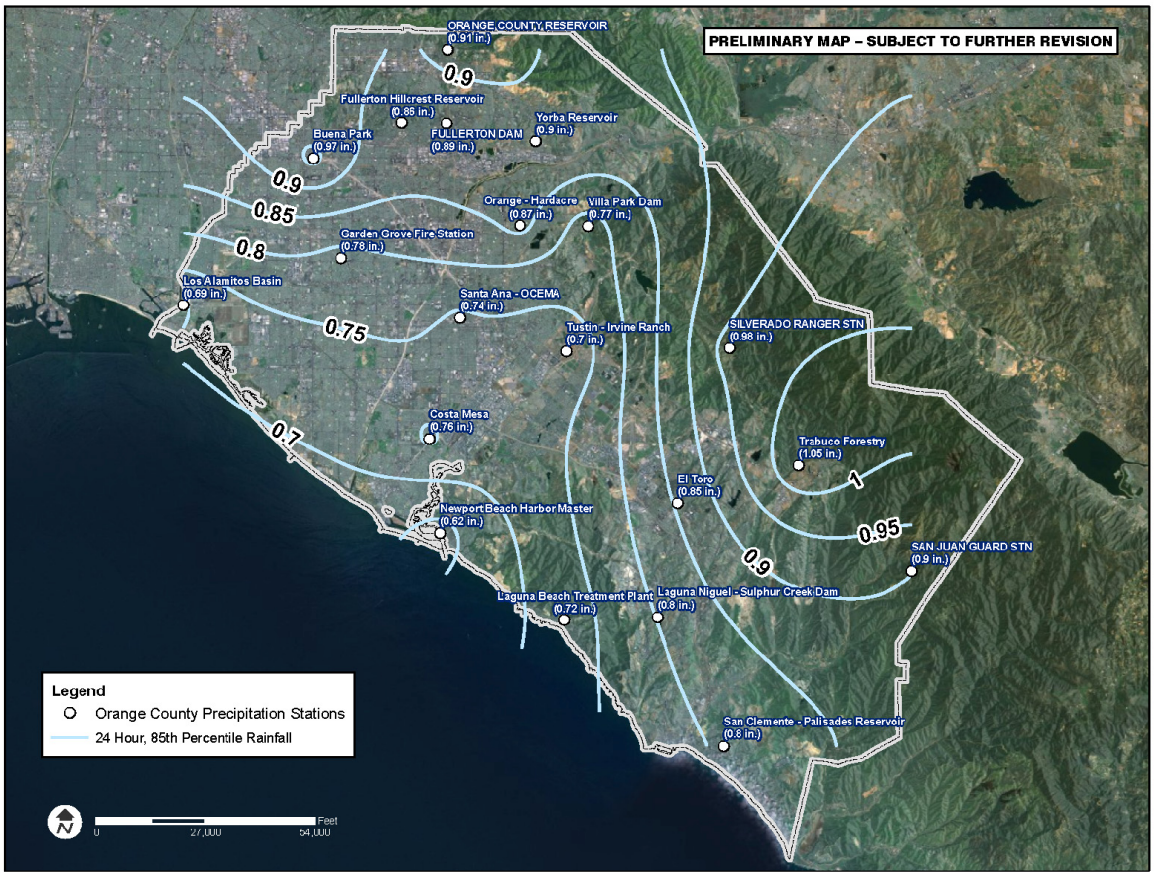

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Figure 6.3
Capture Efficiency Nomograph for Constant Drawdown Systems in Orange County

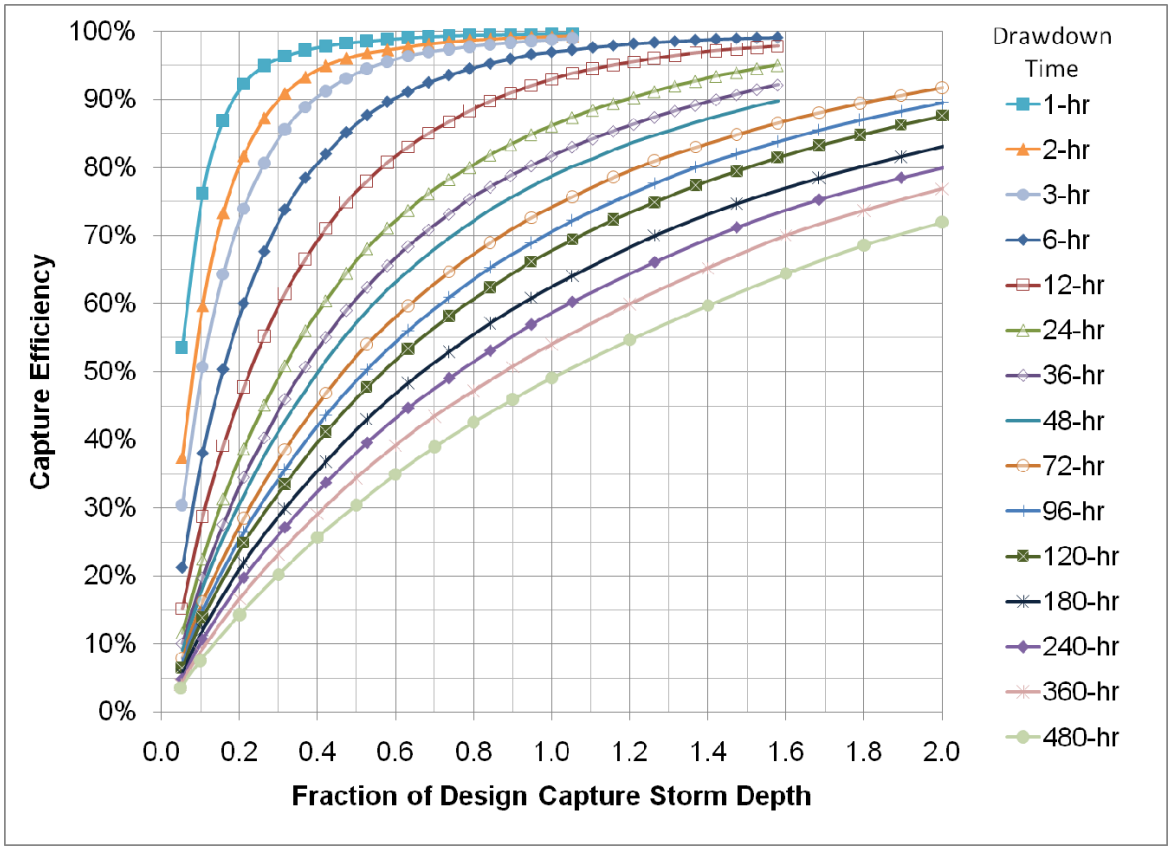

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Figure 6.4
Capture Efficiency Nomograph for Harvest and Use Systems with Irrigation Demand in Orange County

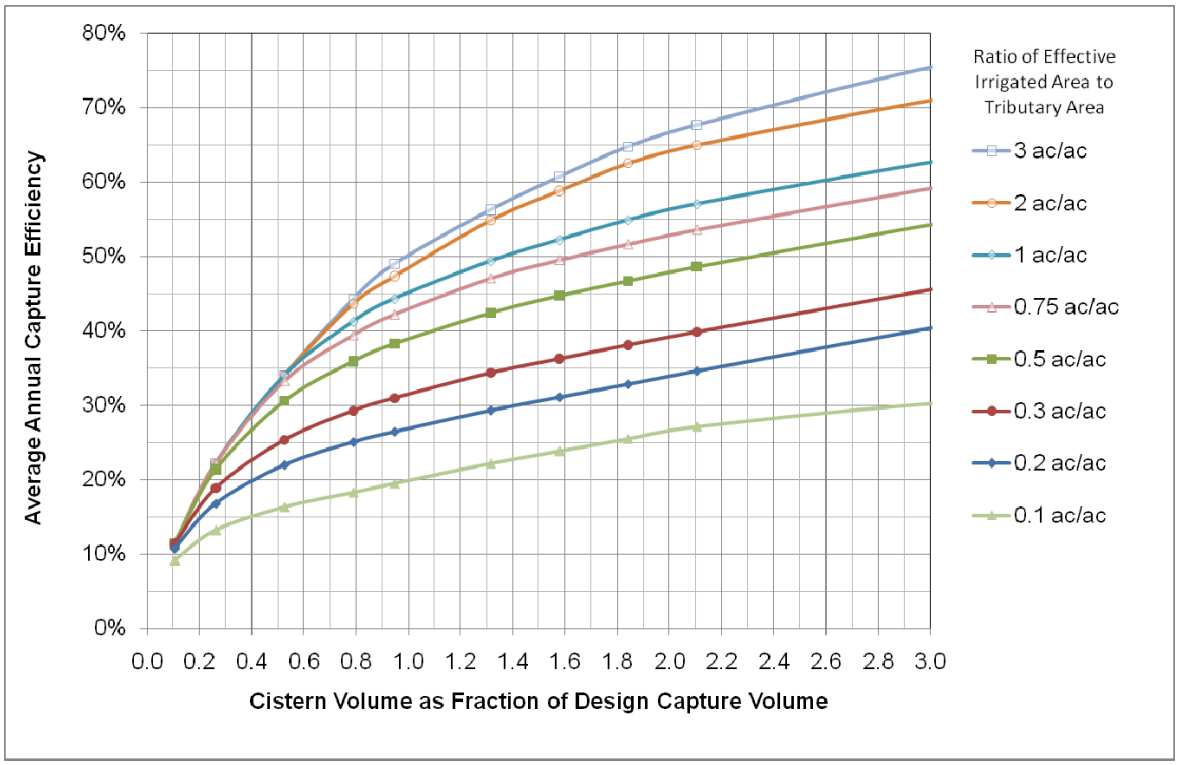

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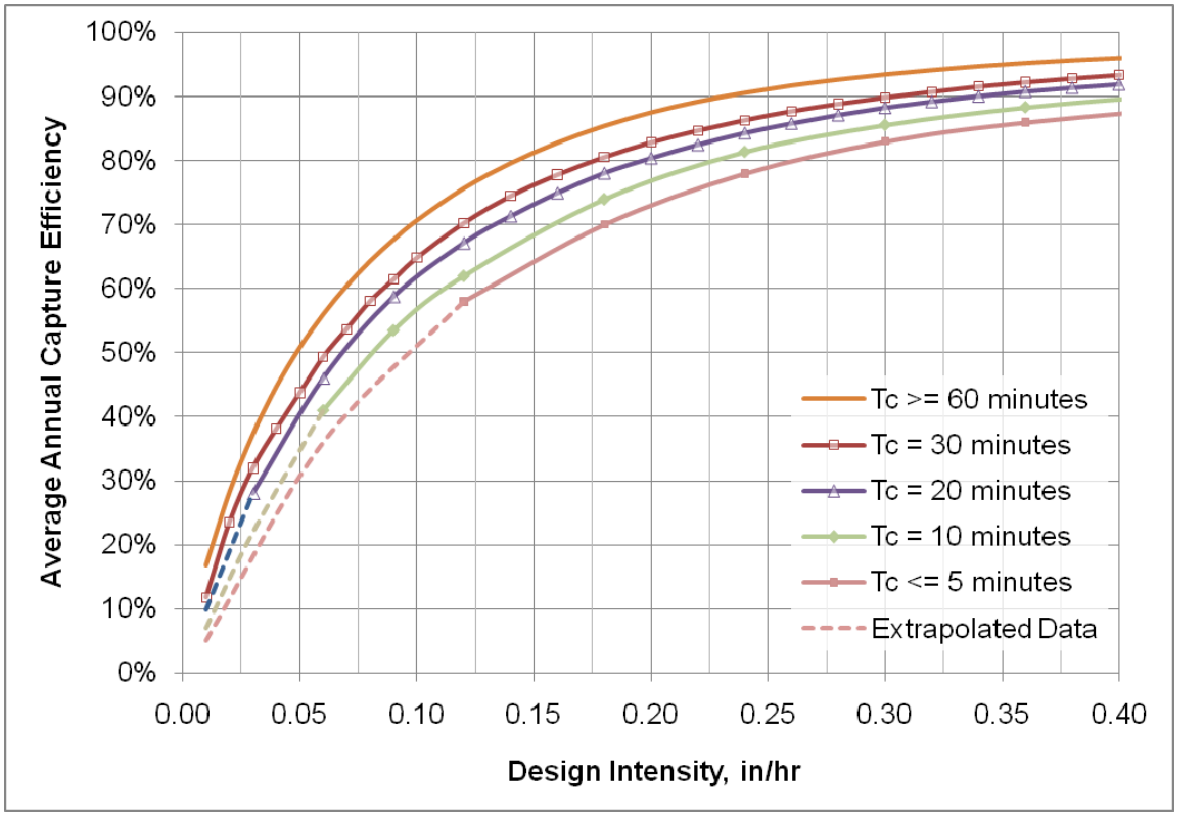
Figure 6.5
Capture Efficiency Nomograph for Off-line Flow-based Systems in Orange County



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6.4.2. Methods of Calculating Design Criteria

6.4.2.1. Simple Sizing Method

This section describes the simplest method of calculating design criteria. It may result in BMPs that achieve greater than the target average annual capture efficiency, therefore may be somewhat oversized. This sizing method may be documented using Worksheet E.

Stepwise Instructions:

1) Look up the design capture storm depth from **Figure 6.2**.

2) Compute the design capture volume using hydrologic methods described in Sections 2.3.1, accounting for hydrologic source controls implemented upstream.

3) Design BMP(s) to ensure that the design capture volume is fully retained (i.e., no surface discharge during the design event) and the stored volume draws down in no longer than 48 hours.

4) ~~For green roofs, brown roofs, and blue roofs, drawdown criteria are suspended. The system must be designed to retain the design capture volume starting from a dry condition, but is not required to fully evaporate this water within 48 hours after the storm event. Volume that discharges from green roofs is considered biotreated and does not require additional treatment.~~

Treatment control performance criteria are fully met where this method is used.

Example 6.1: Computing Design Criteria using Simple Method
Given:
• Redevelopment project, 85th percentile, 24-hr storm depth = 0.85 inches
• Drainage Area = 1.5 acres
• Imperviousness = 80%
• Effect of provided HSCs (d_{HSC}) = 0.2 inches
• Design infiltration rate = 0.5 in/hr
Required:
• Determine volume required to achieve LID performance criteria by Simple Method and check that this volume can be drawn down in less than or equal to 48 hours
Solution:
1) Design capture storm depth = 0.85 inches from Figure 6.2
2) Remaining design capture volume after HSCs = 1.5 ac × (0.8*0.75 + 0.15) × (0.85 inches – 0.2 inches) * 43,560 sf/ac × 1/12 in/ft = 2,650 cu-ft (see Section 2.3.1)

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Number: 1 Author: staff Subject: Highlight Date: 7/6/2010 11:35:44 AM

Not found.

Number: 2 Author: staff Subject: Highlight Date: 7/6/2010 11:40:59 AM

These methods are incorrect.

Number: 3 Author: staff Subject: Cross-Out Date: 7/12/2010 12:45:25 PM

This language presupposes how the roof will be designed. Separate criteria should be provided for both circumstances where the design capture volume will be drawn down using ET (retention) and drawdown via discharge (biotreatment).

3) Design BMP to provide remaining design capture volume and ensure ≤ 48 hour drawdown.

   Minimum area required = [design capture volume] / [maximum retention depth that can draw down in 48 hours]

   Max retention depth that can be drawn down in 48 hrs = 48 hrs × 0.5 in/hr = 24 inches = 2 ft

   Minimum area required = 2,650 cu-ft / 2-ft = 1,325 sq-ft = 2.0 percent of project site. This effective area should be provided for infiltration to ensure that water is completed drawn down in no greater than 48 hours.

Retention depth may be provided through surface storage plus pore storage as described in Section 6.4.3 and respective BMP fact sheets.

6.4.2.2. [1] ~~*Sizing to Achieve Target Average Annual Capture Efficiency for Volume-based, Constant Drawdown BMPs*~~

This section describes the recommended method to compute design criteria to achieve target average annual capture efficiency. This method is required where BMPs cannot draw down in less than 48 hours. This method is optional where BMPs can draw down in less than 48 hours and may produce more efficient (i.e., smaller) sizing.

By nature, this is an iterative process that requires some assumptions about BMP design parameters. For example sizing calculations depend on the assumed drawdown time, which depends on BMP depth, which may in turn depend on the required size. In general, the selection of reasonable BMP design parameters in the first iteration will result in minimal required additional iterations.

For most volumetric BMPs, the drawdown rate can be approximated as constant throughout the year. For these BMPs, **Figure 6.3** should be used with the instructions below. For BMPs with seasonally-varying drawdown, Section 6.4.2.5 should be used. For flow-based BMPs, Section 6.4.2.3 should be used.

This method should be documented using Worksheet F

<u>Stepwise Instructions:</u>

1) Look up the 85th percentile, 24-hour storm depth from **Figure 6.2**.

2) Estimate the drawdown time of the proposed BMP. See corresponding BMP Fact Sheet for specific guidance on how to convert BMP geometry to estimated drawdown time. Locate where the estimated drawdown time intersects with 80 percent capture on **Figure 6.3**. Pivot and read to the horizontal axis to yield [2] X_1.

3) Determine the capture efficiency achieved upstream of the BMP and trace a horizontal line on **Figure 6.3** corresponding to this value. This will generally be the capture

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Number: 1 Author: staff Subject: Cross-Out Date: 6/30/2010 1:43:03 PM

Earlier references to this section indicate that it describes the "Capture Efficiency Method". Retitle this section to be consistent with earlier references and ease of discovery.

Number: 2 Author: staff Subject: Highlight Date: 7/6/2010 12:15:51 PM

The axis needs to be labeled accordingly.

efficiency achieved by upstream HSCs (Table 6.8), but may account for the effect of an upstream LID BMP as well if a treatment train is used.

4) Find where the line traced in (3) intersects with the drawdown time estimated in (2). Pivot and read down to the horizontal axis to yield X_2.

5) Subtract X_2 from X_1 to determine the fraction of the design volume that must be provided to achieve 80 percent capture.

6) Multiply the result of (5) by the 85th percentile, 24-hour storm depth (1).

7) Compute runoff from the storm depth computed in (6) per guidance contained in Section 2.3.1. This is the required BMP design volume.

8) Design the BMP to retain the required volume, and confirm that the drawdown time is no more than 25 percent greater than estimated in (2). If the computed drawdown time is greater than 125 percent of the estimated drawdown, then return to (2) and revise.

See the respective BMP facts sheets for BMP-specific instructions for the calculation of volume and drawdown time.

Example 6.2: Computing Design Criteria to Achieve Target Capture Efficiency, Bioretention BMP

Given:

- 85th percentile, 24-hr storm depth = 0.85 inches
- Drainage Area = 1.5 acres
- Imperviousness = 80%
- Effect of provided HSCs (d_{HSC}) = 0.2 inches
- Assume to priority BMP to be considered is bioretention without underdrains, 24-inch total retention depth (surface ponding + pore space)
- Design infiltration rate = 0.25 in/hr

Required:

- Determine volume required to achieve 80 percent capture

Solution:

1) 85th percentile, 24-hr storm depth = 0.85 inches (Figure 6.2)

2) BMP has total retention depth of 24 inches with 0.25 in/hr.
   →24 in / 0.25 in/hr = 96 hour total drawdown
   →Volume contained in media pores is not subject to 72-hr drawdown limitation.
   →From Figure 6.6: X_1 = 1.38

3) Capture efficiency achieved by 0.2 inches of HSCs = 31% (Table 6.8).

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4) From Figure 6.6: X_2 = 0.26

5) Fraction of 85th percentile, 24-hour storm depth required ($X_1 - X_2$) = (1.38 – 0.26) = 1.12

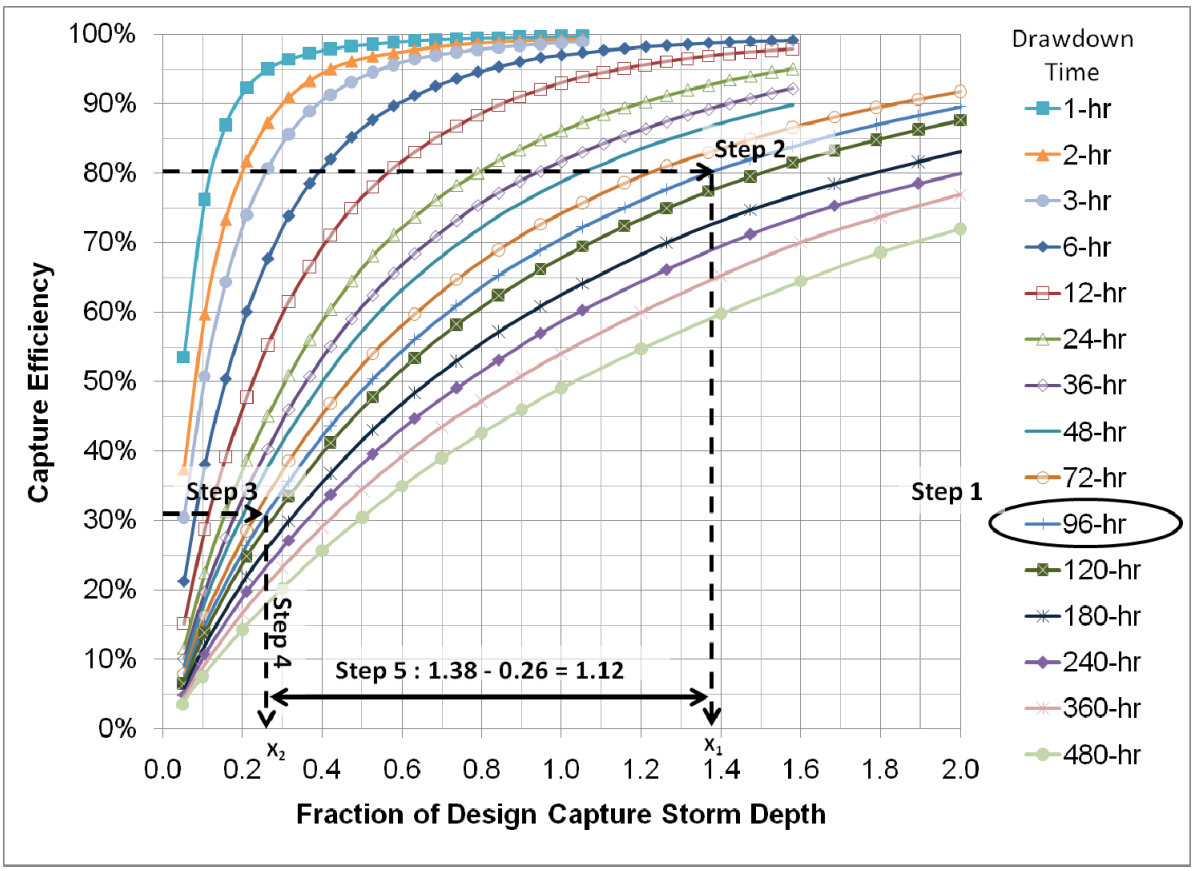
6) Required design storm depth = 0.85 inches * (1.12) = 0.95 inches

7) Required storage volume = 1.5 ac × 0.95 inches × (0.8×0.75 + 0.15) × 43560 sf/ac × 1/12 in/ft = 3,880 cu-ft

8) Check that 96 hour drawdown can be achieved for this volume. If recomputed drawdown time is more than 25% higher than original assumption, repeat steps starting with Step 2.

Graphical operations supporting solution:

Figure 6.6
Graphical Operations Supporting Example 6.2



6.4.2.3. Sizing to Achieve Target Average Annual Capture Efficiency, Flow-based BMPs

This section describes the recommended method to compute design criteria for flow-based BMPs to achieve 80 percent average annual capture efficiency. This method is required if it is desired to account for HSCs or other BMPs upstream of the flow-based BMP. Alternatively,

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flow-based BMPs may be sized per the criteria contained in Section 2.2.3 if it is not desired to account for upstream BMPs.

This method may be documented using Worksheet H.

Stepwise Instructions:

1) Estimate the time of concentration (T_c) of the tributary area per Section 2.3.3.

2) Locate where the T_c line intersects with 80 percent capture on **Figure 6.5**. Pivot and read to the horizontal axis to yield I_1.

3) Determine the capture efficiency achieved upstream of the BMP and trace a horizontal line on **Figure 6.5** corresponding to this value. This will generally be the capture efficiency achieved by upstream HSCs (Table 6.8), but may account for the effect of an upstream LID BMP as well if a treatment train is used.

4) Locate where the T_c line intersects with the line traced in (3). Pivot and read down to the horizontal axis to yield I_2.

5) Subtract I_2 from I_1 to yield the design intensity required to yield 80 percent capture.

6) Compute runoff flowrate from the design intensity as specified in Section 2.3.1. This is the required design flowrate for the BMP.

7) Design the BMP to treat the required design flowrate.

Example 6.3: Sizing to Achieve Target Average Annual Capture Efficiency, Flow-based BMPs
Given:
• 85th percentile, 24-hr storm depth = 0.95 inches
• Drainage Area = 3.5 acres
• Imperviousness = 95%
• Retention BMP provided upstream achieves 45 percent capture; does not fully meet requirements
• Assume swale is added as a biotreatment BMP downstream of retention
Required:
• Determine swale design flowrate required to achieve 80 percent capture cumulatively
Solution:
1) T_c = 10 minutes (calculation would be conducted per Section 2.3.3)
2) From Figure 6.7 I_1 = 0.23 in/hr
3) Capture efficiency achieved in upstream BMPs = 45 percent (given)
4) From Figure 6.7 I_2 = 0.07 in/hr

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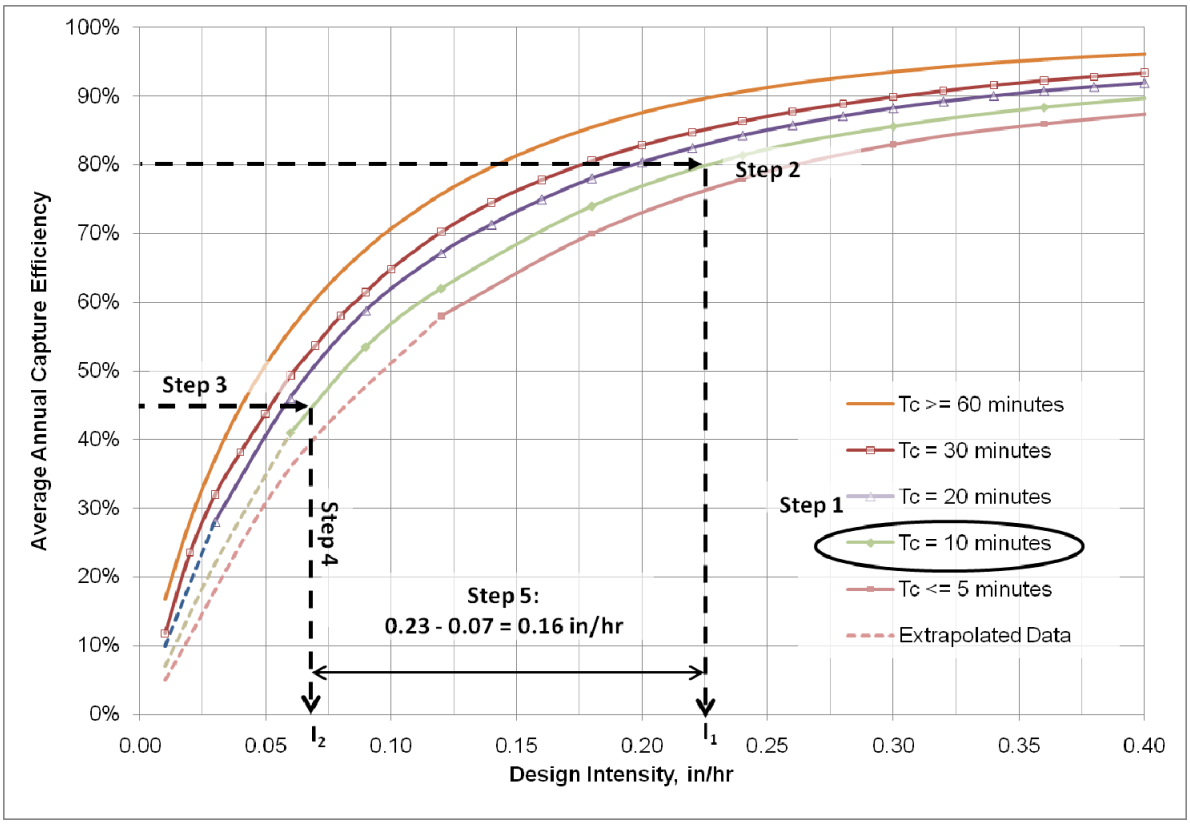
5) $I_1 - I_2$ = design intensity = 0.16 in/hr

6) Q_{LID} = [(0.95×0.75+0.15) × 0.16 in/hr × 3.5 ac]= 0.48 cfs

Graphical operations supporting solution:

Figure 6.7
Graphical Operations Supporting Example 6.3



6.4.2.4. Computing Capture Efficiency of Volume-based, Constant Drawdown BMP from Description of System Configuration

This section describes instructions for computing the capture efficiency for a given volume-based BMP configuration, considering the cumulative effects of upstream controls. This is applicable for BMPs that can be approximated to have a constant drawdown rate throughout the year (i.e., use rate is not a function of irrigation demand). This calculation method would be used in cases where it is not feasible to achieve the full target capture efficiency. It is necessary to determine what level of control has been achieved so that remaining sizing criteria can be calculated.

The user enters this computation with a description of the system and the capture efficiency that has already been achieved by upstream BMPs. If the capture efficiency of a series of BMPs

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is desired, the user starts with the most upstream BMP and then repeats the steps for each sequential BMP provided downstream.

Stepwise Instructions for Volume-based BMPs (without seasonally-varying use rate):

1) Determine the storage volume provided in the BMP, and use the equation presented in Section 2.3.1 to back-compute the effective design storm depth provided. Divide the provided storm depth by the design capture storm depth so that it is expressed as a fraction of the design capture volume. For example, if 0.6 inches of storage is provided and the design capture storm depth is 0.9 inches, then the provided volume would be expressed as (0.6/0.9) = 0.67 of the design capture volume.

2) Compute the drawdown time of the provided storage volume per guidance provided for respective BMPs in Sections 6.6 through 6.11.

3) Determine the capture efficiency that has already been provided upstream. This will have already been computed in a previous iteration of this method if upstream BMPs are provided. Trace a horizontal line corresponding to this capture efficiency on **Figure 6.3**. Locate where this line intersects with the drawdown line (2). Pivot and read down to the horizontal axis. This is X_1.

4) Add the result of (1) to the result of (3). This is X_2.

5) Draw a vertical line at X_2 to intersect with the drawdown line.

6) Pivot and read to the vertical axis. This is the cumulative capture efficiency achieved by the BMP plus the upstream BMPs.

Example 6.4: Determining the Capture Efficiency of a Volume-based, Constant Drawdown BMP Based on Description of System
Given:
• High Density Project in Rainfall Zone 4: 85th percentile, 24-hr storm depth = 0.95 inches • Drainage Area = 3.5 acres • Imperviousness = 95% • Hydrologic source controls: 0.2 inches total = 31 percent capture • BMP Storage Volume Provided = 5,400 cu-ft with 72 hour drawdown
Required:
• Compute cumulative capture efficiency of the system described above
Solution:
1) Storage Volume Provided = 5,400 cu-ft (given). →Effective design storm depth, d = 5,400 cu-ft × 12 in/ft/[(0.95*0.75+0.15) × 3.5 ac × 43560 sf/ac] = 0.49 inches (Equation 2.2 Section 2.3.1) →Fraction of design capture volume = 0.49 inches/0.95 inches = 0.52

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2) 72-hr constant drawdown (given)

3) 31 percent (0.2" of HSCs, Table 6.8). From Figure 6.8: $X_1 = 0.22$

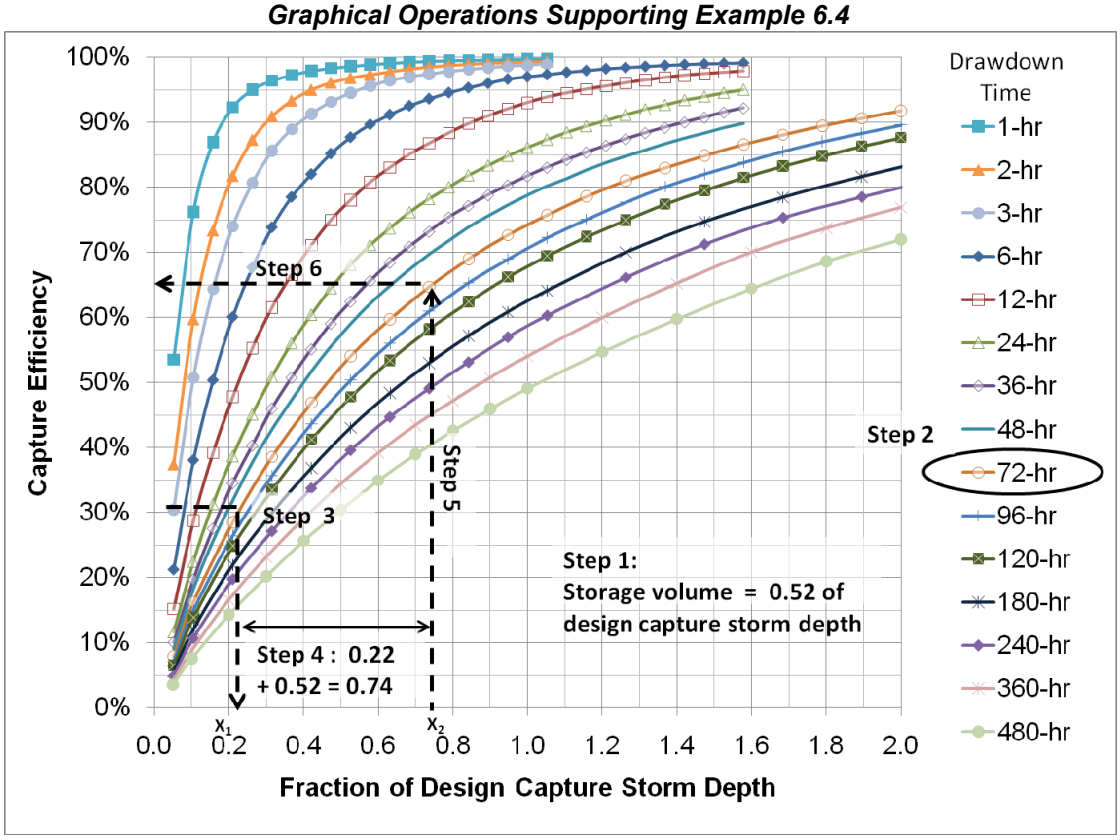
4) $X_2 = 0.22 + 0.52 = 0.74$

5) $X_2 = 0.74$ (draw line up to 72 hour drawdown line)

6) From Figure 6.8, the cumulative capture efficiency achieved by the combination of HSCs and the volumetric BMP is 65%.

Graphical operations supporting solution:

Figure 6.8
Graphical Operations Supporting Example 6.4



6.4.2.5. *Computing Average Annual Capture Efficiency of Harvest and Use BMPs with Seasonally-Varying Use Rate (Irrigation Demand) based on System Description*

This section describes instructions for computing the capture efficiency for a given harvest and use BMP configuration with seasonally varying use rate (irrigation demand), considering the cumulative effects of upstream controls. This calculation method would be used in cases where it is not feasible to achieve the 80 percent capture target. It is necessary to determine what level of control has been achieved so that remaining sizing criteria can be calculated.

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The user enters this computation with a description of the system and the capture efficiency that has already been achieved by upstream BMPs. If the capture efficiency of a series of BMPs is desired, the user starts with the most upstream BMP and then repeats the steps for each sequential BMP provided downstream.

Stepwise Instructions for Harvest and Use BMP (with seasonally-varying irrigation demand):

1) Determine the storage volume provided in the BMP, and use the equation presented in Section 2.3.1 to back-compute the effective design storm depth provided. Divide the provided storm depth by the design capture storm depth so that it is expressed as a fraction of the design capture volume. For example, if 0.6 inches of storage is provided and the design capture storm depth is 0.9 inches, then the provided volume would be expressed as (0.6/0.9) = 0.67 of the design capture volume.

2) Estimate the effective irrigation area ratio of the system (*IR*):

   IR = IA × Kc/[IE × Tributary Impervious Area]

   Where:

   IR = effective irrigated area ratio (ac/ac)

   IA = area irrigated with harvested water, ac

   Kc = Crop coefficient = ratio of actual evapotranspiration rate to reference evapotranspiration (ETo) when water is present. Account for low water use landscaping requirement when selecting this value.

   IE = irrigation efficiency = depth of agronomic demand applied for each unit depth of irrigation supplied. Default is 0.75 inches/inch

3) Determine the capture efficiency that has already been provided upstream. This will have already been computed in a previous iteration of this method if upstream BMPs are provided. Trace a horizontal line corresponding to this capture efficiency on **Figure 6.4**. Locate where this line intersects with the Irrigation Area Ratio line (2). Pivot and read down to the horizontal axis. This is X_1.

4) Add the result of (1) to the result of (3). This is X_2.

5) Draw a vertical line at X_2 to intersect with the drawdown line.

6) Pivot and read to the vertical axis. This is the cumulative capture efficiency achieved by the BMP plus the upstream BMPs.

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6.4.2.6. Computing Average Annual Capture Efficiency of Flow-based BMP Based on System Description

This section describes instructions for computing the capture efficiency for a given flow-based BMP configuration, considering the cumulative effects of upstream controls. This calculation method would be used in cases where it is not feasible to achieve the full 80 percent capture target. It is necessary to determine what level of control has been achieved so that remaining sizing criteria can be calculated.

The user enters this computation with a description of the system and the capture efficiency that has already been achieved by upstream BMPs. If the capture efficiency of a series of BMPs is desired, the user starts with the upstream BMP and then repeats the steps for each sequential BMP provided.

Stepwise Instructions for Flow-based BMPs:

1) Determine the design flowrate of the BMP, and use the equation presented in Section 2.3.1 to back-compute the effective design storm intensity provided.

2) Estimate the time of concentration (T_c) of the tributary area per Section 2.3.3.

3) Determine the capture efficiency that has already been provided upstream. This will have already been computed in a previous iteration of this method if upstream BMPs are provided. Trace a horizontal line corresponding to this capture efficiency on **Figure 6.5**. Locate where this line intersects with the T_c line (2). Pivot and read down to the horizontal axis. This is I_1.

4) Add the result of (1) to the result of (3). This is I_2.

5) Draw a vertical line at I_2 to intersect with the T_c line.

6) Pivot and read to the vertical axis. This is the cumulative capture efficiency achieved by the BMP plus the upstream BMPs.

6.4.2.7. Calculating the System Performance of a Multi-Component System

The maximized BMP design for a given set of site constraints may consist of multiple parts (i.e., retention and biotreatment; volume-based and flow-based). For example, retention storage may be provided within the pores of amended soil in a bioretention area without underdrains, and the surface may function as a vegetated swale providing flow-based biotreatment. Or retention storage may be provided in a cistern which overflows to a planter box with underdrains to provide the remaining biotreatment volume. The distinction between retention volume and biotreatment volume in a multi-component system is discussed in Section 6.4.3.

The methods described in Sections 6.4.2.2, 6.4.2.3, 6.4.2.4, 6.4.2.5, or 6.4.2.6 may be used in combination to determine the incremental benefit of each component of the system. In most cases, the performance of the retention component would be estimated first using Section 6.4.2.4, 6.4.2.5, or 6.4.2.6 (depending on the BMP type), and then the biotreatment component

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would be sized using Section 6.4.2.2 or 6.4.2.3 to achieve the remaining capture up to 80 percent capture. This process would be used for the following examples:

- Retention volume provided in bioretention below underdrains, and biotreatment volume added above the underdrains.
- Retention storage provided within the pores of amended soil in a bioretention area without underdrains, and biotreatment provide in vegetated swale on surface of bioretention area.
- Retention storage provided in a cistern which overflows to a planter box with underdrains to provide the remaining biotreatment.
- Retention volume provided in an infiltration trench which overflows to a planter box with underdrains or vegetated swale to provide remaining biotreatment.
- Other similar configurations.

The exception to this process is when biotreatment is provided upstream of a retention BMP as pretreatment. In this case, the biotreatment BMP should be sized to achieve 1 ~~80 percent capture.~~ Then the 2 retention BMP should be maximized but the performance is not critical since anything that overflows would already be biotreated. This process would apply in the following example and similar examples:

- Pretreatment is provided in planter boxes with underdrains connected to an infiltration gallery. The planter boxes would be sized to capture 80 percent and would not bypass untreated flow to the infiltration gallery. 3 ~~Overflow from the infiltration gallery would be considered biotreated.~~

6.4.3. Definition of Retention and Biotreatment Volumes of a BMP

The retention volume of a BMP is the portion of the storage volume that does not contribute to offsite stormwater discharges. If a BMP *does not* have an underdrain or other treatment outlet, then the entire storage volume below the overflow outlet is the retention volume (i.e., drawdown of the stored water within the BMP is only caused by infiltration, evapotranspiration, or non-potable rainwater use). However, if the BMP *does* have an underdrain, the retention volume is pore volume of the gravel layer, amended soil layer, or other storage matrix beneath the underdrain. Amended BMP soils above an underdrain also includes some retention volume in the form of soil moisture remaining after gravity drainage (e.g., field capacity (FC) minus wilting point (WP)). This volume is typically minor relative to other components of the total retention volume, but is a critical component of BMPs that rely primarily on evapotranspiration for volume losses (e.g., green roofs).

The biotreatment volume of a BMP is the portion of the storage volume that discharges through an underdrain or treatment outlet. For example, for bioretention with underdrain the biotreatment volume includes the surface storage volume plus the freely drained pore volume

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Until the benefit of "80 percent capture" is fully explained, this must remain as design capture volume.

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There would be a very narrow range of projects or BMP combinations where this strategy would be allowable or even necessary under the required hierarchy. A rain garden or vegetated swale and underground retention vault is one set of examples. However, in both cases, the design capture volume of the vault would be the driving calculation, with any additional flow from the upstream facilities being credited towards biotreatment of any remaining volume untreated by the vault. It would not be the other way around as this language suggests.

Number: 3 Author: staff Subject: Cross-Out Date: 8/9/2010 8:04:30 AM

This depends on how overflow is handled. If overflow is subject to the treatment mechanisms of a biotreatment BMP, this would be true, but not as a rule. If under overflow conditions, the planter box functions as a vegetated swale or overflow still passes through the filter media, overflow could be considered biotreated, depending on treatment residence time and treatment effectiveness. But if overflow ponded on top of the planter, then discharges to the storm drain system, this would not be true. This example needs to be more clear.

of the media (i.e., porosity minus field capacity (FC)). Figure 6.9 is a conceptual cross-section of a biotreatment BMP that defines the retention volume and the biotreatment volume components of the design storage volume. The components described in this cross section can be extrapolated to described most systems where both retention and biotreatment volume are provided.

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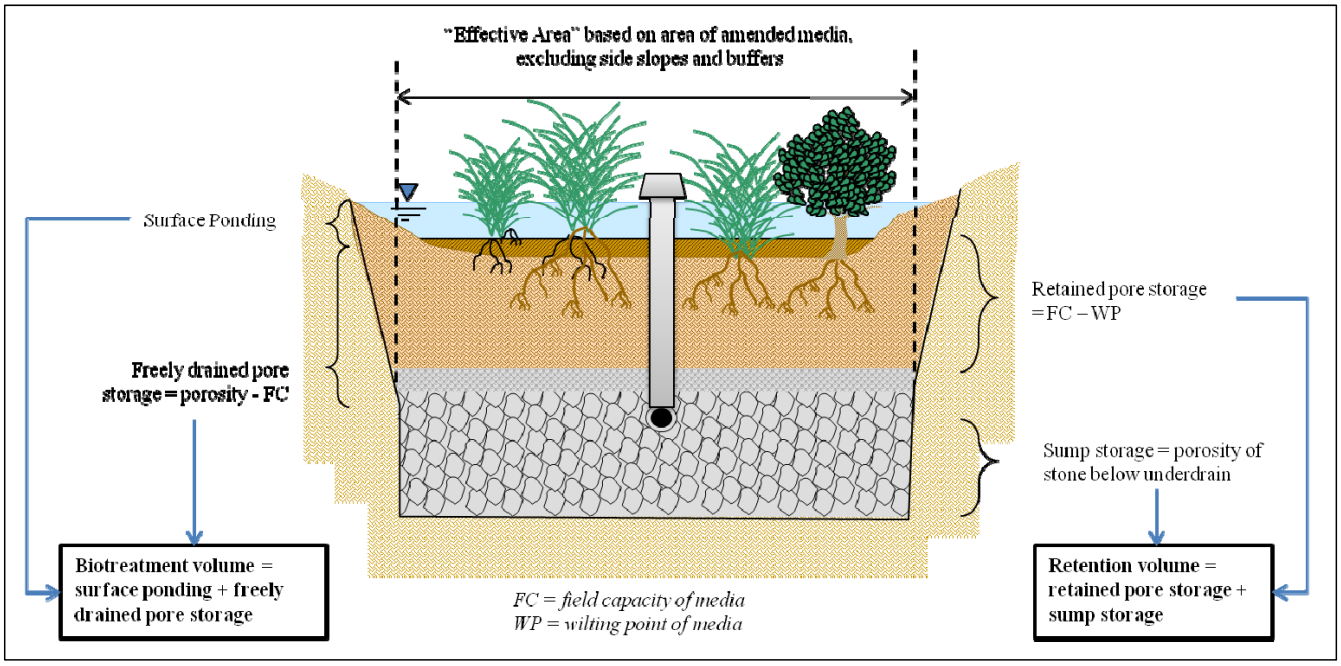
Figure 6.9
Conceptual Schematic of Retention Volume and Biotreatment Volume in Biotreatment BMP



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6.5. Hydrologic Source Control BMPs

This section provides (1) an introduction to hydrologic source controls (HSCs), (2) criteria for integrating HSCs into stormwater management systems, and (3) concise descriptions of hydrologic source controls which may be used to reduce the volume of stormwater runoff reaching downstream BMPs.

6.5.1. Introduction

Hydrologic source controls can be considered to be a hybrid between site design practices and LID BMPs. HSCs are distinguished from site design BMPs in that they do not reduce the tributary area or reduce the imperviousness of a drainage area; rather they reduce the runoff volume that would result from a drainage area with a given imperviousness compared to what would result if HSCs were not used. HSCs are differentiated from LID BMPs in that they tend to be more highly integrated with site designs and tend to have less defined design and operation. For example, it may not be possible to precisely describe the storage volume and drawdown rate of a pervious area receiving drainage from downspout disconnects; however these systems can be very effective at reducing runoff.

6.5.2. Quantifying Benefit of HSCs in Sizing Calculations

Each of the fact sheets below includes criteria for quantifying the benefit of HSCs in terms of storm depth retained as a function of design criteria. There may be more than one HSC in a single drainage area, and the effect of the suite of HSCs over a drainage area should be combined and area weighted as follows.

$$d_{HSC\ total} = \sum d_{HSCi} \times IA_i / IA_{total} \qquad \text{Equation 6.1}$$

Where:

$d_{HSC\ total}$ = combined effect of HSCs in drainage area, inches

d_{HSCi} = effect of individual HSC_i per criteria in Section 6.5.3, inches

IA_i = impervious area tributary to individual HSC_i (for street trees this is the impervious area beneath a fully established perennial canopy); areas cannot be counted twice if more than one HSC captures runoff from the same impervious area (e.g., street trees covering a roof top that is disconnected).

IA_{total} = total impervious area in drainage area

Table 6.7 provides a template for calculation of the combined effective of HSCs in the drainage area (expressed in inches reduction of the design capture storm depth). These calculations may be documented using Worksheet J. *Note: the selection and accounting of HSCs is not required unless it is otherwise infeasible to meet LID performance criteria on the project site.*

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Table 6.7: Hydrologic Source Control Calculation Worksheet

		drainage area ID	A	
		Total drainage area	2.1	acres
		Total drainage area Impervious Area (IA_{total})	1.3	acres
HSC ID	HSC Type/ Description/ Reference Section	Effect of individual HSC_i per criteria in Section 6.5.3 (d_{HSCi})	Impervious Area Tributary to HSC_i (IA_i)	$d_i \times IA_i$
A-1	Downspout Dispersion, 1:2 ratio (0.5) of rooftop to pervious area for 0.38 acres, Section 6.5.3.2	0.25”	0.38	0.095
A-2	Street Trees, perennial canopy over 0.25 acres of impervious area, Section 6.5.3.4	0.05”	0.25	0.0125
A-3	Downspout Infiltration, 10-15 cu-ft storage per 1000 sf of roof for 0.21 acres	0.15”	0.21	0.032
A-4	Residential Rain Barrels, four 55 gallon barrels per 1000 sf of roof (4*55*50%=110 gal/1000 sf) for 0.2 acres	0.18”	0.2	0.036
		Box 1:	$\sum d_i \times IA_i =$	0.175
		Box 2:	$IA_{total} =$	1.3
		[Box 1]/[Box 2]:	$d_{HSC\ total} =$	0.135

Table 6.8 below provides a relationship between the total storm depth retained in HSCs ($d_{HSC\ total}$) and the average annual capture efficiency achieved (i.e., the average annual reduction in stormwater runoff as a result of HSCs). Linear interpolation may be used with this chart.

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Table 6.8: Capture Efficiency Achieved by Hydrologic Source Controls		
Cumulative HSC Adjustment to Design Capture Storm Depth (**Table 6.7**)	Capture Efficiency Achieved Lowland Regions (<1,000 ft)	Capture Efficiency Achieved Mountainous Regions (>1,000 ft)
<0.05	0	0%
0.05”	8%	7%
0.1”	20%	16%
0.2”	37%	31%
0.3”	48%	42%
0.4”	57%	50%
0.5”	64%	57%
0.6”	70%	63%
0.7”	75%	68%
0.8”	80%	72%
0.9”	80%	76%
1.0”	80%	80%

6.5.3. Hydrologic Source Control Fact Sheets

This section provides fact sheets for several types of HSCs. Criteria specifically described in these fact sheets override guidance contained in referenced documents. Where criteria are not specified, user should defer to best professional judgment based on the recommendations of the referenced guidance material or other ~~reputable and citable source.~~ 1

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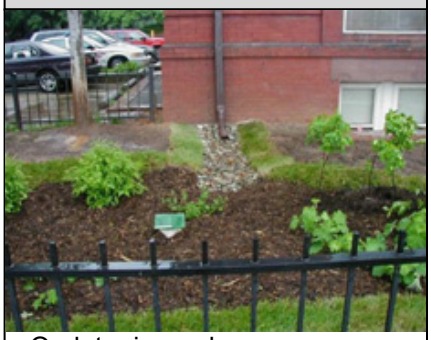
published and generally accepted sources

6.5.3.1. *Localized On-Lot Infiltration*

Localized on-lot infiltration refers to the practice of collecting on-site runoff and diverting it to a dedicated on-site percolation area. This technique can include disconnecting downspouts into pits or depressions, taking advantage of natural site topography, or retention grading to convey runoff to french drains, trenches, small rain gardens, or a surface depression. For downspout disconnections and other impervious area disconnection involving dispersion over pervious surfaces, but without significant ponding intending, see Impervious Area Dispersion (Section 6.5.3.2).

Also known as:

- *Downspout infiltration*
- *Retention grading*
- *French drains*
- *On-lot rain gardens*



On-lot rain garden
Source: lowimpactdevelopment.org

Level 1 Screening Considerations

- Localized on-lot infiltration shall be screened as Infiltration BMPs for Level 1 Suitability screening (Sections 6.2.1.2).

Opportunity Criteria

- Runoff can be directed to infiltration unit via disconnected downspouts, existing natural depressions, or retention grading that are greater than 1 inch in depth.
- Soils are adequate for infiltration or can be amended to achieve the required infiltration rate (see Section 6.5.3.3).
- Infiltration area is not located over a seasonally high groundwater table (within 2 feet of the bottom of the infiltration unit) or over an area of known groundwater contamination.
- Do not locate over shallow utilities.

OC-Specific Design Criteria and Considerations

- ☐ A single on-lot infiltration area should not be sized to retain runoff from impervious areas greater than 4,000 sq. ft.; if the drainage area exceeds this criteria, sizing should be based on calculations for bioretention areas (see Sections 6.6.2.3 and 6.9.2.1) or infiltration trenches (see Section 6.6.2.2).
- ☐ Soils should be sufficiently permeable to eliminate ponded water within 24 hours following a 85th percentile, 24-hour storm event.
- ☐ Infiltration via depression storage, french drains, or rain gardens should be located greater than 10 feet from building foundations.
- ☐ Infiltration should not cause geotechnical hazards related to slope stability.
- ☐ Site slope should be less than 15%.
- ☐ Infiltration unit should not be located within 50 feet of steep slopes (>25%).
- ☐ Side slopes of rain garden or depression storage should not exceed 3H:1V.
- ☐ Ponding depth should be shouldow (maximum of 6 inches) and should completely drain within 12 hours.
- ☐ Effective energy dissipation and uniform flow spreading methods should be employed to prevent erosion and facilitate dispersion.

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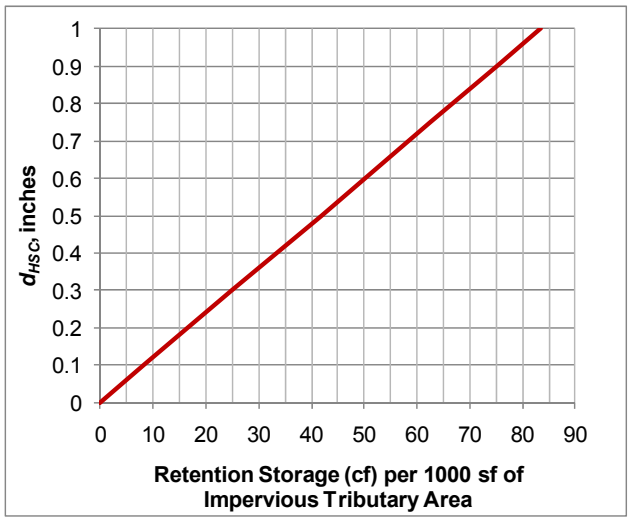
- ☐ Soils should be preserved from their natural condition or restored via soil amendments to meet minimum criteria described in Section 6.5.3.3.
- ☐ Depression overflow point should be located such that it does not cause erosion or inadvertent inundation.

Calculating HSC Retention Volume

- The retention volume provided by localized on-lot infiltration can be computed as the storage volume provided by surface ponding and the pore space within an amended soil layer or gravel trench.
- Estimate the average retention volume per 1000 square feet impervious tributary area provided by on-lot infiltration.
- Look up the storm retention depth, d_{HSC} from the chart to the right.
- The max d_{HSC} is equal to the design storm depth for the project site.



Soil Condition Checklist

- ☐ Maximum slope of 2 percent.
- ☐ If necessary for infiltration, minimum soil amendments per criteria in Section 6.5.3.3.

Configuration for Use in a Treatment Train

- Localized on-lot infiltration would typically serve as the second step in a treatment train, preceded by impervious area disperson (e.g., downspout disconnection) or retention grading. Depending on the quality of the runoff, pretreatment may also be necessary (i.e., gross solids removal).
- The use of impervious area disconnection reduces the sizing requirement for downstream LID and/or conventional treatment control BMPs.

Additional References for Design Guidance

- LID Center – Rain Garden Design Template. http://www.lowimpactdevelopment.org/raingarden_design/
- University of Wisconsin Extension. Rain Gardens: A How-To Manual for Homeowners. http://clean-water.uwex.edu/pubs/pdf/home.rgmanual.pdf

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6.5.3.2. *Impervious Area Dispersion*

Impervious area dispersion refers to the practice of routing runoff from impervious areas, such as rooftops, walkways, and patios onto the surface of adjacent pervious areas. Runoff is dispersed uniformly via splash block or dispersion trench and soaks into the ground as it move slowly across the surface of pervious areas. Minor ponding may occur, but it is not the intent of this practice to actively promote localized on-lot storage (See Localized On-lot Infiltration, Section 6.5.3.1).

Also known as:

- *Downspout disconnection*
- *Impervious area disconnection*
- *Sheet flow dispersion*

Simple Downspout Dispersion
Source: toronto.ca/environment/water.htm

Level 1 Screening Considerations

- Impervious area dispersion shall be screened as an Infiltration BMP for Level 1 Suitability screening (Sections 6.2.1.2).
- Likely to result in significant losses to ET, but has potential to result in geotechnical hazards associated with infilltration.

Opportunity Criteria

- Rooftops and other low traffic impervious surface present in drainage area.
- Soils are adequate for infiltration (NRCS Hydrologic Soil Groups A and B). If not, soils can be amended to improve capacity to absorp dispersed water (see Section 6.5.3.3).
- Significant pervious area present in drainage area at ratio of at least 1 part pervious capable of receiving flow to 5 parts impervious.
- Pervious area able to receive flow has slope ≤ 2 percent and path lengths of ≥ 10 feet per 1000 sf of impervious area.
- Overflow from pervious area can be safely managed.

OC-Specific Design Criteria and Considerations

- ☐ Soils should be preserved from their natural condition or restored via soil amendments to meet minimum criteria described in Section 6.5.3.3.
- ☐ Dispersion areas should be maintained to remove trash and debris, loose vegetation, and rehabilitate any areas of bare soil.
- ☐ Runoff from high traffic areas should be treated by an LID BMP (see Sections 6.6 through 6.9).

Calculating HSC Retention Volume

- The retention volume provided by downspout dispersion is a function of the ratio of impervious to pervious area and the condition of soils in the pervious area.
- Determine flow patterns in pervious area and estimate footprint of pervious area receiving dispersed flow. Calculate the ratio of pervious to impervious area.
- Check soil conditions using the checklist below; amend if necessary.
- Look up the storm retention depth, d_{HSC} from the chart below.

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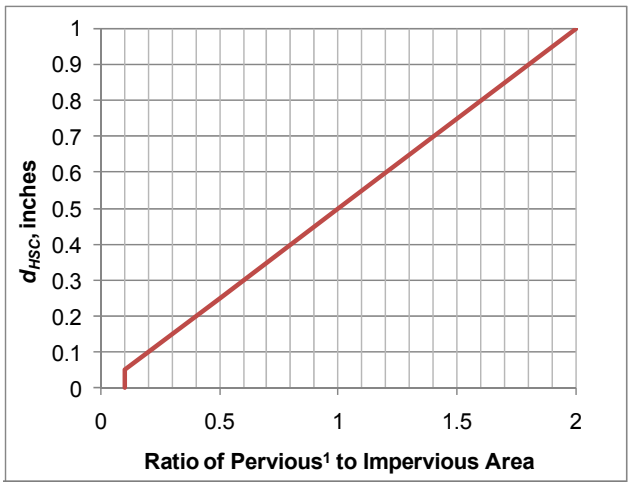
- The max d_{HSC} is equal to the design storm depth for the project site.



[1] Pervious area used in calculation should only include the pervious area receiving flow, not pervious area receiving only direct rainfall or upslope pervious drainage.

Soil Condition Checklist

- ☐ Maximum slope of 2 percent
- ☐ Well-established lawn or landscaping
- ☐ Minimum soil amendments per criteria in Section 6.5.3.3

Configuration for Use in a Treatment Train

- Impervious area disconnection is an HSC that may be used as the first element in any treatment train
- The use of impervious area disconnection reduces the sizing requirement for downstream LID and/or treatment control BMPs

Additional References for Design Guidance

- SMC LID Manual (pp 131) http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- City of Portland Bureau of Environmental Services. 2010. How to manage stormwater – Disconnect Downspouts. http://www.portlandonline.com/bes/index.cfm?c=43081&a=177702
- Seattle Public Utility: http://www.cityofseattle.org/util/stellent/groups/public/@spu/@usm/documents/webcontent/spu01_006395.pdf
- Thurston County, Washington State (pp 10): http://www.co.thurston.wa.us/wwm/Engineering_Standards/Drainage_Manual/PDFs/DG-5%20Roof%20Runoff%20Control.pdf

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6.5.3.3. *Amended Soils*

A soil amendment is anything that is added or done (e.g., aeration) to the soil to alter its physical, chemical, and biological characteristics. Soil amendments alter the soil characteristics to allow it to absorb, infiltrate, and retain more water to help reduce runoff volume and velocity, filter pollutants, increase the quality and quantity of vegetation, and reduce erosion potential more effectively than soils without soil amendments. Mulch is an amendment that is added on the top of the soil, rather than mixed into the soil, which reduces evaporation and adds to the aesthetics of a site. Compost and fertilizers are common soil amendments that must be completely mixed into the soil to function properly.

Soil amended area at U.S. EPA Ariel Rios building.
Source: http://www.epa.gov/oaintrnt/stormwater/hq_projects.htm

General Criteria

- Planting media should consist of: 60 – 70% sand, 15 – 25% compost, 10 – 20% clean topsoil. The organic content of the soil mixture should be 8 – 12%; the pH range should be 5.5 – 7.5.
- Compost, soil conditioners, and fertilizers should be roto-tilled into the native soil to a minimum depth of 6”. Mulch at grade should be spread over all planting areas to a depth of 3”.

Sand

- Sand should be free of stones, stumps, roots or other similar objects larger than 5 mm, and have the following gradation:

Sieve Size (ASTM D422)	% Passing
#4	100
#6	88-100
#8	79-97
#50	11-35
#200	5-15

Organic Content

- Incorporating compost and other organics into the root zone results in enhanced biological activity, attenuation of envrionemntal contaminants, increased moisture holding capacity, and improved soil structure. The physical requirements for compost are as follows:
- pH: 5.0 – 8.5
- Soluble salt concentration: < 10 dS/m
- Moisture: 30 – 60% wet weight basis
- Organic matter: 30 – 65% dry weight basis
- Stability (Carbon Dioxide evolution rate): >80% relative to positive control
- Maturity (seed emergence and seedling vigor): >80% relative to positive control
- Particle size: 98% pass through ¾” sieve or smaller

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- Chemical contaminants should meet or exceed US EPA Class A Standard, 40 CFR § 503.13, Tables 1 and 3 levels
- Biological contaminants should meet or exceed US EPA Class A Standard, 40 CFR § 503.32(a) levels

Topsoil

- Topsoil should be free of stones, stumps, roots or other similar objects larger than 2 inches and have the following characteristics:
- Soluble salts: < 4.0 dS/m
- pH range: 5.5 – 7.0
- Organic matter: > 5%
- Carbon to Nitrogen ratio: < 20:1
- Moisture content: 25 – 55%

Particle Size	% Passing
¾”	98
Sand (0.05 – 2.0 mm)	50-75
Silt (0.002 – 0.05 mm)	15-40
Clay (< 0.002 mm)	<5

Additional References

- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 3:
- http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- Santa Barbara BMP Guidance Manual, Chapter 5:
- http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf
- San Diego County LID Handbook Appendix 4 (Factsheet 30): http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf

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6.5.3.4. *Street Trees*

By intercepting rainfall trees can provide several aethetic and stormwater benefits including peak flow control, increased infiltration and evapotranspiration, and runoff temperature reduction. The volume of precipitation intercepted by the canopy reduces the treatment volume required for downstream treatment BMPs. Shading reduces the heat lisland effect as well as the temperature of adjacent impervious surfaces, over which stormwater flows, and thus reduces the heat transferred to the downstream waterbody. Tree roots also strengthen the soil structure and provide infiltrative pathways, simultaneously reducing erosion potential and enhancing infiltration.

Also known as:

- *Canopy interception*

Street trees
Source: Geosyntec Consultants

Level 1 Screening Considerations

- Not applicable

Opportunity Criteria

- Street trees can be incorporated in green streets designs along sidewalks, streets, parking lots, or driveways.
- Street trees can be used in combination with bioretention systems along medians or in traffic calming bays.
- There must be sufficient space available to accommodate both the tree canopy and root system.

OC-Specific Design Criteria and Considerations

- ☐ Mature tree canopy, height, and root system should not interfere with subsurface utilities, overhead powerlines, buildings and foundations, or other existing or planned structures. Required setbacks should be adhered to.
- ☐ Depending on space constarints, a 20 to 30 foot canopy (at maturity) is recommended for stormwater mitigation.
- ☐ Native, drought-tolerant species should be selected in order to minimize irrigation requirements and improve the long-term viability of the tree.
- ☐ Trees should not impede pedstrian or vehicle sight lines.
- ☐ Planting locations should receive adequate sunlight and wind protection; other environmental factors should be considered prior to planting.
- ☐ Frequency and degree of vegetation management and maintenance should be considered with respect to owner capabilities (e.g., staffing, funding, etc.).
- ☐ Soils should be preserved in their natural condition (if appropriate for planting) or restored via soil amendments to meet minimum criteria described in Section 6.5.3.3. If necessary, a landscape architect or plant biologist should be consulted.
- ☐ A street tree selection guide, such as that specific to the City of Los Angeles, may need to be consulted to select species appropriate for the site design constraints (e.g., parkway size, tree height, canopy spread, etc.)
- ☐ Infiltration should not cause geotechnical hazards related to adjacent structures (buildings, roadways, sidewalks, utilities, etc.)

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Calculating HSC Retention Volume

- The retention volume provided by streets trees via canopy interception is dependent on the tree species, time of the year, and maturity.
- To compute the retention depth, the expected impervious area covered by the full tree canopy after 4 years of growth must be computed (IA_{HSC}). The maximum retention depth credit for canopy interception (d_{HSC}) is 0.05".

Configuration for Use in a Treatment Train

- As a hydrologic source control, street trees would serve as the first step in a treatment train by reducing the treatment volume and flow rate of a downstream treatment BMP.

Additional References for Design Guidance

- California Stromwater BMP Handbook. http://www.cabmphandbooks.com/Documents/Development/Section_3.pdf
- City of Los Angeles, Street Tree Division - Street Tree Selection Guide. http://bss.lacity.org/UrbanForestryDivision/StreetTreeSelectionGuide.htm
- Portland Stormwater Management Manual. http://www.portlandonline.com/bes/index.cfm?c=35122&a=55791
- San Diego County – Low Impact Development Fact Sheets. http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf

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6.5.3.5. *Residential Rain Barrels*

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 ocean. The reuse of the detained water for irrigation purposes leads to the conservation of potable water and the recharge of groundwater.

Also known as:

- *Small cistern*

Rain Barrel
Source: http://www.auburn.edu/projects/sustainability/website/newsletter/0910.php

Level 1 Screening Considerations

- Rain barrels not [1] ~~actively managed~~ that discharge to infiltration areas shall be screened as Infiltration BMPs for Level 1 Suitability screening (Sections 6.2.1.2).
- Residential barrels that are used for irrigation shall be screened as a Harvest and Use BMPs for Level 1 Suitability screening (Sections 6.2.1.5).

Opportunity Criteria

- Rooftops with downspouts present in the drainage area.
- If detained water will be used for irrigation, sufficient vegetated areas and other impervious surfaces must be present in drainage area.
- Storage capacity and sufficient area for overflow dispersion must be accounted for.

OC-Specific Design Criteria and Considerations

- ☐ Screens on gutters and downspouts to remove sediment and particles as the water enters the barrel or cistern should be used. Removable child-resistant covers and mosquito screening should be used to prevent unwanted access.
- ☐ Above-ground barrels should be secured in place.
- ☐ Above-ground barrels should not be located on uneven or sloped surfaces; if installed on a sloped surface, the base where the cistern will be installed should be leveled prior to installation.
- ☐ Overflow dispersion should occur greater than 5 feet from building foundations.
- ☐ Dispersion should not cause geotechnical hazards related to slope stability.
- ☐ Dispersion should be only allowed to stable vegetated areas where erosion or suspension of sediment is minimized.
- ☐ Effective energy dissipation and uniform flow spreading methods should be employed to prevent erosion and facilitate dispersion.
- ☐ Aesthetics should be considered for placement of barrels and incorporation into surroundings. Placement should allow easy access for regular maintenance.

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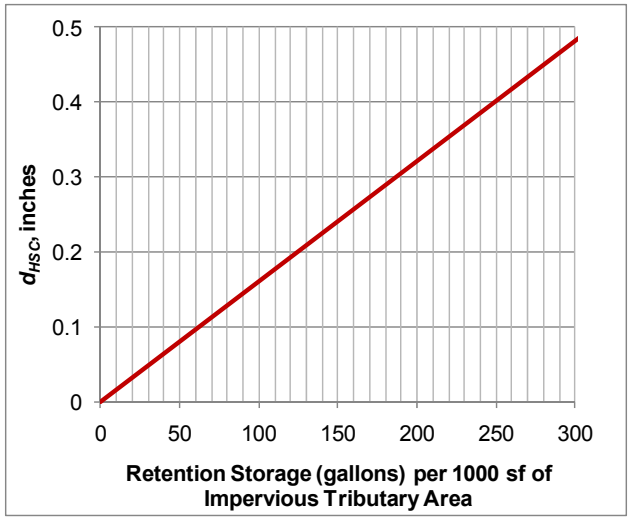
Calculating HSC Retention Volume

- The retention volume provided by rain barrels that are not actively managed can be computed as 50% of the total storage volume (e.g., 22.5 gallons for each 55 gallon barrel.
- If the rain barrel is actively managed then it should be treated as a Cistern as described in Section 6.7.2.1.
- Estimate the average retention volume per 1000 square feet impervious tributary area provided by rain barrels.
- Look up the storm retention depth, d_{HSC} from the chart to the right.
- The max d_{HSC} is equal to the design storm depth for the project site.



Configuration for Use in a Treatment Train

- Rain barrels can be combined into a treatment train to provide enhanced water quality treatment and reductions in the runoff volume and rate. For example, if a green roof is placed upgradient of a rain barrel, the rate and volume of water flowing to the barrel can be reduced and the water quality enhanced.
- Rain barrels can be incorporated into the landscape design of a site and can be aesthetically pleasing as well as functional for irrigation purposes

Additional References for Design Guidance

- Santa Barbara BMP Guidance Manual, Chapter 6:
- http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf
- County of Los Angeles Low Impact Development Standards Manual: http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf
- SMC LID Manual (pp 114): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- San Diego County LID Handbook Appendix 4 (Factsheet 26): http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf

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6.6. Infiltration BMPs

6.6.1. Introduction

Infiltration BMPs are LID BMPs that capture, store and infiltrate stormwater 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 lose some water to evapotranspiration, but are characterized by having their most dominant volume losses due to infiltration.

6.6.2. Infiltration BMP Fact Sheets

This section provides fact sheets for several types of infiltration BMPs. Criteria specifically described in these fact sheets should override guidance contained in referenced documents where conflicts exist. Where criteria are not specified in these fact sheets, the user should defer to best professional judgment based on the recommendations of the referenced guidance material.

6.6.2.1. Infiltration Basin Fact Sheet

Also known as:

- *Recharge basins*
- *Infiltration pond*

Infiltration Basin
Source: Pennsylvania Stormwater BMP Manual

An infiltration basin consists of an earthen basin constructed in naturally pervious soils (Type A or B soils) with a flat bottom. An energy dissipating inlet must be provided along with an emergency spillway to control excess flows. An optional relief underdrain may be provided to drain the basin if standing water conditions occur. A forebay settling basin or separate treatment control measure must be provided as pretreatment. An infiltration basin retains the stormwater quality design volume in the basin and allows the retained runoff to percolate into the underlying soils in 72 hours or less. The bottom of an infiltration basin is typically vegetated with dryland grasses or irrigated turf grass; however other types of vegetation are permissible if they can survive periodic inundation and long inter-event dry periods.

Level 1 Screening Considerations

- Infiltration bains shall be screened as Infiltration BMPs for Level 1 Suitability and Effectiveness Screening (Sections 6.2.1.2 and 6.2.1.3, respectively).
- Potential risk of groundwater contamination; may not provide significant attenuation of stormwater pollutants if underlying soils have high permeability.

Opportunity Criteria

- Soils are adequate for infiltration (NRCS Hydrologic Soil Groups A and B).
- Typically need 2-5 percent of drainage area available for infiltration.
- Space available for pretreatment (biotreatment or treatment control BMP as described below).

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- Potential for groundwater contamination can be mitigated through isolation of pollutant sources, pre-treatment of inflow, and/or demonstration of adequate treatment capacity of underlying soils.
- Infiltration is into native soil, or depth of engineered fill is ≤ 5 feet from the bottom of the facility to native material and infiltration into fill is approved by a geotechnical professional.

OC-Specific Design Criteria and Considerations

☐ Placement of BMPs should observe geotechnical recommendations with respect to geological hazards (e.g. landslides, liquefaction zones, erosion, etc.) and set-backs (e.g., foundations, utilities, roadways, etc.).

☐ Minimum pre-treatment should be provided upstream of the infiltration basin, and water bypassing pre-treatment should not be directed to the infiltration basin.

☐ Infiltration basins should not be used for drainage areas with high sediment production potential unless preceded by full treatment control with a BMP effective for sediment removal.

☐ Side-slopes should be no steeper than 3H:1V.

☐ Design infiltration rate should be determined through a minimum of 2 tests for the first 100 sq-ft and an additional test for each additional 100 sq-ft up to a maximum of 4 per facility.

Computing Sizing Criteria for Infiltration Basins

Infiltration basins should be sized per either:

- The simple method (Section 6.4.2.1), or
- The target capture efficiency method for constant drawdown BMPs (Section 6.4.2.2)

In the event that a basin cannot be sized to meet these criteria, smaller sizing may be used and the performance of the infiltration basin as designed should be computed per Section 6.4.2.4.

Calculating Infiltration Basin Drawdown Time

Infiltration basins lose water primarily through their flat bottom, but also through their side slopes. The drawdown time of an infiltration basin can be approximated by dividing the total stored volume by the discharge rate through the facility surface area at mid-depth (halfway between overflow elevation and empty).

$DD = \{V \times 12 \text{ in/ft}\}/\{SA_{MID\text{-}DEPTH} \times K_{DESIGN}\}$

Where:

DD = time to completely drain infiltration basin from brim full, hours

V = volume of water stored in the infiltration basin, cu-ft

$SA_{MID\text{-}DEPTH}$ = surface area of infiltration basin at mid-depth, sq-ft

K_{DESIGN} = design infiltration rate, in/hr

Configuration for Use in a Treatment Train

- Infiltration basins may be preceeded in a treatment train by hydrologic source controls in the drainage area, which would reduce the required design volume of the basins.
- Infiltration basins must be preceeded by some form of pre-treatment, which may be biotreatment or a treatment control BMP; if an approved biotreatment BMP is used as pretreatment, the overflow from the infiltration basin may be considered “biotreated” for the purposes of meeting the LID requirements.

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- The overflow or bypass from an infiltration basin can be routed to a downstream biotreatment BMP and/or a treatment control BMP if additional control is required to achieve LID or treatment control requirements.

Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-22.pdf
- SMC LID Manual (pp 141): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 6: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- City of Portland Stormwater Management Manual (Basin, pp 2-57) http://www.portlandonline.com/bes/index.cfm?c=47954&a=202883
- San Diego County LID Handbook Appendix 4 (Factsheet 2): http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf

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6.6.2.2. *Infiltration Trench Fact Sheet*

An infiltration trench is a long, narrow, rock-filled trench with no outlet other than an overflow outlet. Runoff is stored in the void space between the stones and infiltrates through the bottom and sides of the trench. Infiltration trenches provide the majority of their pollutant removal benefits through volume reduction. Pretreatment is important for limiting amounts of coarse sediment entering the trench which can clog and render the trench ineffective. *Note: if an infiltration trench is "deeper than its widest surface dimension," or includes an assemblage of perforated pipes, drain tiles, or other similar mechanisms intended to distribute runoff below the surface of the ground, it would probably be considered a "Class V Injection Well" under the federal Underground Injection Control (UIC) Program, which is regulated in California by U.S. EPA Region 9. A UIC permit may be required for such a facility (for details see http://www.epa.gov/region9/water/groundwater/uic-classv.html).*

Also known as:

- *French Drains*
- *Rock Trenches*
- *Exfiltration Trenches*
- *Soak-aways*
- *Soakage Trenches*

Infiltration Trench
Source: www.dot.ca.gov

Level 1 Screening Considerations

- Infiltration trenches shall be screened as Infiltration BMPs for Level 1 Suitability and Effectiveness Screening (Sections 6.2.1.2 and 6.2.1.3, respectively).
- May not provide significant attenuation of stormwater pollutants if underlying soils have high permeability; potential risk of groundwater contamination.
- Evaporation tends to be minor, therefore increases in infiltration compared to natural conditions may result.

Opportunity Criteria

- Soils are adequate for infiltration (NRCS Hydrologic Soil Groups A and B).
- Drainage area area is ≤ 5 acres and has low to moderate sediment production.
- 2-3 percent of drainage area available for infiltration (generally requires less surface area than infiltration basins and bioretention areas without underdrain).
- Space available for pretreatment (biotreatment or treatment control BMP as described below).
- Potential for groundwater contamination can be mitigated through isolation of pollutant sources, pre-treatment of inflow, and/or demonstration of adequate treatment capacity of underlying soils.
- Infiltration is into native soil, or depth of engineered fill is ≤ 5 feet from the bottom of the facility to native material and infiltration into shallow fill is approved by a geotechnical professional.

OC-Specific Design Criteria and Considerations

☐ Must comply with local, state, and federal UIC regulations if applicable; a permit may be required.

☐ Placement of BMPs should observe geotechnical recommendations with respect to geological hazards (e.g. landslides, liquefaction zones, erosion, etc.) and set-backs (e.g., foundations, utilities, roadways, etc.).

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- ☐ Minimum pre-treatment should be provided upstream of the infiltration basin, and water bypassing pre-treatment should not be directed to the infiltration basin.
- ☐ Infiltration trenches should not be used for drainage areas with high sediment production potential unless preceded by full treatment control with a BMP effective for sediment removal.
- ☐ Ponded water should not persist within 1 foot of the surface of the facility for longer than 72 hours following the end of a storm event (observation well is needed to allow observation of drain time).

Computing Sizing Criteria for Infiltration Trenches

Infiltration trenches should be sized per either:

- The simple method (Section 6.4.2.1), or
- The target capture efficiency method for constant drawdown BMPs (Section 6.4.2.2)

In the event that a trench cannot be sized to meet these criteria, smaller sizing may be used and the performance of the infiltration trench as designed should be computed per Section 6.4.2.4.

Calculating Infiltration Trench Storage Volume

The retention volume provided in an infiltration trench is a function of facility geometry and the properties of the rock used to fill the trench.

$$V = [SA \times D \times n]$$

Where:

V = volume of water stored in the infiltration trench, cu-ft

SA = surface area of infiltration trench, sq-ft

D = depth of rock fill, ft

n = porosity, 0.35 is common and may be assumed where other information is not available

Calculating Infiltration Trench Drawdown Time

Infiltration trenches lose water through the bottom and sides. The drawdown time of an infiltration trench can be approximated by dividing the total stored volume by the discharge rate through the facility bottom area plus one-third of the wall area (assuming the design discharge rate).

$$DD = \{V \times 12\ in/ft\}/\{[SA_{BOTTOM} + 0.33 \times SA_{SIDES}] \times K_{DESIGN}\}$$

Where:

DD = time to completely drain infiltration trench from brim full, hours

V = volume of water stored in the infiltration trench, cu-ft

SA_{BOTTOM} = surface area of bottom of infiltration trench, sq-ft

SA_{SIDES} = surface area of walls of infiltration trench, sq-ft

K_{DESIGN} = design infiltration rate, in/hr

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Configuration for Use in a Treatment Train

- Infiltration trenches may be preceeded in a treatment train by hydrologic source controls in the drainage area, which would reduce the required volume of the trench.
- Infiltration trenches must be preceeded by some form of pre-treatment which may be biotreatment or a treatment control BMP; if an approved biotreatment BMP is used as pretreatment, the overflow from the infiltration trench may be considered "biotreated" for the purposes of meeting the LID requirments
- The overflow or bypass from an infiltration trench can be routed to a downstream biotreatment BMP and/or a treatment control BMP if additional control is required to achieve LID or treatment control requirements

Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-10.pdf
- SMC LID Manual (pp 141): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 6: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandrainageareaintenance.pdf
- City of Portland Stormwater Management Manual (Soakage Trenches, pp 2-82) http://www.portlandonline.com/bes/index.cfm?c=47954&a=202883
- San Diego County LID Handbook Appendix 4 (Factsheet 1): http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf

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6.6.2.3. *Bioretention with No Underdrain*

Bioretention stormwater treatment facilities are landscaped shallow depressions that capture and filter stormwater runoff. These facilities function as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. The facilities normally consist of a ponding area, mulch layer, planting soils, and plants. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, and biodegraded by the soil and plants. For areas with low permeability native soils or steep slopes, bioretention areas can be designed with an underdrain system that routes the treated runoff to the storm drain system rather than depending entirely on infiltration. See Section 6.9.2.1 for the bioretention with underdrains fact sheet.

Also known as:

- *Rain gardens*
- *Infiltration planter*

Bioretention
Source: Geosyntec Consultants

Level 1 Screening Considerations

- Bioretention shall be screened as Infiltration BMPs for Level 1 Suitability and Effectiveness Screening (Sections 6.2.1.2 and 6.2.1.3, respectively).
- Evaporation tends to be minor, therefore increases in inflilitration compared to natural conditions may result.

Opportunity Criteria

- Land use may include commercial, residential, mixed use, institutional, and subdivisions. Bioretention may also be applied in parking lot islands, cul-de-sacs, traffic circles, road shoulders, and road medians.
- Drainage area is ≤ 5 acres, preferrably ≤ 1 acre.
- Typically 2-6 percent of drainage area available for infiltration.
- Soils are adequate for infiltration or can be amended to improve infiltration capacity. Underdrains are required if the the infiltration rate, after accounting for soil amendments, is less than 0.3 inches per hour (See Section 6.9.2.1 for bioretention with underdrain design criteria).
- Site slope is less than 15 percent.

OC-Specific Design Criteria and Considerations

☐ Placement of BMPs should observe geotechnical recommendations with respect to geological hazards (e.g. landslides, liquefaction zones, erosion, etc.) and set-backs (e.g., foundations, utilities, roadways, etc.).

☐ If sheet flow is conveyed to the treatment area over stabilized grassed areas, the site must be graded in such a way that minimizes erosive conditions; sheet flow velocities should not exceed 1 foot per second.

☐ Ponding depth should not exceed 18 inches; fencing may be required if ponding depth exceeds 6 inches.

☐ A forebay should be provided for all tributary surfaces that contain landscaped areas; forebay should be designed to prevent standing water during dry weather and should be planted with a

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plant palette that is tolerant of wet conditions.

- ☐ The minimum amended soil depth is 2 feet (3 feet is preferred). Soil must be amended per criteria in Section 6.5.3.3).
- ☐ The maximum drawdown time of the planting soil is 48 hours. The maximum drawdown time of the gravel drainage layer is 72 hours, if applicable (observation well required).
- ☐ Infiltration pathways may need to be restricted due to the close proximity of roads, foundations, or other infrastructure. A geomembrane liner, or other equivalent water proofing, may be placed along the vertical walls to reduce lateral flows. This liner should have a minimum thickness of 30 mils.
- ☐ Plant materials should be tolerant of summer drought, ponding fluctuations, and saturated soil conditions for 48 hours; native plant species and/or hardy cultivars that are not invasive and do not require chemical fertilizers or pesticides should be used to the maximum extent practicable.
- ☐ The bioretention area should be covered with 2-4 inches (average 3 inches) of mulch at startup and an additional placement of 1-2 inches of mulch should be added annually.

Computing Sizing Criteria for Bioretention

Bioretention should be sized per either:

- The simple method (Section 6.4.2.1),
- The target capture efficiency method for constant drawdown BMPs (Section 6.4.2.2)

In the event that a bioretention area cannot be sized to meet these criteria, smaller sizing may be used and the performance of the bioretention area as designed should be computed per Section 6.4.2.4.

Calculating Bioretention Storage Volume

The retention volume provided in a bioretention facility is a function of facility geometry and the properties of the soil used to fill the bioretention cell.

$$V = [SA \times D \times n] + V_{POND}$$

Where:

V = volume of water stored in the bioretention cell, cu-ft

SA = surface area of bioretention cell, sq-ft

D = depth of planting mix, ft

n = porosity

V_{POND} = volume ponded over the surface of the bioretention cell

Calculating Bioretention Drawdown Time

- The drawdown time of a bioretention facility can be approximated by dividing the total stored volume by the discharge rate through the facility bottom area (assuming the design discharge rate). Note infiltration through the sides of the facility is not accounted for in the following equation (assumes vertical liners installed).
- $DD = \{V \times 12 \text{ in/ft}\}/\{SA_{BOTTOM} \times K_{DESIGN}\}$

Where:

DD = time to completely drain bioretention cell from brim full, hours

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V = volume of water stored in the bioretention, cu-ft

SA_{BOTTOM} = surface area of bottom of bioretention, sq-ft

K_{DESIGN} = design infiltration rate, in/hr

Configuration for Use in a Treatment Train

- Bioretention areas may be preceeded in a treatment train by hydrologic source controls in the drainage area, which would reduce the required volume of the bioretention cell.
- Bioretention areas can be incorporated in a treatment train to provide enhanced water quality treatment and reductions in runoff volume and rate. For example, runoff can be collected from a roadway in a vegetated swale that then flows to a bioretention area. Similarly, bioretention could be used to manage overflow from a cistern.

Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-32.pdf
- SMC LID Manual (pp 68): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 5: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- San Diego County LID Handbook Appendix 4 (Factsheet 7): http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf
- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4:
- http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- County of Los Angeles Low Impact Development Standards Manual, Chapter 5:
- http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf

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6.6.2.4. *Drywell*

Drywells are similar to infiltration trenches in their design and function. A drywell is a subsurface storage facility designed to temporarily store and infiltrate runoff, primarily from rooftops or other impervious areas with low pollutant loading. A drywell may be either a small excavated pit filled with aggregate or a prefabricated storage chamber or pipe segment. Drywells can be used to reduce the volume of runoff from roofs and other relatively clean surfaces. While roofs are generally not a significant source of stormwater pollutants, they can be a major contributor of runoff volumes. Therefore, drywells can indirectly enhance water quality by reducing the water quality design volume that must be treated by other, downstream stormwater management facilities. *Note: A drywell is considered a "Class V Injection Wells" under the federal Underground Injection Control (UIC) Program regulated in California by U.S. EPA Region 9. A UIC permit may be required (for details see http://www.epa.gov/region9/water/groundwater/uic-classv.html).*

Also known as:

- *Soakaway Pits*
- *Infiltration Sumps*
- *Rock Sumps*
- *Underground Injection Controls*

Drywell
Source: K&A Enterprises

Level 1 Screening Considerations

- Drywells shall be screened as Infiltration BMPs for Level 1 Suitability and Effectiveness Screening (Sections 6.2.1.2 and 6.2.1.3, respectively).
- Potential risk of groundwater contamination.

Opportunity Criteria

- Drywells may be used to infiltrate roof runoff, either directly or from the overflow from a cistern.
- Soils are adequate for infiltration (NRCS Hydrologic Soil Groups A and B).
- Space available for pretreatment (biotreatment or treatment control BMP as described below).
- The drywell must be located in native soil; over-excavated by at least one foot in depth and replaced uniformly without compaction.
- Potential for groundwater contamination can be mitigated through isolation of pollutant sources, pre-treatment of inflow, and/or demonstration of adequate treatment capacity of underlying soils.
- Infiltration is into native soil, or depth of engineered fill is ≤ 5 feet from the bottom of the facility to native material and infiltration into fill is approved by a geotechnical professional.

OC-Specific Design Criteria and Considerations

- ☐ Must comply with local, state, and federal UIC regulations; a permit may be required.
- ☐ Minimum set-backs from foundations and slopes should be observed.
- ☐ Infiltration should not cause geotechnical concerns related to slope stability, liquefaction, or erosion.
- ☐ Drywells should not receive untreated stormwater runoff, except rooftop runoff; pretreatment of runoff from other surfaces is necessary to prevent premature failure that results from clogging

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with fine sediment, and to prevent potential groundwater contamination due to nutrients, salts, and hydrocarbons.

☐ Design infiltration rate should be determined with an infiltration test at each drywell location.

☐ Drywell should be encased by 1 foot of coarse (3/4" to 2 ½"), round river rock on sides and bottom of facility.

Computing Sizing Criteria for Drywells

Using site tested infiltration rate, drywells should be sized per either:

- The simple method (Section 6.4.2.1),
- The target capture efficiency method for constant drawdown BMPs (Section 6.4.2.2)

Calculating Drywell Drawdown Time

- Drywells lose water through the bottom and sides. The drawdown time of a drywell can be approximated by dividing the total stored volume by the discharge rate.
- Dry well discharge rate should be estimated by the project engineer or project geotechnical engineer on a site-specific basis, giving consideration for long-term maintenance and deterioration of discharge rate.

Configuration for Use in a Treatment Train

- Drywells may be preceded in a treatment train by hydrologic source controls in the drainage area, which would reduce the required volume of the drywell.
- Drywells treating any areas other than roof tops must be preceded by a biotreatment or conventional treatment.
- Drywells may be used in conjunction with other infiltration BMPs to increase the infiltration capacity of the entire treatment train system.

Additional References for Design Guidance

- Stormwater Management in Western Washington (Volume III: Hydrologic Analysis and Flow Control Design BMPs)
- http://www.ecy.wa.gov/pubs/0510031.pdf
- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4: http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- City of Portland Stormwater Management Manual (Drywell, pp 2-87) http://www.portlandonline.com/bes/index.cfm?c=47954&a=202883
- San Diego County LID Handbook Appendix 4 (Factsheet 25):
- http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf
- City of Santa Barbara Storm Water BMP Guidance Manual, Chapter 6:
- http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf

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6.6.2.5. *Permeable Pavement (concrete, asphalt, and pavers)*

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). All permeable pavements treat stormwater and remove sediments and metals to some degree within the pavement pore space and gravel base. While conventional pavement result in increased rates and volumes of surface runoff, properly constructed and maintained porous pavements, allow stormwater to percolate through the pavement and enter the soil below. This facilitates groundwater recharge while providing the structural and functional features needed for the roadway, parking lot, or sidewalk. The paving surface, subgrade, and installation requirements of permeable pavements are more complex than those for conventional asphalt or concrete surfaces. For porous pavements to function properly over an expected life span of 15 to 20 years, they must be properly sited and carefully designed and installed, as well as periodically maintained. Failure to protect paved areas from construction-related sediment loads can result in their premature clogging and failure.

Also known as:

- *Pervious pavement*
- *Porous concrete*
- *Pavers*
- *Permeable asphalt*

Permeable Pavement
Source: Geosyntec Consultants

Level 1 Screening Considerations

- Permeable pavement shall be screened as Infiltration BMPs for Level 1 Suitability and Effectiveness Screening (Sections 6.2.1.2 and 6.2.1.3, respectively).
- Potential risk of groundwater contamination; may not provide significant attenuation of stormwater pollutants if underlying soils have high permeability.

Opportunity Criteria

- Permeable pavement areas can be applied to individual lot driveways, walkways, parking lots, low-traffic roads, high-traffic (with low speeds) roads/lots, golf cart paths, within road right-of-ways, and in parks and along open space edges.
- Impervious surfaces draining to the BMP are limited to surfaces immediately adjacent to the permeable pavement, rooftop runoff, or other surfaces that do not contain significant sediment loads.
- Soils are adequate for infiltration (NRCS Hydrologic Soil Groups A and B).
- Infiltration is into native soil, or depth of engineered fill is ≤ 5 feet from the bottom of the facility to native material and infiltration into fill is approved by a geotechnical professional.

OC-Specific Design Criteria and Considerations

☐ Placement of BMPs should observe geotechnical recommendations with respect to geological hazards (e.g. landslides, liquefaction zones, erosion, etc.) and set-backs (e.g., foundations, utilities, roadways, etc.)

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- ☐ A biotreatment BMP should be provided for all runoff from off-site sources that are not directly adjacent to the permeable pavement
- ☐ Permeable pavement should not be used for drainage areas with high sediment production potential unless preceded by full treatment control with a BMP effective for sediment removal
- ☐ A layer of small sized aggregate (e.g., No. 8) just under the permeable pavement may be installed to provide a level surface for installing the permeable pavement and also acts as a filter to trap particles and help prevent the reservoir layer from clogging
- ☐ Bedding course should be 1.5 to 3 inches deep and may be underlain by choking stone to prevent the smaller sized aggregate from migrating into the large aggregate base layer
- ☐ The subsurface gravel layer should be designed to function as a support layer as well as a reservoir layer and may be divided into two layers, a filter layer that underlies the choking layer and a reservoir layer; the reservoir layer is typically washed, open-graded No. 57 aggregate without any fine sands
- ☐ The type of pedestrian traffic should be considered when determining which type of permeable pavement to use in particular locations (e.g., pavers may not be a good option for locations where people will be walking wearing high heels)

Computing Sizing Criteria for Permeable Pavement

- Permeable pavement reservoir base should be sized per either:
- The simple method (Section 6.4.2.1),
- The target capture efficiency method for constant drawdown BMPs (Section 6.4.2.2)
- In the event that permeable pavement cannot be sized to meet these criteria, smaller sizing may be used and the performance of the permeable pavement as designed should be computed per Section 6.4.2.4.

Calculating Permeable Pavement Storage Volume

The retention volume provided by permeable pavement is a function of facility geometry and the properties of the gravel used to fill the reservoir layer.

$$V = [SA \times D \times n]$$

Where:

V = volume of water stored in the subsurface gallery, cu-ft

SA = surface area of permeable pavement, sq-ft

D = depth of subsurface reservoir, ft

n = porosity

Calculating Permeable Pavement Drawdown Time

Permeable pavement facilities lose water through the bottom and sides of the gravel reservoir. The drawdown time can be approximated by dividing the total stored volume by the discharge rate through the facility bottom area plus one-third of the wall area (assuming the design discharge rate).

$$DD = \{V \times 12\ in/ft\}/\{[SA_{BOTTOM} + 0.33 \times SA_{SIDES}] \times K_{DESIGN}\}$$

Where:

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DD = time to completely drain permeable pavement subsurface reservoir brim full, hours

V = volume of water stored in the permeable pavement subsurface reservoir, cu-ft

SA_{BOTTOM} = surface area of bottom of permeable pavement subsurface reservoir, sq-ft

SA_{SIDES} = surface area of walls of permeable pavement subsurface reservoir, sq-ft

K_{DESIGN} = design infiltration rate, in/hr

Configuration for Use in a Treatment Train

- Permeable pavement may be preceded in a treatment train by hydrologic source controls in the drainage area, which would reduce the runoff volume to be infiltrated by the permeable pavement
- Permeable pavement areas can be combined with other basic and storm water runoff BMPs that can provide enhanced water quality treatment and reductions in runoff volume and rate. For example, overflow from permeable pavement can be directed to a vegetated swale or a bioretention area for further treatment, volume reduction, and flow control.

Additional References for Design Guidance

- SMC LID Manual (pp 141): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4: http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- City of Portland Stormwater Management Manual (Pervious Pavement pp 2-40) http://www.portlandonline.com/bes/index.cfm?c=47954&a=202883
- San Diego County LID Handbook Appendix 4 (Factsheets 8, 9 & 10):
- http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf
- City of Santa Barbara Storm Water BMP Guidance Manual, Chapter 6:
- http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf
- County of Los Angeles Low Impact Development Standards Manual, Chapter 5:
- http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf

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6.6.2.6. *Underground Infiltration*

Underground infiltration is a vault or chamber with an open bottom that used to store runoff and percolate into the subsurface. A number of vendors offer proprietary infiltration products that allow for similar or enhanced rates of infiltration and subsurface storage while offering durable prefrabricated structures. There are many varieties of proprietary infiltration BMPs that can be used for roads and parking lots, parks and open spaces, single and mult-family residential, or mixed-use and commercial uses.

Also known as:

- *Infiltration vault*
- *Recharge vault*

Underground Infiltration
Source: http://www.contech-cpi.com

Level 1 Screening Considerations

- Infiltration bains shall be screened as Infiltration BMPs for Level 1 Suitability and Effectiveness Screening (Sections 6.2.1.2 and 6.2.1.3, respectively)
- Potential risk of groundwater contamination; may not provide significant attenuation of stormwater pollutants if underlying soils have high permeability;

Opportunity Criteria

- Soils are adequate for infiltration (NRCS Hydrologic Soil Groups A and B).
- Appropriate for sites with limited surface space.
- Can be placed beneath roads, parking lots, parks, and aethletic fields.
- Potential for groundwater contamination can be mitigated through isolation of pollutant sources, pre-treatment of inflow, and/or demonstration of adequate treatment capacity of underlying soils.
- Infiltration is into native soil, or depth of engineered fill is ≤ 5 feet from the bottom of the facility to native material and infiltration into fill is approved by a geotechnical professional.

OC-Specific Design Criteria and Considerations

- ☐ Placement of BMPs should observe geotechnical recommendations with respect to geological hazards (e.g. landslides, liquefaction zones, erosion, etc.) and set-backs (e.g., foundations, utilities, roadways, etc.).
- ☐ Minimum pre-treatment should be provided upstream of the infiltration facility, and water bypassing pre-treatment should <u>not</u> be directed to the facility.
- ☐ Underground infiltration should not be used for drainage areas with ~~high~~ sediment production potential unless preceded by full treatment control with a BMP effective for sediment removal.
- ☐ Design infiltration rate should be determined through a minimum of 2 tests for the first 100 sq-ft and an additional test for each additional 100 sq-ft up to a maximum of 4 per facility.
- ☐ For infiltration facilities beneath roads and parking areas, structural requirements should meet H-20 load requirements.

Computing Underground Infiltration Device Size

Underground infiltration devices should be sized according to:

- The simple method (Section 6.4.2.1), or
- The target capture efficiency method for constant drawdown BMPs (Section 6.4.2.2).

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Draw down should be verifiable, using inspection ports or similar design features.

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In the event that a basin cannot be sized to meet these criteria, smaller sizing may be used and the performance of the infiltration basin as designed should be computed per Section 6.4.2.4.

If a proprietary device is used, specific sizing guidelines from manufacturer should be followed.

Additional References for Design Guidance

- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 5:

http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850

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6.7. Harvest and Use BMPs

6.7.1. Introduction

Harvest and Use (aka Rainwater Harvesting) BMPs are LID BMPs that capture and store stormwater 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. The use of captured water used should comply with codes and regulations and should not result in runoff to storm drains or receiving waters (except indirectly via the sanitary sewer/municipal wastewater treatment system). Uses of captured water may potentially include irrigation demand, indoor non-potable demand, industrial process water demand, or other demands.

6.7.2. Harvest and Use BMP Fact Sheets

6.7.2.1. Cisterns

Cisterns are large rain barrels. While rain barrels are less than 100 gallons, cisterns range from 100 to 10,000 gallons in capacity. Cisterns collect and temporarily store runoff from rooftops for later use as irrigation and/or other non-potable uses. The following components are generally required for installing and utilizing a cistern: (1) pipes that divert rooftop runoff to the cistern, (2) an overflow for when the cistern if full, (3) a pump, and (4) a distribution system to supply the intended end uses.

Also known as:

- *Large Rain Barrels*

Above-Ground Cisterns
Source: Sunset Publishing Corporation

Level 1 Screening Considerations

- Above-ground cisterns shall be screened as a Harvest and Use BMPs for Level 1 Suitability and Effectiveness Screening (Sections 6.2.1.5 and 6.2.1.6).
- Orange County regulatory obstacles may limit rainwater use opportunities.

Opportunity Criteria

- Above-ground cisterns may collect rooftop runoff.
- Above-ground cisterns may be installed in any type of land use provided space is available and adequate water demand exists.

OC-Specific Design Criteria and Considerations

☐ Cisterns should consist of screens on gutters and downspouts to remove vegetative debris and sediment from the runoff prior to entering the cistern.

☐ Above-ground cisterns should be secured in place.

☐ Above-ground cisterns should not be located on uneven or sloped surfaces; if installed on a sloped surface, the base where the cistern will be installed should be leveled and designed for the weight of the filled cistern prior to installation.

☐ Child-resistant covers and mosquito screens should be placed on all water entry holes.

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- ☐ A first flush diverter may be installed so that initial runoff bypasses the cistern.
- ☐ Above-ground cisterns should be installed in a location with easy access for maintenance or replacement.
- ☐ Plumbing systems should be installed in accordance with the current California Building and Plumbing Codes (CBC – part of California Code of Regulations, Title 24).
- ☐ In cases where there is non-potable indoor use demand, proper pre-treatment measures should be installed such as pre-filtration, cartridge filtration, and/or disinfection.

Rainwater Use Demands

- Harvested rainwater can be used for irrigation and other non-potable uses (if local, State, and Federal ordinances allow). The use of captured stormwater allows a reduced demand on the potable water supply. Cross-contamination should be prevented when make-up water is required for rainwater use demand by providing a backflow prevention system on the potable water supply line and/or an air gap.

Irrigation Use

- Subsurface (or drip) irrigation should not require disinfection pre-treatment prior to use; other irrigation types, such as spray irrigation, may require additional pre-treatment prior to use
- Selecting native and/or drought tolerant plants for landscaped area will reduce irrigation demand, therefore, reducing the needed size of the storage facility

Domestic Use

- Domestic uses may include toilet flushing and clothes washing (if local, State, and Federal ordinances allow)
- Pre-treatment requirements per local, State, or Federal codes and ordinances should be applied
- The following table summarizes domestic daily per capita water use for these demands:

Non-Potable Indoor Uses	Daily per capita Water Use (gallons)
Clothes Washers	15.0
Toilets[1]	18.5

Source: American Waterworks Association Research Foundation,1999. *Residential End Uses of Water*. Denver, CO: AWWARF.

- Other Non-Potable Uses
- Other non-potable uses may include vehicle/equipment washing, evaporative cooling, industrial processes, and dilution water for recycled water systems (if local, State, and Federal ordinances allow)
- Pre-treatment requirements per local, State, or Federal codes and ordinances should be applied

Computing Sizing Criteria for Above-Ground Cisterns

Above-ground cisterns used to store water for either outdoor irrigation demand only or indoor steady demand only should be sized per:

- The target capture efficiency method for constant drawdown BMPs (Section 6.4.2.2).

In the event that the cistern cannot be sized to meet this criterion, smaller sizing may be used and the performance of the cistern as designed should be computed per Section 6.4.2.4.

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Include urinals.

Above-ground cisterns used to store water for either a mix of indoor and outdoor demand or irregular demand should be sized based on project-specific analysis to meet performance criteria.

Calculating the Effective Irrigation Area Ratio

In cases where the rainwater use demand is irrigation, the effective irrigation area ratio of the system (*IR*) is calculated using the following formula:

IR = IA x Kc/[IE x Tributary Impervious Area]

Where:

IR = effective irrigated area ratio (ac / ac)

IA = area irrigated with harvested water, ac

Kc = Crop coefficient = ratio of actual evapotranspiration rate to reference evapotranspiration (ETo) when water is present. Account for low water use landscaping requirement when selecting this value.

IE = irrigation efficiency = depth of agronomic demand applied for each unit depth of irrigation supplied. Default is 0.75 inches/inch.

Calculating Above-Ground Cistern Drawdown Time

The drawdown time of above-ground cisterns is dependent on the rainwater use demand of the system and can be approximated by dividing the total stored volume by the use demand.

DD = V / WD

Where:

DD = time to completely drain cistern from brim full, days

V = volume of water stored in the cistern, gallons

WD = daily water demand, gallons

Configuration for Use in a Treatment Train

- Cisterns can be combined into a treatment train to provide enhanced water quality treatment and reductions in the runoff volume and rate. For example, if a green roof is placed upgradient of a cistern, the rate and volume of water flowing to the cistern can be reduced and the water quality enhanced.
- Cisterns can be incorporated into the landscape design of a site and can be aesthetically pleasing as well as functional for irrigation purposes.
- Treatment of the captured rainwater (i.e. disinfection) may be required depending on the end use of the water.

Additional References for Design Guidance

- Santa Barbara BMP Guidance Manual, Chapter 6:
- http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf
- County of Los Angeles Low Impact Development Standards Manual, Chapter 5: http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf
- SMC LID Manual (pp 114): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- San Diego County LID Handbook Appendix 4 (Factsheet 26): http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf

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6.7.2.2. *Underground Detention*

Underground detention facilities are subsurface tanks, vaults, or oversized pipes that store stormwater runoff. Similar to cisterns, underground detention facilities can store water for later use as irrigation and/or other non-potable uses.

Also known as:

- *Underground Cisterns*
- *Underground Detention Basin/Tank/Vault*

Underground detention tank
Source: www.webtecgeos.com

Level 1 Screening Considerations

- If used as part ofa harvest and use system, then underground detention facilities shall be screened as a Harvest and Use BMPs for Level 1 Suitability and Effectiveness Screening (Sections 6.2.1.5 and 6.2.1.6).
- If used for flow-control only, then Level 1 Feasibility screening is not applicable.
- Orange County regulatory obstacles may limit reuse opportunities.

Opportunity Criteria

- Underground detention facilities may collect stormwater runoff from rooftops or from ground level impervious surfaces.
- Underground detention facilities may supply non-potable water use demands suchs as irrigation and toilet flushing.
- Underground detention facilities may be used for flow control.
- Water stored in underground detention facilities may be used for groundwater recharge.

OC-Specific Design Criteria and Considerations

- ☐ Access entry covers (36” diameter minimum) should be locking and within 50 feet of all areas of the detention tank.
- ☐ In cases where the detention facility provides sediment containment, the facility should be laid flat and there should be at least ½ foot of dead storage within the tank or vault.
- ☐ Outlet structures should be designed using the 100-year storm as overflow and should be easily accessible for maintenance activities.
- ☐ For detention facilities beneath roads and parking areas, structural requirements should meet H-20 load requirements.
- ☐ In cases where groundwater may cause flotation, these forces should be counteracted with backfill, anchors, or other measures.
- ☐ Underground detention facilities should be installed on consolidated and stable native soil; if the facility is constructed in fill slopes, a geotechnical analysis should be performed to ensure stability.
- ☐ Plumbing systems should be installed in accordance with the current California Building and Plumbing Codes (CBC – part of California Code of Regulations, Title 24).
- ☐ In cases where there is non-potable indoor reuse demand, proper pre-treatment measures should be installed such as pre-filtration, cartridge filtration, and/or disinfection.

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Harvested Water Use Demands

- Harvested rainwater can be used for irrigation and other non-potable uses (if local, State, and Federal ordinances and allow). The use of captured stormwater allows a reduced demand on the potable water supply. Cross-contamination should be prevented when make-up water is required for rainwater use demand by providing a backflow prevention system on the potable water supply line and/or an air gap.

Irrigation Use

- Subsurface (or drip) irrigation should not require disinfection pre-treatment prior to use; other irrigation types, such as spray irrigation, may require additional pre-treatment prior to use
- Selecting native and/or drought tolerant plants for landscaped area will reduce irrigation demand, therefore, reducing the needed size of the storage facility

Domestic Use

- Domestic uses may includes toilet flushing and clothes washing (if local, State, and Federal ordinances and allow)
- Pre-treatment requirements per local, State, or Federal codes and ordinances should be applied
- The following table summaries domestic daily per capita water use for these demands:

Non-Potable Indoor Uses	Daily per capita Water Use (gallons)
Clothes Washers	15.0
Toilets	18.5

Source: American Waterworks Association Research Foundation,1999. *Residential End Uses of Water*. Denver, CO: AWWARF.

- Other Non-Potable Uses
- Other non-potable uses may include vehicle/equipment washing, evaporative cooling, industrial porcesses, and dilution water for recycled water systems (if local, State, and Federal ordinances allow)
- Pre-treatment requirements per local, State, or Federal codes and ordinances should be applied

Computing Sizing Criteria for Underground Detention Facilities

Underground detention facilitites used to store water for either outdoor irrigation demand only or indoor steady demand only should be sized per:

- The target capture efficiency method for constant drawdown BMPs (Section 6.4.2.2).

In the event that the detention facility cannot be sized to meet this criteria, smaller sizing may be used and the performance of the facility as designed should be computed per Section 6.4.2.4.

Detention facilities used to store water for either a mix of indoor and outdoor demand or irregular demand should be sized based on project-specific analysis to meet performance criteria.

Calculating the Effective Irrigation Area Ratio

In cases where the reuse demand is irrigation, the effective irrigation area ratio of the system (*IR*) is calculated using the following formula:

IR = IA x Kc/[IE x Tributary Impervious Area]

Where:

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IR = effective irrigated area ratio (ac / ac)

IA = area irrigated with harvested water, ac

Kc = Crop coefficient = ratio of actual evapotranspiration rate to reference evapotranspiration (ETo) when water is present. Account for low water use landscaping requirement when selecting this value.

IE = irrigation efficiency = depth of agronomic demand applied for each unit depth of irrigation supplied. Default is 0.75 inches/inch.

Calculating Underground Detention Drawdown Time

The drawdown time of underground detention facilities is dependent on the reuse demand of the system and can be approximated by dividing the total stored volume by the reuse demand.

DD = V / WD

Where:

DD = time to completely drain underground detention tank from brim full, days

V = volume of water stored in the tank, gallons

WD = daily water demand, gallons

Configuration for Use in a Treatment Train

- Underground detention facilities can be incorporated into a treatment train to provide initial or supplemental storage to other detention storage facilities and/or infiltration BMPs.
- Treatment of the captured rainwater (i.e. disinfection) may be required depending on the end use of the water.

Additional References for Design Guidance

- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4: http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- Western Washington Stormwater Management Manual (Volume III Hydrologic Analysis and Flow Control Design/BMPs): http://www.ecy.wa.gov/programs/wq/stormwater/manual.html
- Portland StormwaterManagement Manual, Chapter 2: http://www.portlandonline.com/bes/index.cfm?c=47952&
- SMC LID Manual (pp 114): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf

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6.8. Evapotranspiration BMPs

6.8.1. Introduction

ET BMPs are LID BMPs that capture stormwater runoff and lose water primarily to evaporation and/or transpiration. These BMPs are engineered to store (retain and detain) a specified volume of water. Depending on the outlet design, the storage volume may include 1) the total available pore space within a soil matrix and/or surface detention, or 2) only the plant available water (field capacity-wilting point) portion of the pore space within a soil matrix. Due to the reliance on evaporation and transpiration for volume losses, these BMPs function best when the surface area exposed to wind and solar radiation is maximized.

6.8.2. Evapotranspiration BMP Fact Sheets

6.8.2.1. Green Roof/Brown Roof

Green roofs are also known as ecoroofs, roof gardens, or vegetated roof covers. Green roofs are roofing systems that layer a soil/vegetative cover over a waterproofing membrane. There are two types of green roofing systems; extensive, which is a light weight system and intensive, which is a heavier system that allows for larger plants but requires additional maintenance. A green roof mimics pre-development conditions by limiting the impervious area created by development. Green roofs filter, absorb, and evapotranspire precipitation to help mitigate the effects of urbanization on water quality and delivery of excess runoff to the local storm water conveyance systems.

Also known as:

- *Ecoroofs*
- *Roof Gardens*
- *Vegetated Roof Covers*
- *Brown Roofs*

Green Roof
Source: Milwaukee Department of Environmental Sustainability

Brown roofs are essentially a type of green roof designed to maximize biodiversity. Brown roofs typically utilize natural soil and locally available substrates to create a protected biodiverse habitat for specific species of local flora and fauna. Rather than landscaping the roof during construction, plants are left to germinate and grow on their own in the native soils, thus the "brown" (i.e., initially unvegetated) designation. Hand-seeding may be implemented where self-colonization via airborne seeds is unlikley.

Level 1 Screening Considerations

- Green roofs and brown roofs shall be screened as evapotranspiration BMPs for Level 1 Suitability and Effectiveness Screening (Sections 6.2.1.7 and 6.2.1.8).

Opportunity Criteria

- Green roofs can be applied to residential, commercial, or institutional land uses including rooftops and decks above building structures (e.g., parking structures, outdoor eating area roofs, or storage facilities.

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- Building structure must be adequate to support the additional weight of the soil, retained water, and plants.
- Roof slope must be < 25%.
- Overflow must be captured in another acceptable BMP (biotreatment BMP) or conveyed safely to a stormwater conveyance system.

OC-Specific Design Criteria and Considerations

☐ Saturated soil will weigh approximately10 – 25 lbs/square foot. If the building is not designed to hold this weight (such as in a retrofit situation), a licensed structural engineer should be consulted.

☐ Soil depth should range from 2 - 6 inches, depending on whether the design is intensive or extensive.

☐ A drain pipe (gutter) is required to convey runoff safely from the roof.

☐ Depending on the design of the roof, a drainage layer may be required to move the excess runoff off of the roof.

☐ A waterproof membrane, preventing the roof runoff from penetrating and damaging the roofing material, should be used. There are many materials available for this purpose; they come in various forms (i.e., rolls, sheets, liquid) and exhibit different characteristics (e.g., flexibility, strength, etc.). Depending on the type of membrane chosen a root barrier may be required to prevent roots from compromising the integrity of the membrane.

☐ Green roofs should be about 90% vegetated with a mix of erosion resistant plant species that effectively bind the soil and can withstand the extreme environment of rooftops (i.e., heat, cold, and high winds).

☐ A diverse selection of low growing plants that thrive under the specific site, climatic, and watering conditions should be specified. A mixture of drought tolerant, self-sustaining (perennial or self-sowing without need for fertilizers, herbicides, and or pesticides) is most effective. Native or adapted sedum/succulent plants are preferred because they generally require less fertilizer, limited maintenance, and are more drought resistant than exotic plants. When appropriate, green roofs may be planted with larger plants; however, this depends on structural support, soil depth, and irrigation requirements.

☐ Irrigation is required if the seed is planted in spring or summer. Use of a permanent smart (self-regulating) irrigation system, or other watering system, may help provide maximal water quality performance. Drought-tolerant plants should be specified to minimize irrigation requirements. For projects seeking “High Performance Building” recognition, ASHRAE Standard 189.1 states that potable water cannot be used for irrigating green roofs after they are established.

☐ Locate the green roof in an area without excessive shade to avoid poor vegetative growth. For moderately shaded areas, shade tolerant plants should be used.

☐ Project-specific planting recommendations should be provided by a landscape professional including recommendations on appropriate plants, fertilizer, mulching applications, and irrigation requirements (if any) to ensure healthy vegetation growth.

Sizing

Green roofs and brown roofs should be sized using the simple method (Section 6.4.2.1). The retention storage volume (e.g., field capacity minus wilting point plus any moisture retention layer) should equal the design capture volume, V_{LID}. The drawdown time criteria, or the rate at which the retention volume becomes available, does not apply to green roofs and brown roofs. All runoff in excess of the retention volume that flows through the soil matrix is considered biotreated.

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Soil Condition Guidelines

- The soil layer must have excellent drainage and be adequately fertile as a growing medium for plants. Many companies sell their own proprietary soil mixes. However, a simple volumetric mix of ¼ topsoil, ¼ compost, and the remainder pumice perlite may be used for many applications. Other soil amendments may be substituted for the compost and the pumice perlite, see Section 6.5.3.3 for additional information on soil amendments. The soil mix used should not contain any clay.

Configuration for Use in a Treatment Train

- If implemented in a treatment train, green roofs are typically at the most upstream end. A green roof placed upgradient of a cistern can improve the quality and reduce the rate and volume of water flowing to the cistern. Alternatively, a planter box could be placed downstream of a downspout that drains the green roof.

Additional References for Design Guidance

- Los Angeles Unified School District Stormwater Technical Manual, 2009.
- City of Santa Barbara, Technical Guidance Manual for Post-Construction Storm Water Management, 2008.
- Portland Stormwater Management Manual. http://www.portlandonline.com/bes/index.cfm?c=35122&a=55791
- San Diego County – Low Impact Development Fact Sheets. http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf
- Brown Roofs. http://www.brownroofs.co.uk/brown-roof-maintenance.php

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6.8.2.2. *Blue Roof*

Blue roofs, also known as rooftop detention systems, serve as a rooftop storage designed to reduce runoff peaks and volumes. Captured stormwater, up to the design depth, is held on the rooftop until the water either evaporates or is slowly metered out via flow restriction valves. With sufficent waterproofing blue roofs can be implemented on exisiting structures, given that the roof and building are of sufficent structural integrity to support the weight for the ponded water. As blue roofs lack vegetation, they require significantly less maintenance than green or brown roofs. *Note: The use of blue roofs as an ET BMP may be limited due to vector control restrictions associated with standing water.*

Also known as:

- *Rooftop Detention Systems*

Blue Roof
Source: New York Department of Environmental Protection

Level 1 Screening Considerations

- Blue roofs shall be screened as evapotranspiration BMPs for Level 1 Suitability and Effectiveness Screening (Sections 6.2.1.7 and 6.2.1.8).

Opportunity Criteria

- Blue roofs can be applied to residential, commercial, or institutional land uses including rooftops and decks above building structures (e.g., parking structures, outdoor eating area roofs, or storage facilities).
- Building structure must be adequate to support the additional weight of the retained water.
- Roof slope must be flat.

OC-Specific Design Criteria and Considerations

- ☐ A licensed structural engineer should be consulted regarding the weight bearing capacity of the structure prior to design. Retrofit may be required.
- ☐ Blue roof discharges must be treated by an acceptable biotreatment BMP.
- ☐ A drain pipe (gutter) is required to convey runoff safely from the roof.
- ☐ A waterproof membrane, preventing the retained water from penetrating and damaging the roofing material, should be used. There are many materials available for this purpose; they come in various forms (i.e., rolls, sheets, liquid) and exhibit different characteristics (e.g., flexibility, strength, etc.).
- ☐ Unless covered, the maximum detention time should comply with all local, state, and federal regulations. Maximum hold time is typically 72-hours to prevent the breeding of mosquitoes.
- ☐ Over time rooftop vegetation may sprout by means of windblown sediment and seeds, especially in a dusty, windy environment. Roof drains should be inspected for clogging, as this may adversely affect downstream BMPs.

Sizing

Blue roofs should be sized using the simple method (Section 6.4.2.1). The retention storage volume (i.e., the volume <u>not</u> available for discharge) should equal the design capture volume, V_{LID}. The design volume

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would simply be the design depth multiplied by the roof area, taking into account any sloped edges. The drawdown time criteria, or the rate at which the retention volume becomes available, does not apply to blue roofs. All runoff in excess of the retention volume must be biotreated.

Configuration for Use in a Treatment Train

- A blue roof would serve as the first unit within a treatment train, with captured flows metered to a planter box, rain garden, infiltration gallery, or, if the site is not conducive for infiltration, potentially to a cistern or underground detention area for on-site rainwater use.

Additional References for Design Guidance

- City of New York – Sustainable Stormwater Management Plan, 2008. http://www.nyc.gov/html/planyc2030/downloads/pdf/sustainable_stormwater_plan.pdf
- Enviornmental Protection – Blue Roofs the Stormwater-Sustainability Link. http://eponline.com/blogs/planetshed/2010/04/blue-roofs-the-stormwatersustainability-link.aspx

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6.9. Biotreatment BMPs

6.9.1. Introduction

Biotreatment BMPs are a broad class of BMPs that treat stormwater using a suite of treatment mechanisms characteristic of biologically active systems and discharge water to the downstream storm drain system or directly to receiving waters. Treatment mechanisms include media filtration (though biologically-active media), vegetative filtration (straining, sedimentation, interception, and stabilization of particles resulting from shallow flow through vegetation), general sorption processes (i.e., absorption, adsorption, ion-exchange, precipitation, surface complexation), biologically-mediated transformations, and other processes to address both suspended and dissolved constituents. Biotreatment BMPs include both flow-based and volume-based BMPs.

Note: Biotreatment BMPs may reduce the volume of stormwater via incidental infiltration and evapotranspiration. However, these BMPs are intended to provide treatment for runoff when on-site retention of the design volume has been determined to be infeasible.

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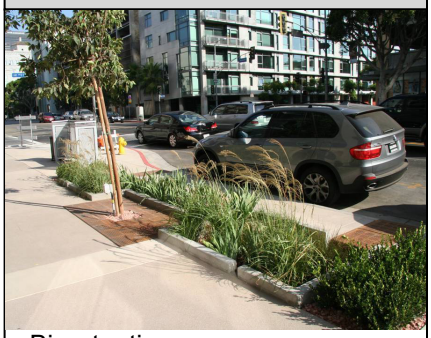
6.9.2. Biotreatment BMP Fact Sheets

6.9.2.1. Bioretention with Underdrain

Bioretention stormwater treatment facilities are landscaped shallow depressions that capture and filter stormwater runoff. These facilities function as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. The facilities normally consist of a ponding area, mulch layer, planting soils, and plants. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, biodegraded, and sequestered by the soil and plants. Bioretention with an underdrain are utilized for areas with low permeability native soils or steep slopes where the underdrain system that routes the treated runoff to the storm drain system rather than depending entirely on infiltration. Bioretention may be designed without an underdrain in areas of high soil permeability and are discussed in Section 6.6.2.3.

Also known as:

- *Rain gardens with underdrains*
- *Vegetated media filter*
- *Downspout planter boxes*



Bioretention
Source: Geosyntec Consultants

Level 1 Screening Considerations

- Bioretention with underdrains may cause incidental infiltration. Therefore, Level 1 Infiltration Feasibility Screening (Section 6.2.1.2) should be conducted to evaluate whether the BMP should include an impermeable liner to avoid infiltration into the subsurface.

Opportunity Criteria

- Land use may include commercial, residential, mixed use, institutional, and subdivisions. Bioretention may also be applied in parking lot islands, cul-de-sacs, traffic circles, road shoulders, road medians, and next to buildings in planter boxes.
- Drainage area is ≤ 5 acres.
- Typically 2-6 percent of drainage area available for the BMP.
- Site must have adequate relief between land surface and the stormwater conveyance system to permit vertical percolation through the soil media and collection and conveyance in underdrain to stormwater conveyance system.

OC-Specific Design Criteria and Considerations

- ☐ Ponding depth should not exceed 18 inches; fencing may be required if ponding depth is greater than 6 inches.
- ☐ A forebay should be provided for all tributary surfaces that contain landscaped areas. The forebay should be designed to prevent standing water during dry weather and should be planted with a plant palette that is tolerant of wet conditions.
- ☐ The minimum soil depth is 2 feet (3 feet is preferred).
- ☐ The maximum drawdown time of the planting soil is 48 hours. The maximum drawdown time of the gravel drainage layer is 72 hours, if applicable.
- ☐ Infiltration pathways may need to be restricted due to the close proximity of roads, foundations, or other infrastructure. A geomembrane liner, or other equivalent water proofing, may be placed along the vertical walls to reduce lateral flows. This liner should have a minimum thickness of 30 mils.

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- ☐ The planting media placed in the cell should be highly permeable and high in organic matter (e.g., loamy sand mixed thoroughly with compost amendment) and a surface mulch layer.
- ☐ Planting media should consist of 60 to 70% sand, 15 to 25% compost, and 10 to 20% clean topsoil. The organic content of the soil mixture should be 8% to 12%; the pH range should be 5.5 to 7.5.
- ☐ Plant materials should be tolerant of summer drought, ponding fluctuations, and saturated soil conditions for 48 hours; native place species and/or hardy cultivars that are not invasive and do not require chemical inputs should be used to the maximum extent practicable.
- ☐ The bioretention area should be covered with 2-4 inches (average 3 inches) or mulch at the start and an additional placement of 1-2 inches of mulch should be added annually.
- ☐ Underdrain should be sized with a 6 inch minimum diameter and have a 0.5% minimum slope. Underdrain should be slotted polyvinyl chloride (PVC) pipe; underdrain pipe should be more than 5 feet from tree locations (if space allows).

Computing Sizing Criteria for Bioretention

Bioretention with underdrains should be sized for the biotreatment volume per:

- The target capture efficiency method for constant drawdown BMPs (Section 6.4.2.2)

In the event that a bioretention area cannot be sized to meet this criteria, smaller sizing may be used and the performance of the bioretention area as designed should be computed per Section 6.4.2.4.

Note: the biotreatment volume is the design volume required to achieve the target capture efficiency after accounting for the retention volume achieved by upstream BMPs. Bioretention with underdrains include additional retention volume in the pore space of the media (field capacity minus wilting point) and within a gravel layer beneath the underdrain (see Figure 6.9).

Calculating Bioretention Drawdown Time

The design discharge rate for bioretention with underdrains depends on the infiltration rate of the planting soil. The planting soil design specifications listed above can be assumed to have a long-term design infiltration rate (K_{DESIGN}) of 2.5 in/hr. Therefore, the drawdown time of a bioretention facility with underdrains can be approximated by dividing the total design volume by the discharge rate through the facility bottom area (assuming the design discharge rate). Note, infiltration through the sides of the facility is not accounted for in the following equation (assuming vertical liners installed).

$$DD = \{V \times 12 \text{ in/ft}\}/\{SA_{BOTTOM} \times K_{DESIGN}\}$$

Where:

DD = time to completely drain bioretention cell from brim full, hours

V = volume of water stored in the bioretention, cu-ft

SA_{BOTTOM} = surface area of bottom of bioretention, sq-ft

K_{DESIGN} = design infiltration rate, in/hr

Configuration for Use in a Treatment Train

- Bioretention areas may be preceeded in a treatment train by hydrologic source controls in the drainage area, which would reduce the required design volume of the bioretention cell.
- Bioretention areas can be incorporated in a treatment train to provide enhanced water quality treatment. For example, runoff can be collected from a roadway in a vegetated swale that then flows to a bioretention area. Similarly, bioretention could be used to manage overflow from a cistern.

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Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-32.pdf
- SMC LID Manual (pp 68): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 5: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- San Diego County LID Handbook Appendix 4 (Factsheet 7): http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf
- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4:
- http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- County of Los Angeles Low Impact Development Standards Manual, Chapter 5:
- http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf

6.9.2.2. *Vegetated Swale*

Vegetated swale filters (vegetated swales) are open, shallow channels with low-lying vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. Vegetated swales provide pollutant removal through settling and filtration in the vegetation (usually grasses) lining the channels. In addition, they provide the opportunity for volume reduction through infiltration and evapotranspiration, and reduce the flow velocity in addition to conveying storm water runoff. Where soil conditions allow, volume reduction in vegetated swales can be enhanced by adding a gravel drainage layer underneath the swale allowing additional flows to be retained and infiltrated. Where slopes are shallow and soil conditions limit or prohibit infiltration, an underdrain system or low flow channel for dry weather flows may be required to minimize ponding and convey treated and/or dry weather flows to an acceptable discharge point. An effective vegetated swale achieves uniform sheet flow through a densely vegetated area for a period of several minutes. The vegetation in the swale can vary depending on its location within the project area and is the choice of the designer, depending on the design criteria outlined in this section.

Also known as:

- *Bioswale*
- *Biofiltration swale*
- *Grass swale*

Vegetated Swale
Source: Geosyntec Consultants

Level 1 Screening Considerations

- Swales may cause incidental infiltration. Therefore, Level 1 Infiltration Feasibility Screening (Section 6.2.1.2) should be conducted to evaluate whether the BMP should include an impermeable liner to avoid infiltration into the subsurface.

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Opportunity Criteria

- Open areas are needed for vegetated swales, including, but not limited to, road shoulders, road medians, park and athletic field and can be constructed in residential or commercial areas.
- Site slope is less than 10 percent..
- Drainage area is ≤ 5 acres.
- Vegetated swales must not interfere with flood control functions of existing conveyance and detention structures.

OC-Specific Design Criteria and Considerations

☐ Swales should have a minimum bottom width of 2 feet and a maximum bottom width of 10 feet. Swale dividers should be used if the bottom width must exceed 10 feet.

☐ The channel side slope should not exceed 2:1 (H:V) for a total swale depth of 1 foot or less. For deeper swales or mowed grass swales, the maximum channel side slope should be 3:1. Where space is constrained, swales may have vertical concrete or block walls provided that slope stability, maintenance access and public safety considerations are met.

☐ A minimum length of 100 feet should be adhered to. This must result in a minimum residence time of 10 minutes. [1] The vegetated swale can be shorter than 100 feet and have less than a 10 minute residence time if it is used for pretreatment.

☐ The maximum bed slope in flow direction should not exceed 6% (unles check dams are provided)

☐ The maximum flow velocity should not exceed 1.0 ft/sec for water quality treatment swales. For strictly flood conveyance swales, the maximum flow velocity should not exceed 3.0 ft/sec.

☐ For infrequently mowed swales, a maximum flow depth of 4 inches should be implemented. For frequently mowed turf swales, the maximum flow depth is 2 inches.

☐ The vegetation height should be maintained between 4 to 6 inches.

☐ Gradual meandering bends in the swale are desirable for aesthetic purposes and to promote slower flow and particulate settling.

☐ If an underdrain is included, an amended soil layer of 1 foot minimum thickness must be provided above the underdrain.

Computing Size Criteria for Vegetated Swales

Vegetated Swales should be sized for the biotreatment flow rate per:

- The target capture efficiency method for annual capture effeciency of flow-based BMPs (Section 6.4.2.2)

Note: the biotreatment flow rate for vegetated swales is the design flow required to achieve the target capture efficiency after accounting for the retention volume achieved by upstream BMPs. Vegetated swales may be designed to include amended soils and underdrains to provide some additional retention volume in the pore space of the amended soil (field capacity minus wilting point) and within a gravel layer beneath the underdrain (see Figure 6.9).

Configuration for Use in a Treatment Train

- Vegetated swales can be incorporated in a treatment train to provide enhanced water quality treatment and reductions in runoff volume and rate. For example, if a vegetated swale is placed upgradient of a dry extended detention (ED) basin, the rate and volume of water flowing to the dry

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ED basin can be reduced and the water quality enhanced. As another example, dry ED basins may be placed upstream a vegetated swale to reduce the size of the vegetated swale.

Additional References for Design Guidance

- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4:
- http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- Santa Barbara BMP Guidance Manual, Chapter 6:
- http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf
- County of San Diego Drainage Design Manual for design criteria, Section 5.5: http://www.sdcounty.ca.gov/dpw/docs/hydrologymanual.pdf
- County of Los Angeles Low Impact Development Standards Manual, Chapter 5:
- http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf
- Los Angeles County Stormwater BMP Design and Maintenance Manual, Chapter 3: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf

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6.9.2.3. *Vegetated Filter Strip*

Vegetated filter strips are designed to treat sheet flow runoff from adjacent impervious surfaces or intensive landscaped areas such as golf courses. Filter strips decrease runoff velocity, filter out total suspended solids and associated pollutants, and provide some infiltration into underlying soils. While some assimilation of dissolved constituents may occur, filter strips are generally more effective in trapping sediment and particulate-bound metals, nutrients, and pesticides. Filter strips are more effective when the runoff passes through the vegetation and thatch layer in the form of shallow, uniform flow. Biological and chemical processes may help break down pesticides, uptake metals, and utilize nutrients that are trapped in the filter.

Also known as:

- *Buffer strip*
- *Vegetated buffer*

Vegetated filter strip.
Source: http://www.wsdot.wa.gov/Environment/WaterQuality/Research/Reports.htm

Level 1 Screening Considerations

- Vegetated filter strips may cause incidental infiltration. Therefore, Level 1 Infiltration Feasibility Screening (Section 6.2.1.2) should be conducted to evaluate whether the BMP should include an impermeable liner to avoid infiltration into the subsurface.

Opportunity Criteria

- Open areas are needed for vegetated filter strips, including road and highway shoulders, small parking lots, and residential, commercial, or institutional landscaped areas.
- Must be sited adjacent to impervious surfaces.
- Shallow, evenly distributed flow across entire width of strip is recommended.
- Steep terrain and/or a large tributary area may cause concentrated, erosive flows. The site slope should not exceed 5%.
- Seasonably high groundwater table must be at least 2 feet below the filter strip.
- Drainage area is ≤ 2 acres with a maximum length (in the direction of flow towards the filter strip) of 150 feet.

OC-Specific Design Criteria and Considerations

- ☐ A minimum length of 15 feet in the flow direction should be adhered to. The maximum length in the flow direction is 150 feet.
- ☐ The width of the filter strip should extend across the full width of the tributary area, with the upstream boundary of the filter strip located contiguous to the developed area.
- ☐ A minimum design residence time of 10 minutes is recommended.
- ☐ The bed slope in flow direction should be between 2 - 6%.
- ☐ The minimum design flow depth should be 1 inch.
- ☐ The design fow velocity should not exceed 1 ft/sec.

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- ☐ Irrigated turf grass or approved equal should be used for vegetation. Grass height should be maintained between 2 – 4 inches.
- ☐ The top of the strip should be installed 2 to 5 inches below the adjacent pavement to allow for vegetation and sediment accumulation at the edge of the strip. A beveled transition is acceptable and may be required per roadside design specifications

Computing Size Criteria for Vegetated Filter Strips

Vegetated Filter Strips should be sized for the biotreatment flow rate per:

- The target capture efficiency method for annual capture effeciency of flow-based BMPs (Section 6.4.2.2)

Note: the biotreatment flow rate for vegetated filter strips is the design flow required to achieve the target capture efficiency after accounting for the retention volume achieved by upstream BMPs. Filter strips may be designed to include amended soils and underdrains to provide some additional retention in the pore space of the amended soil (field capacity minus wilting point) and within a gravel layer beneath the underdrain (see Figure 6.9).

Configuration for Use in a Treatment Train

- Filter strips are often used as pre-treatment devices for other larger capacity BMPs such as bioretention areas and assist by filtering sediment and associated pollutants prior to entering the larger capacity BMP, preventing clogging and reducing the maintenance requirements for larger capacity BMPs.
- Filter strips provide an attractive and inexpensive vegetative storm water runoff BMP that can be easily incorporated into the landscape design of a site. Filter strips are commonly used in the landscape designs of residential, commercial, industrial, institutional, and roadway applications.

Additional References for Design Guidance

- Santa Barbara BMP Guidance Manual, Chapter 6:
- http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf
- Los Angeles County Stormwater BMP Design and Maintenance Manual, Chapter 4: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4:
- http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- SMC LID Manual (pp 135): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf

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6.9.2.4. *Dry Extended Detention Basin*

Dry extended detention basins (DEDBs) are basins whose outlets have been designed to detain the stormwater quality design volume, SQDV, for 36 to 48 hours to allow particulates and associated pollutants to settle out. DEDBs do not have a permanent pool; they are designed to drain completely between storm events. They can also be used to provide hydromodification and/or flood control by modifying the outlet control structure and providing additional detention storage. The slopes, bottom, and forebay of DEDBs are typically vegetated. Considerable stormwater volume reduction can occur in DEDBs when they are located in permeable soils and are not lined with an impermeable barrier.

Also known as:

- *Dry Ponds*
- *Detention Ponds*

Dry Extended Detention Basin,
Source: Geosyntec Consultants

Level 1 Screening Considerations

- Level 1 feasibility screening is not applicable to DEDBs; however the potential risk of groundwater contamination should be considered in selection and design.

Opportunity Criteria

- Most applicable for larger drainage areas where significant area is available at the downstream end of the drainage area.
- Can be integrated into open areas or play fields.
- Not ideal in areas where high seasonal groundwater would limit depth or require lining.
- Not ideal where topography does not allow elevation drop across facility.
- Can be integrated into flood control facilities where essential functions of flood control facilities are not compromised.

Criteria for Categorization of DEDBs as Biotreatment BMP

In order to to be categorized as "biotreatment" BMPs, DEDBs should be designed to meet the following minimum criteria. DEDBs not meeting these criteria but meeting the OC-Specific design criteria listed next are categorized as treatment control BMPs.

- ☐ Maximum treatment depth should be 6 feet
- ☐ Robust, diverse, and extensive vegetation should be designed and maintained to an average height not less than > 12 inches. Soils should be amended per soil amendment criteria contained in Section 6.5.3.3 if vegetation cannot be readily established.
- ☐ Hardscape within basin should be limited to essential access roads.
- ☐ Design should include a vegetated sediment forebay that encompasses between 20 and 30 percent of the basin volume.
- ☐ The basin should be designed to draw down over 48 to 72 hours. The basin should be designed such that drawdown time for the bottom 50 percent of the treatment volume is not less than 2/3 of the entire drawdown time.

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- ☐ The L:W ratio of the basin should meet or exceed 2:1.
- ☐ A micropool should be provided upstream of the outlet structure and/or media filtration should be integrated with the outlet structure.

OC-Specific Design Criteria and Considerations

- ☐ Minimum set-backs from foundations and slopes should be observed
- ☐ Infiltration should not cause geotechnical concerns related to slope stability or erosion. Proposed basins in areas with slopes greater than 15 percent or within 200 feet from the top of a hazardous slope or landslide area require geotechnical investigation.
- ☐ Depth from bottom of facility to seasonal high groundwater table should be ≥ 2 feet.
- ☐ DEDBs are preferrably off-line, designed to bypass peak flows.
- ☐ Minimum freeboard equals 1 foot for offline facilities and 2 feet for online facilities.
- ☐ Maximum side slope (H:V) preferably equals 4:1 interior and 3:1 exterior; steeper slopes permitted with fencing and geotechnical analysis.
- ☐ Longitudinal slope preferably 0%-2%.
- ☐ Low flow channel with gravel infiltration trench preferably provided where infiltration is allowable; designed to eliminate maximum estimated dry weather flowrate.

Computing Sizing Criteria for Dry Extended Detention Basins

DEDBs should be sized for the biotreatment volume per either:

- The simple method (Section 6.4.2.1),
- The target capture efficiency method for constant drawdown BMPs (Section 6.4.2.2), or
- Alternative methods demonstrating 80 percent average annual capture, including upstream BMPs

Note: the biotreatment volume for DEDBs is the design volume required to achieve the target capture efficiency after accounting for the retention volume achieved by upstream BMPs. DEDBs may be specifically designed to include amended soils and underdrains to provide some additional retention in the pore space of the amended soil (field capacity minus wilting point) and within a gravel layer beneath the underdrain (see Figure 6.9).

Providing DEDB Design Storage Volume

The treatment volume provided in a DEDB is a function of facility geometry and outlet structure design. The treatment volume should consist of the volume provide below the overflow elevation and above the low flow orifice elevation. It is recommended that the volume be calculate through stage-area relationships or more sophisticated methods of volume calculation.

Providing DEDB Drawdown Time

- Outlet structures should be designed to meet DEDB drawdown criteria using hydraulic routing methods considering stage-area relationships of the basin.

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Configuration for Use in a Treatment Train

- Dry extended detention basins may be preceeded in a treatment train by hydrologic source controls and LID BMPs in the drainage area, which would reduce the remaining biotreatment/treatment control requirements and allow the basin to be smaller in volume.
- Dry extended detention basins can be located upstream of LID or treatment control BMPs to provide peak flow equalization.

Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-11.pdf
- SMC LID Manual (pp 145): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 2: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- City of Portland Stormwater Management Manual (Pond, pp 2-68) http://www.portlandonline.com/bes/index.cfm?c=47954&a=202883
- San Diego County LID Handbook Appendix 4 (Factsheet 3): http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf

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6.9.2.5. *Wet Detention Basin*

Wet detention basins are constructed, naturalistic ponds with a permanent or seasonal pool of water (also called a "wet pool" or "dead storage"). Aquascape facilities, such as artificial lakes, are a special form of wet pool facility that can incorporate innovative design elements to allow them to function as a stormwater treatment facility in addition to an aesthetic water feature. Wet ponds require base flows to exceed or match losses through evaporation and/or infiltration, and they must be designed with the outlet positioned and/or operated in such a way as to maintain a permanent pool. Wet ponds can be designed to provide extended detention of incoming flows using the volume above the permanent pool surface.

Also known as:

- *Wet Ponds*
- *Retention Ponds*

Wet Detention Basin
Source: Geosyntec Consultants

Level 1 Screening Considerations

- Level 1 feasibility screening is not applicable to wet ponds; however the potential risk of groundwater contamination should be considered in selection and design.

Opportunity Criteria

- Can provide aesthetic/recreational value for a project.
- Requires relatively large open space area at outlet of drainage area.
- Generally most applicable for drainage areas larger than 10 acres; however may be applied to smaller drainage areas.
- Applicable in drainage areas with source of base flow to maintain water level.

OC-Specific Design Criteria and Considerations

- ☐ Minimum set-backs from foundations and slopes should be observed
- ☐ Retention of permanent pool volume should not cause geotechnical concerns related to slope stability. Proposed basins in areas with slopes greater than 15 percent or within 200 feet from the top of a hazardous slope or landslide area require geotechnical investigation.
- ☐ Depth without sediment storage should be a minimum of 4 feet for first cell and a maximum of 8 feet for any cell.
- ☐ Design should include a sediment forebay to remove coarse solids.
- ☐ Flow path length to width ratio is 2:1 (minimum) and 3:1 or greater (preferred).
- ☐ Maximum side slope (H:V) should be 4:1 interior and 3:1 exterior, unless protected from public access by fencing and approved for stability by a geotechnical professional.
- ☐ Wetland vegetation occupying no more than 25% of surface area.

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Computing Sizing Criteria for Wet Detention Basins

- This document does not provide specific sizing guidance for wet detention basins. Wet basins should be designed by a team of specialists that understand wetland ecology and biology and are aware of methods to avoid stagnation, odors, and vector issues associated with maintaining a permanent pool. The BMP designer(s) must demonstrate that the facility is sized to capture and treat the volume of runoff not being addressed by upstream BMPs such that the target percent capture of the total average annual runoff from the site is retained or treated.
- The retention volume within a wet detention basin is the equal to the permanent pool volume. The drawdown time criteria, or the rate at which the retention volume becomes available, does not apply to wet detention basins. All runoff in excess of the retention volume that flows through the basin is considered biotreated.

Calculating Wet Detention Basin Storage Volume

The volume provided in a wet detention basin is a function of facility geometry and basin design. Permanent pool volume should be calculated to fulfill facility aesthetic, recreation, and water quality requirements. Extended detention volume should consist of the volume provided below the overflow elevation and above the outfall orifice elevation. It is recommended that the volume be calculated through stage-area relationships or more sophisticated methods of volume calculation.

Configuration for Use in a Treatment Train

- Wet detention basins would generally be designed to serve as the final BMP before discharging runoff off-site.
- Wet detention basins may be preceeded in a treatment train by hydrologic source controls and LID BMPs in the drainage area, which would reduce the pollutant load and volume of runoff entering the basin, thereby reducing the sizing requirments of the wet detention basin.
- Wet detention basins can be designed to precede other LID or treatment control BMPs, providing equalization and pre-treatment.

Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-20.pdf
- Los Angeles County Stormwater BMP Operations and Maintenance Manual: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- LA County LID Manual, Chapter 5: http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf
- Portland Stormwater Management Manual: http://www.portlandonline.com/bes/index.cfm?c=47953&
- Western Washington Stormwater Management Manual, Volume V, Chapter 10: http://www.ecy.wa.gov/programs/wq/stormwater/manual.html

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6.9.2.6. *Constructed Wetland*

A constructed wetland is a system consisting of a sediment forebay and one or more permanent micro-pools with aquatic vegetation covering a significant portion of the basin. Constructed treatment wetlands typically include components such as an inlet with energy dissipation, a sediment forebay for settling out coarse solids and to facilitate maintenance, shallow sections (1 to 2 feet deep) planted with emergent vegetation, deeper areas or micro pools (3 to 5 feet deep), and a water quality outlet structure. The interactions between the incoming stormwater runoff, aquatic vegetation, wetland soils, and the associated physical, chemical, and biological unit processes are a fundamental part of constructed wetlands.

Also known as:

- *Stormwater Wetlands*
- *Wetland Basins*
- *Treatment Wetland*

Constructed Wetland
Source: Geosyntec Consultants

Level 1 Screening Considerations

- Level 1 feasibility screening is not applicable to constructed wetlands; however the potential risk of groundwater contamination should be considered in selection and design.

Opportunity Criteria

- Potential regional treatment for drainage area.
- Applicable for use with projects involving roads, highways, commercial residences, parks, open spaces, or golf courses.
- Requires large footprint area. Applicable for drainage areas treating areas larger than 10 acres and less than 10 square miles.
- Applicable in drainage areas with source of base flow to maintain water level.
- Wetlands present potential safety concerns and habitat for mosquito and midge breeding.

OC-Specific Design Criteria and Considerations

- ☐ Minimum set-backs from foundations and slopes should be observed
- ☐ Infiltration should not cause geotechnical concerns related to slope stability or erosion. Proposed basins in areas with slopes greater than 7 percent or within 200 feet from the top of a hazardous slope or landslide area require geotechical investigation and report completed by licensed civil engineer.
- ☐ Drawdown time for extended detention 36-48 hours.
- ☐ Design includes sediment forebay to remove coarse solids. Forebay 10%-20% of total basin volume.
- ☐ Depth of sediment forebay equals 4-8 feet.
- ☐ Maximum residence time equals 7 days (dry weather).
- ☐ Flow path length to width ratio is 3:1 (minimum) and 4:1 or greater (preferred).

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- ☐ Maximum side slope (H:V) equals 4:1 interior, 2:1 exterior, 3:1 landscaped.
- ☐ Buffer zone equals a minimum of 25 feet.
- ☐ A source of water should be provided if water balance indicates losses will exceed inputs.

Computing Sizing Criteria for Constructed Wetlands

- This document does not provide specific sizing guidance for constructed wetlands. Wetlands should be designed by a team of wetland specialists that understand wetland ecology and biology and are aware of methods to avoid stagnation, odors, and vector issues associated with maintaining a permanent pool. The BMP designer(s) must demonstrate that the facility is sized to capture and treat the volume of runoff not being addressed by upstream BMPs such that 80 percent of the total average annual runoff from the site is retained or treated.
- The retention volume within a constructed wetland is the equal to the permanent pool volume. The drawdown time criteria, or the rate at which the retention volume becomes available, does not apply to constructed wetlands. All runoff in excess of the retention volume that flows through the wetland is considered biotreated.

Calculating Constructed Wetland Storage Volume

The volume provided in a constructed wetland basin is a function of facility geometry and basin design. Permanent pool volume should be calculated to fulfill facility aesthetic, recreation, and water quality requirements. Extended detention volume should consist of the volume provided below the overflow elevation and above the outfall orifice elevation. It is recommended that the volume be calculated through stage-area relationships or more sophisticated methods of volume calculation.

Configuration for Use in a Treatment Train

- Constructed wetland basins would generally be designed to serve as the final BMP before discharging runoff off-site.
- Constructed wetland basins may be preceeded in a treatment train by hydrologic source controls and LID BMPs in the drainage area, which would reduce the pollutant load and volume of runoff entering the basin, thereby reducing the sizing requirments of the wet detention basin.
- Constructed wetland basins can be designed to precede other LID or treatment control BMPs, providing equalization and pre-treatment.

Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-21.pdf
- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 7: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- LA County LID Manual, Chapter 5: http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf
- SMC LID Manual: http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- Western Washington Stormwater Management Manual, Volume V, Chapter 10: http://www.ecy.wa.gov/programs/wq/stormwater/manual.html

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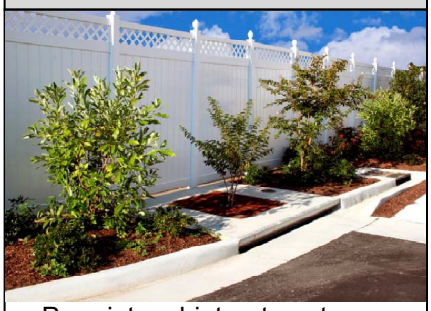
6.9.2.7. *Proprietary Biotreatment*

Proprietary biotreatment devices are devices that are manufactured to mimic natural systems such as bioretention areas by incorporating plants, soil, and microbes engineered to provide treatment at higher flow rates or volumes and with smaller footprints than their natural counterparts. Incoming flows are typically filtered through a planting media (mulch, compost, soil, plants, microbes, etc.) and either infiltrated or collected by an underdrain and delivered to the storm water conveyance system. Tree box filters are an increasingly common type of proprietary biotreatment device that are installed at curb level and filled with a bioretention type soil. For low to moderate flows they operate similarly to bioretention systems and are bypassed during high flows. Tree box filters are highly adaptable solutions that can be used in all types of development and in all types of soils but are especially applicable to dense urban parking lots, street, and roadways.

Also known as:

- *Catch basin planter box*
- *Bioretention vault*
- *Tree box filter*



Proprietary biotreatment
Source: http://www.americastusa.com/index.php/filterra/

Level 1 Screening Considerations

- Proprietary biotreatment devices that are unlined may cause incidental infiltration. Therefore, Level 1 Infiltration Feasibility Screening (Section 6.2.1.2) should be conducted to evaluate whether the BMP should include an impermeable liner to avoid infiltration into the subsurface.

Opportunity Criteria

- Drainage areas of 0.25 to 1.0 acres.
- Land use may include commercial, residential, mixed use, institutional, and subdivisions. Proprietary biotreatment facilities may also be applied in parking lot islands, traffic circles, road shoulders, and road medians.
- Must not adversely affect the level of flood protection provided by the drainage system.

OC-Specific Design Criteria and Considerations

☐ Frequent maintenance and the use of screens and grates to keep trash out may decrease the likelihood of clogging and prevent obstruction and bypass of incoming flows.

☐ Consult proprietors for specific criteria concerning the design and performance.

☐ Proprietary biotreatment may include specific media to address pollutants of concern. However, for proprietary device to be considered a biotreatment device the media must be capable of supporting rigorous growth of vegetation.

Computing Size Criteria for Proprietary Biotreatment Device

- Proprietary biotreatment devices can be volume based or flow-based BMPs.
- Volume-based proprietary devices should be sized for the target capture efficiency described in Section 6.4.2.2
- Flow-based proprietary devices should be sized for the target capture efficienty described in Section 6.4.2.3

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Additional References for Design Guidance

- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 5: http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- Los Angeles County Stormwater BMP Design and Maintenance Manual, Chapter 9: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- Santa Barbara BMP Guidance Manual, Chapter 6:
- http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf

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6.10. Treatment Control BMPs

Treatment Control BMPs are described in Section 8.4. This section provides fact sheets for treatment control BMPs. These BMPs may also serve as pretreatment of LID BMPs.

6.10.1. Treatment Control BMP Fact Sheets

This section provides fact sheets for several types of treatment control BMPs as well as references to other guidance documents containing design criteria. Criteria specifically described in these fact sheets should override guidance contained in the referenced documents where conflicts occur. Where criteria are not specified in these fact sheets, the user should defer to best professional judgment based on the recommendations of the referenced guidance material.

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6.10.1.1. *Media Filters*

Media filters operate by filtering stormwater through a constructed media bed (generally sand) with an underdrain system. Runoff enters the filter and spreads over the surface. 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 vertical (downward through the media) to an engineered underdrain system that is connected to the downstream storm drainage system. As stormwater 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.

Also known as:

- *Sand Filter*

Media Filter
Source: CABMPHB, TC-40

Level 1 Screening Considerations

- Not applicable

Opportunity Criteria

- Intended for use when retention and biotreatment options are infeasible.
- Locate away from trees producing leaf litter or areas contributing significant sediment that could cause clogging.
- Pretreatment is necessary to eliminate significant sediment load or other large particles that could reduce the infiltration capacity of the filter. Refer to Section 6.11 for information on pretreatment devices. Pretreatment can also be performed in a sedimentation chamber, which preceeds the filter bed.
- Drainage area topography and downstream drainage configuration must have adequate relief to allow for percolation through the sand and collection and coveyance through the underdrain stormwater conveyance system; four feet is recommended between inlet and outlet of filter.
- Not applicable in areas of permanent or seasonal high groundwater (less than five feet below ground surface)

OC-Specific Design Criteria and Considerations

- ☐ Where incidental infiltration would potentially cause geotechnical concerns, systems should be lined with an impermeable membrane or layer.
- ☐ Minimum set-backs from foundations and slopes should be observed if the facility is not lined.
- ☐ Filter bed depth (i.e., media thickness) is at least 24 inches, but 36 inches preferred.
- ☐ Max ponding depth above filter should not exceed 6 feet.
- ☐ Saturated hydraulic conductivity of media should be selected to address pollutants of concern and factors of safety in design should be set to account for deterioration of performance between maintenance.
- ☐ Side slopes should not exceed and 2:1 H:V unless stabilization approved by licensed geotechnical engineer.

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☐ Minimum pre-treatment should be provided upstream of the filter, and water bypassing pre-treatment should not be directed to the filter.

☐ Filters should be designed and maintained such that ponded water should not persist for longer than 72 hours following a storm event.

Computing Sizing Criteria for Media Filter

Media filters should be sized according to guidance given in the following sections.

- Media filters used to capture the design storm volume: Section 6.4.2.1 (volume-based), or 6.4.2.3 (flow-based)
- Media filters used as part of an alternative compliance program:Section 8.4.3

Media filters with significant surface storage should be sized as volume-based BMPs. Alternatively, media filters may be sized as flow-based BMPs when storage is not significant.

Calculating Sand Filter Drawdown Rate for Volume-based Sizing Calculations

For volume-based sizing calculations, drawdown can be estimated as.

$$DD = V/Q$$

Where,

D = drawdown time, hours

V = volume of surface storage, cu-ft

$Q = K_{sat} \times I_{half} \times A \times [24\ hr/day]$

K_{sat} = design saturated hydraulic conductivity, feet/day

I_{half} = gradient across filter bed when storage is half full = (depth of water at half full + depth of media bed)/(depth of media bed)

A = surface area of media bed, sq-ft

Calculating Media Filter Design Flowrate Rate if Sized as Flow-based BMP

If sized as flow-based BMP, the design flowrate may be estimated as:

$$Q_{DESIGN} = K_{sat} \times I_{full} \times A / [24\ hr/day]$$

Where,

K_{sat} = design saturated hydraulic conductivity, feet/day (set to account for long-term deterioration of performance)

I_{full} = gradient across filter bed when storage is full = (depth of water at overflow + depth of media bed)/(depth of media bed)

A = surface area of media bed, sq-ft

Configuration for Use in a Treatment Train

- Media filters may be preceeded in a treatment train by hydrologic source controls and LID BMPs in the drainage area, which would reduce the required size of the filter.
- Media filters should be preceeded by some form of pretreatment which will remove the largest particles before entering and potentially clogging the sand filter.
- Media filters can be used to provide pretreatment for infiltration basins or other LID infiltration BMPs.

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Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-40.pdf
- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 6: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- LA County LID Manual: http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf
- San Diego County LID Handbook Appendix 4 (Factsheet 1): http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf
- SMC LID Manual: http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- LA County LID Manual: http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf
- Portland Stormwater Management Manual: http://www.portlandonline.com/bes/index.cfm?c=47953&
- Kitsap County LID Manual: http://www.kitsaphba.org/LID/resources/Cookbook%20V%201_21%20070109.pdf
- Western Washington Stormwater Management Manual: http://www.ecy.wa.gov/programs/wq/stormwater/manual.html

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6.10.1.2. *Cartridge Media Filter*

Cartridge media filters (CMFs) 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 pre-settling basin for removal of coarse sediment while another chamber acts as the filter bay and houses the filter cartridges. A variety of media types are available from various manufacturers which can target pollutants of concern.

Also known as:

- *Manufactured Media Filters*

Cartridge Media Filter
Source: Contech Stormwater Solution, Inc.

Level 1 Screening Considerations

- Not applicable

Opportunity Criteria

- Intended for use when retention and biotreatment options are infeasible.
- Recommended for drainage area with limited available surface area or where surface BMPs would restrict uses.
- For drainage areas with significant areas of non-stabilized soil, permanent soil stablization must be achieved before before cartridge media filters are installed and put on line to minimize risk of clogging.

OC-Specific Design Criteria and Considerations

☐ Cartridge media filter BMP vendors are to be consulted regarding design and specifications.

☐ Filter media should be selected to target pollutants of concern. A combination of media may be appropriate to remove a variety of pollutants.

☐ If CMF are integrated with a vault for equalization, the system should be designed to completely drain the vault within 72 hours of storm event or otherwise protect against standing water and mosquito breeding concerns.

Computing Sizing Criteria for Media Filter Cartridges

- Cartridge media filters used to achieve 80 percent capture: 6.4.2.3
- Cartridge media filters used as part of an alternative compliance program:Section 8.4.3

Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-40.pdf
- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 9: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- SMC LID Manual: http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- Western Washington Stormwater Management Manual, Volume V, Chapter 12: http://www.ecy.wa.gov/programs/wq/stormwater/manual.html

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6.11. Pretreatment/Gross Solids Removal BMPs

6.11.1. Introduction

Pretreatment and gross solids removal is a desirable first step in optimizing BMP selection for a variety of urban runoff situations. In most cases, implementation of pretreatment BMPs will improve the performance and reduce the maintenance associated with downstream BMPs. In fact, pretreatment may be necessary for some BMPs to perform as intended (i.e. trash and debris removal prior to sand filtration).In some cases, BMPs normally considered as a pretreatment BMP may be the only BMP measure feasible before runoff enters receiving waters. An example of this type of situation could be catch basin inserts within roadways adjacent to storm drain channels or waterways. The following section contains information regarding BMPs normally considered for pretreatment applications.

6.11.2. Pretreatment BMP Fact Sheets

This section provides fact sheets for several types of pretreatment/gross solids removal BMPs as well as references to other guidance documents containing design criteria. Criteria specifically described in these fact sheets should override guidance contained in the referenced documents where conflicts occur. Where criteria are not specified in these fact sheets, the user should defer to best professional judgment based on the recommendations of the referenced guidance material.

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6.11.2.1. *Hydrodynamic Separation Device*

Hydrodynamic separation devices are inline pretreatment units designed to remove trash, debris, and coarse sediment using screening, gravity settling, and centrifugal forces generated by forcing the influent into a circular motion. Several companies manufacture units with a variety of design components including separate chambers, baffles, sorbent media, screens, and flow control orifices. Therefore, additional constituents may be targeted depending on the design; however, the short residence time and potential for captured materials to be released during high flows limits the acceptable use of this BMP type as a standalone treatment control BMP.

Also known as:

- *Vortex Separators*
- *Swirl Concentrators*
- *Gross solids removal devices (GSRDs)*

Hydrodynamic Separation Device
Source: Contech Stormwater Solution, Inc.

Opportunity Criteria

- Hydrodynamic separation devices are effective for the removal of course sediment, trash, and debris, and are useful as pretreatment in combination with other BMP types that target smaller particle sizes. They are most effective in urban areas where course sediment, trash, and debris are pollutants of concern.
- Hydrodynamic devices represent a wide range of device types that have different unit processes and design elements (e.g., storage versus flow-through designs, inclusion of media filtration, etc.) that vary significantly within the category. These design features likely have significant effects on BMP performance; therefore, generalized performance data for hydrodynamic devices is not practical.

OC-Specific Design Criteria and Considerations

☐ Proprietary hydrodynamic device BMP vendors are constantly updating and expanding their product lines so refer to the latest design guidance from each of the vendors. General guidelines on the performance, operations and maintenance of proprietary devices are provided by the vendors.

☐ Operations and maintenance requirements include: clearing trash, debris, and sediment around insert grate and inside chamber, and repairing screens and media if damaged or severely clogged.

Computing Sizing Criteria for Hydrodynamic Devices

- Hydrodynamic separation devices should be adequately sized to pretreat the entire design volume or design flow rate of the downstream BMP. A few manufacturers either size the devices for potential clients or offer calculators on their websites that simplify the design process even further and lessens the possibility of using obsolete design information. For the latest sizing guidelines, refer to the manufacturer's website or contact the manufacturer directly.

Proprietary Hydrodynamic Device Manufacturer Websites

Table 6.9 is a list of manufacturers that provide hydrodynamic separation devices. The inclusion of these manufacturers does not represent an endorse of their products. Other devices and manufacturers may be acceptable for pretreatment.

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Table 6.9 Proprietary Hydrodynamic Device Manufacturer Websites		
Device	**Manufacturer**	**Website**
Rinker In-Line Stormceptor®	Rinker Materials™	www.rinkerstormceptor.com
FloGard® Dual-Vortex Hydrodynamic Separator	KriStar Enterprises Inc.	www.kristar.com
Contech® CDS[a]™	Contech® Construction Products Inc.	www.contech-cpi.com
Contech® Vortechs™	Contech® Construction Products Inc.	www.contech-cpi.com
Contech® Vorsentry™	Contech® Construction Products Inc.	www.contech-cpi.com
Contech® Vorsentry™ HS	Contech® Construction Products Inc.	www.contech-cpi.com
BaySaver BaySeparator	Baysaver Technologies Inc.	www.baysaver.com

Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/MP-51.pdf
- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 9: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf

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6.11.2.2. *Catch Basin Insert Fact Sheet*

Catch basin inserts are manufactured filters or fabric placed in a drop inlet to remove sediment and debris and may include sorbent media (oil absorbent pouches) to remove floating oils and grease. Catch basin inserts are selected specifically based upon the orientation of the inlet and the expected sediment and debris loading.

Also known as:

- *Drop Inlet Filters*
- *Catch Basin Filters*

Catch Basin Insert (DrainPac™)
Source: United Storm Water, Inc.

Opportunity Criteria

- Catch basin inserts come in such a wide range of configurations that it is practically impossible to generalize the expected performance. Inserts should mainly be used for catching coarse sediments and floatable trash and are effective as pretreatment in combination with other types of structures that are recognized as water quality treatment BMPs. Trash and large objects can greatly reduce the effectiveness of catch basin inserts with respect to sediment and hydrocarbon capture.
- Catch basin inserts are applicable for drainage area that include parking lots, vehicle maintenance areas, and roadways with catch basins that discharge directly to a receiving water.

OC-Specific Design Criteria and Considerations

☐ Frequent maintenance and the use of screens and grates to keep trash out may decrease the likelihood of clogging and prevent obstruction and bypass of incoming flows.

☐ Consult proprietors for specific criteria concerning the design of catch basin inserts.

☐ Catch basin inserts can be installed with specific media for pollutants of concern.

Proprietary Manufacturer / Supplier Websites

Table 6.10 is a list of manufacturers that provide catch basin inserts. The inclusion of these manufacturers does not represent an endorse of their products. Other devices and manufacturers may be acceptable for pretreatment.

Table 6.10
Proprietary Catch Basin Insert Manufacturer Websites

Device	Manufacturer	Website
AbTech Industries Ultra-Urban Filter™	AbTech Industries	www.abtechindustries.com
Aquashield Aqua-Guardian™ Catch Basin Insert	Aquashield™ Inc.	www.aquashieldinc.com
Bowhead StreamGuard™	Aquashield™ Inc.	www.aquashieldinc.com
Contech® Triton Catch Basin Filter™	Contech® Construction Products Inc.	www.contech-cpi.com

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Contech® Triton Curb Inlet Filter™	Contech® Construction Products Inc.	www.contech-cpi.com
Contech® Triton Basin StormFilter™	Contech® Construction Products Inc.	www.contech-cpi.com
Contech® Curb Inlet StormFilter™	Contech® Construction Products Inc.	www.contech-cpi.com
Curb Inlet Basket	SunTree Technologies Inc.	www.suntreetech.com
Curb Inlet Grates	EcoSense International™	www.ecosenseinternational.org
DrainPac™	United Storm Water, Inc.	http://www.unitedstormwater.com
Grate Inlet Skimmer Box	SunTree Technologies Inc.	www.suntreetech.com
KriStar FloGard+PLUS®	KriStar Enterprises Inc.	www.kristar.com
KriStar FloGard®	KriStar Enterprises Inc.	www.kristar.com
KriStar FloGard LoPro Matrix Filter®	KriStar Enterprises Inc.	www.kristar.com
Nyloplast Storm-PURE Catch Basin Insert	Nyloplast Engineered Surface Drainage Products	www.nyloplast-us.com
StormBasin®	FabCo® Industries Inc.	www.fabco-industries.com
Stormdrain Solutions Interceptor	FabCo® Industries Inc.	www.fabco-industries.com
Stormdrain Solutions Inceptor®	Stormdrain Solutions	www.stormdrains.com
StormPod®	FabCo® Industries Inc.	www.fabco-industries.com
Stormwater Filtration Systems	EcoSense International™	www.ecosenseinternational.org
Ultra-CurbGuard®	UltraTech International Inc.	www.spillcontainment.com
Ultra-DrainGuard®	UltraTech International Inc.	www.spillcontainment.com
Ultra-GrateGuard®	UltraTech International Inc.	www.spillcontainment.com
Ultra-GutterGuard®	UltraTech International Inc.	www.spillcontainment.com
Ultra-InletGuard®	UltraTech International Inc.	www.spillcontainment.com

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Section 7. Hydromodification Control Design

7.1. Introduction

This section describes methods of designing systems to address HCOCs. HCOCs are defined differently in North and South Orange County and therefore different approaches are required for designing systems to address HCOCs.

7.2. Hydromodification Control Concepts

The physical response of stream channels to changes in catchment runoff and sediment yield caused by land use modifications is referred to as hydromodification. Unless managed, hydromodification can cause channel erosion, migration, or sedimentation, as well as biologic impacts to streams. Such impacts may be associated with impairment of beneficial uses and degradation of stream condition.

Control approaches have evolved over time, with efforts first focused on managing peak flows and then on matching the peak, volume, and timing of an event hydrograph. The current understanding is that the long term frequency, magnitude, and durations of the range of sediment transporting flows needs to be managed. This can be accomplished through the use of structural BMPs designed to control flow duration. In-stream measures, such as grade control structures, can also be used to prevent excess erosion due to increased flow durations. In-stream measures are desirable where stream channels are already degraded due to hydromodification caused by existing development.

Consideration for reductions in sediment supply due to development is also critical, as channel stability is a function of the long term balance between sediment transported from and sediment supplied to a stream reach. [1] However, many uncertainties remain regarding how to account for sediment supply changes when designing hydromodification controls.

There are various alternatives for siting hydromodification control measures, including on-site, regional, and in-stream (described in later in this section); each of which has advantages and disadvantages. The choice of control measure siting will be strongly determined by site-specific considerations, including existing stream conditions, local development patterns, and future growth plans.

Control measure sizing is also highly influenced by local characteristics including rainfall, climate, soils, topography, geology, and stream type. These factors determine the extent to which development changes the natural hydrologic processes and the potential for stream impacts. Therefore, hydromodification management requires a suite of strategies that are tailored to local circumstances and stream conditions.

Maintenance is key to sustaining the performance of hydromodification control measures and these concerns will factor into decisions on control measure siting and the implementation of easements or maintenance agreements between municipalities and property owners.

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7.3. System Design to Address HCOCs in North Orange County

This section describes an approach for developing a hydromodification control design to address HCOCs in North Orange County. This section is intended to be used for Priority Projects with HCOCs. Projects that discharge to receiving waters that are not susceptible to hydromodification impacts do not have HCOCs as described in Section 3.3.

This section is intended to be used following the LID and treatment control system design process. The LID and treatment control system design process requires on-site retention and biotreatment, followed by consideration of off-site LID options and treatment controls.

Figure 7.1 illustrates the general approach for developing a hydromodification control design to address HCOCs in North Orange County.

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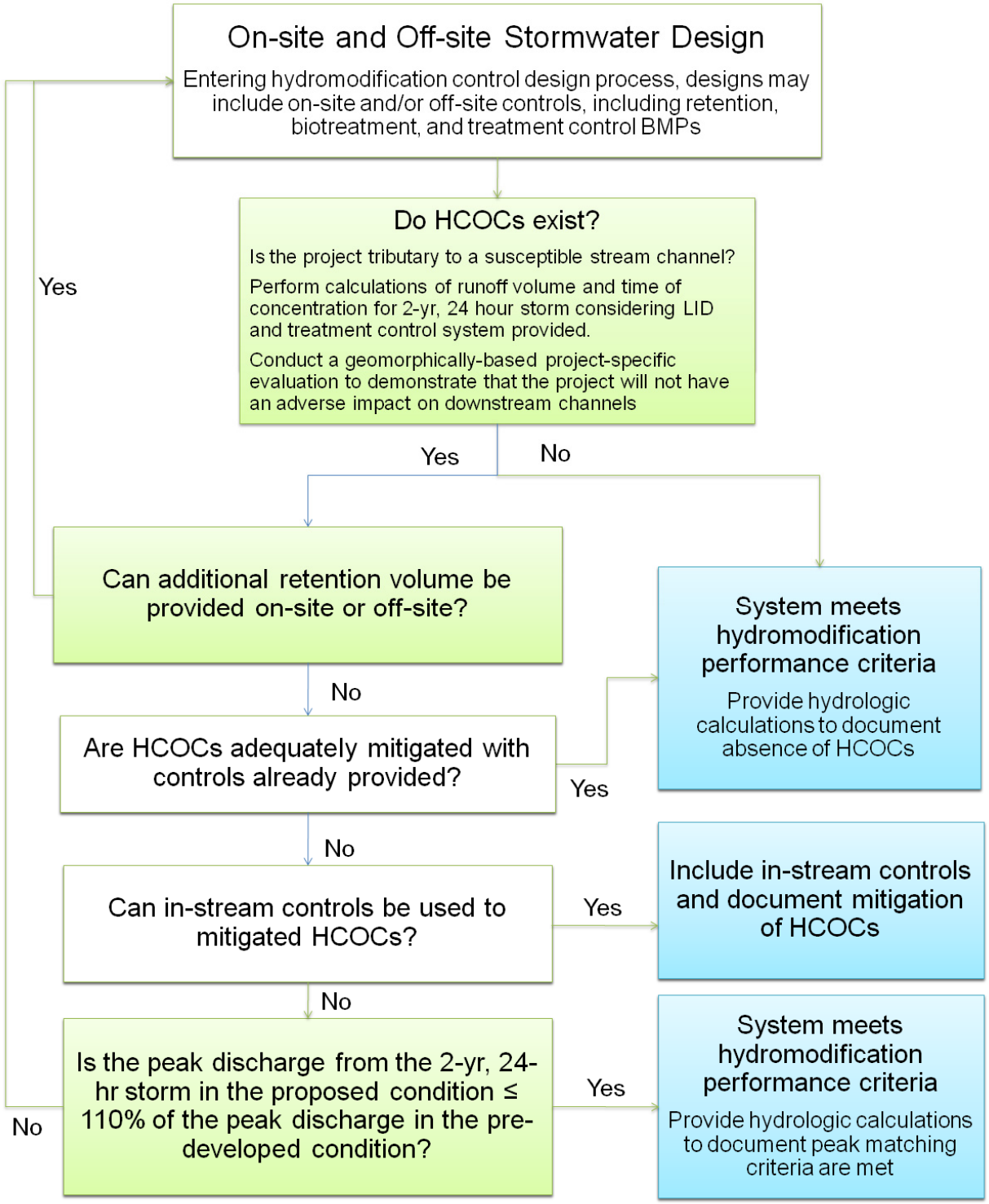
Figure 7.1
North Orange County Hydromodification Design Process



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7.3.1. Determine Whether HCOCs Exist

Hydrologic conditions of concern in North Orange County can be mitigated by to managing runoff such that the post-development runoff volume for the 2-year, 24-hr storm event ($V_{2\text{-yr, POST}}$) does not exceed that of the pre-development condition ($V_{2\text{-yr, PRE}}$) by more than 5%. This can be expressed as:

$$(V_{2\text{-yr, POST}} / V_{2\text{-yr, PRE}}) \leq 1.05$$

The post-development time of concentration (T_c) must also be managed such that:

$$(Tc_{2\text{-yr, POST}} / Tc_{2\text{-yr, PRE}}) \geq 0.95 \text{ (See footnote 4)}$$

The LID and treatment control system, provided previously in the Project WQMP preparation process, may provide significant retention, biotreatment, and/or treatment controls which will contribute to meeting hydromodification control requirements. The volume of runoff retained in LID BMPs serves to reduce $V_{2\text{-yr, POST}}$ and increase $Tc_{2\text{-yr, POST}}$ compared to post-developed conditions without stormwater controls.

The project characteristics and system design documented in previous steps of the Project WQMP preparation process should be evaluated using the hydrologic methods described in Section 2.3.3 to evaluate the above criteria. In order to achieve their intended function, hydromodification control BMPs must be able to accept runoff from sequential storm events. Therefore, if BMPs draw down in greater than 48 hours, only the portion of the system volume that drains in 48 hours may be counted as retained for the purpose of hydromodification control volume matching calculations.

If the results indicate that HCOCs do not exist, then hydromodification requirements are met. The Project WQMP shall document these calculations.

The point of analysis for this assessment of pre- and post-development runoff volume and time of concentration is located where runoff leaves the project site. However, the project proponent may use this same assessment technique for a point of compliance further downstream as part of a geomorphically-based project-specific evaluation of whether the project will adversely impact downstream erosion, sedimentation, or stream habitat, described in Section 3.4.3. For example, if a site is mapped as potentially having a HCOC, but the nearest susceptible channel segment is miles downstream, then the hydromodification impact due to developing the site may be negligible. In this case, it would be appropriate to use a point of analysis located at the nearest susceptible channel for the geomorphically-based impact evaluation.

If HCOCs still exist, then the project proceeds to the next step.

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7.3.2. Evaluate Additional On-site and Off-site Controls

The Project WQMP should consider increasing the size of on-site and off-site controls to attempt to meet the volume- and time of concentration-matching criteria expressed in Section 7.3.1.

If additional volume can be provided, the project should return to the system design phase and modify designs to add this volume. The results of Level 1 and Level 2 feasibility analyses conducted in Section 6.2 and 6.3 should be considered in making this determination.

If additional volume cannot be provided, then the project proceeds to the next step.

7.3.3. Site Specific Evaluation of In-stream Control Options

A site specific evaluation may be conducted to determine whether opportunity exists to mitigate potential impacts through in-stream controls. The site specific evaluation may find that in-stream controls can be feasibly implemented in combination with on-site and regional controls such that the project will not adversely impact downstream erosion, sedimentation, or stream habitat. If this finding is made, in-stream controls shall be designed and included in the Project WQMP along with documentation demonstrating that the project and proposed system will not adversely impact downstream erosion, sedimentation, or stream habitat.

7.3.4. Provide Peak Design for Peak Matching

Where the Project WQMP documents that the excess runoff volume from the 2-yr runoff event cannot feasibly be retained, the project must implement on-site or regional hydromodification controls to:

- Retain the excess volume from the 2-yr runoff event to the MEP.
- Reduce post-development runoff 2-yr peak flow rate to no greater than 110% of the pre-development runoff 2-yr peak flow rate.

Hydrologic calculations demonstrating satisfaction of peak matching criteria should be based on methods described in Section 2.3.3. If the system as proposed cannot satisfy this criterion, the project must return to the system design phase and make the changes necessary such that this criterion is met.

7.4. System Design to Address HCOCs in South Orange County

The definition of HCOCs in South Orange County requires the use of a site-specific design and analysis process to develop hydromodification control designs. The fundamental concepts that underlie such a process are discussed in the section below, however instructions for performing a site specific analysis are beyond the scope of this document.

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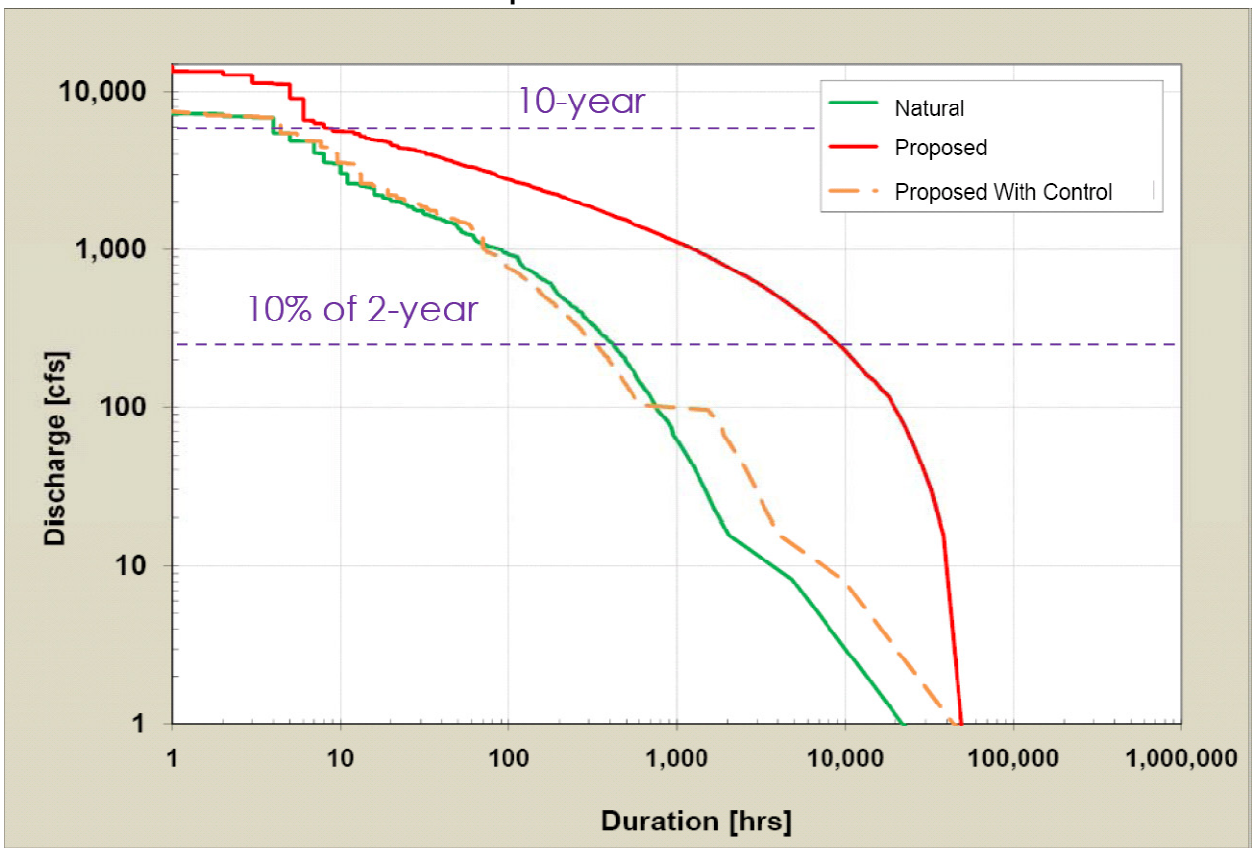
The environmental impacts of any in-stream controls must be analyzed by the local jurisdiction pursuant to CEQA and the necessary permits from regulatory agencies must be obtained.

7.4.1. Hydromodification Control Flow Duration Control Analysis (South Orange County)

The interim hydromodification standard in the South Orange County focuses on controlling hydromodification by mimicking pre-development (naturally occurring) flow magnitudes and durations over a long period of record rather than for the discrete 2-year storm event. A flow duration curve is the primary means of demonstrating changes in flow magnitudes and durations over a continuous period of record. A flow-duration curve is a plot of discharge versus the duration of time the discharge is exceeded. It is developed through continuous simulation of project under the following conditions: pre-developed (natural), post-developed, and post-developed with controls. An example flow duration curve is show in **Figure 7.2**.

Figure 7.2
Example Flow Duration Chart



In order to mitigate HCOCs in South Orange County, flow rates and durations must be controlled between 10 percent of the 2-year storm event and the 10-year storm event, as indicated by purple dashed lines on **Figure 7.2**. This means that the post-development flow duration curve (red line in **Figure 7.2**) needs to be lowered such that it is at or below the pre-development flow duration curve (green line) within the bounds of the purple dashed lines. In order to accomplish this, site design, volume reduction, and flow duration control BMPs can be used. This process must be based on continuous simulation of stormwater controls or through use of design charts developed from continuous simulation of stormwater controls.

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7.5. On-Site / Distributed Controls

A variety of volume / flow management structural BMPs are available that utilize the following two basic principles:

- Detain runoff and release it in a controlled way that either mimics pre-development ~~flow durations~~ [1]r reduces flow durations to account for a reduction in sediment supply.
- Manage excess runoff volumes through one or more of the following pathways: infiltration, evapotranspiration, storage and use, discharge at a rate below the critical rate for adverse impact, or discharge downstream to a non-susceptible water body.

Distributed facilities are small scale facilities, typically treating runoff from less than ten acres. These types of facilities include, but are not limited to, bioretention areas, permeable pavement, green roofs, cisterns, vegetated swales, and filter strips. These types of facilities will also help to achieve the LID performance standard.

Design guidance for on-site controls LID BMPs and treatment control BMPs are provided in Sections 6.5 through 6.10.

7.6. Detention/Retention Basins

Detention/retention basins are stormwater management facilities that are designed to detain and infiltrate runoff from one or multiple projects or project areas. These basins are typically shallow with flat, vegetated bottoms. Detention/retention basins can be constructed by either excavating a depression or building a berm to create above ground storage, such that runoff can drain into the basin by gravity. Runoff is stored in the basin as well as in the pore spaces of the surface soils. Pretreatment BMPs such as swales, filter strips, and sedimentation forebays minimize fine sediment loading to the basins, thereby reducing maintenance frequencies.

Detention/retention basins for hydromodification management incorporate outlet structures designed for flow duration control. These basins can also be designed to support flood control and water quality treatment objectives in addition to hydromodification. If underlying soils are not suitable for infiltration, the basin may be designed for flow detention only, with alternative practices to manage increased volumes, such as storage and use, discharge at a rate below the critical rate for adverse impacts, or discharge to a non-susceptible water body.

Detention/retention basins should be designed to receive flows from developed areas only, for both design optimization as well as to avoid intercepting coarse sediments from open spaces that should ideally be passed through to the stream channel. Reduction in coarse sediment loads contributes to channel instability.

7.7. In-Stream Controls

Hydromodification management can also be achieved by in-stream controls, including drop structures, bed and bank reinforcement, and grade control structures.

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hydrograph

7.7.1. Drop Structures

Drop structures are designed to reduce the channel slope, thereby reducing the shear stresses generated by stream flows. These controls can be incorporated as natural appearing rock structures with a step-pool design which allows drop energy to be dissipated in the pools while providing a reduced longitudinal slope between structures.

7.7.2. Grade Control Structures

Grade control structures are designed to maintain the existing channel slope while allowing for minor amounts of local scour. These control measures are often buried and would entail a narrow trench across the width of the stream backfilled with concrete or similar material, as well as the creation of a "plunge pool" feature on the downstream side of the sill by placing boulders and vegetation. A grade control option provides a reduced footprint and impact compared to drop structures, which are designed to alter the channel slope.

7.7.3. Bed and Bank Reinforcement

Channel reinforcement serves to increase bed and bank resistance to stream flows. In addition to conventional techniques such as riprap and concrete, a number of vegetated approaches are increasingly utilized, including products such as vegetated reinforcement mats. This technology provides erosion control with an open-weave material that stabilizes bed and bank surfaces and allows for re-establishment of native plants, which serves to further increase channel stability.

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Section 8. Alternative Compliance Approaches

This section describes the criteria for developing an alternative compliance plan and the elements that could be included in such a plan. An alternative compliance plan is required if LID requirements for a proposed project cannot be met through on-site LID BMPs or, in North Orange County only, through regional or sub-regional LID BMPs. This section is intended to support Section 7.II-2.4 of the Model WQMP.

Section 8.1 describes the criteria for developing an alternative compliance approach in either North or South Orange County and describes how the various alternative compliance programs are used in combination.

Section 8.2 describes water quality credits which may be available to some projects as part of an alternative compliance plan. In North Orange County, these can be accessed outside of a waiver process. In South Orange County, these can be accessed after the waiver process.

Section 8.3 describes the waiver process. A waiver request must be prepared and submitted prior to approving an alternative compliance plan. In North Orange County, a waiver would not be required if water quality credits are sufficient to fulfill alternative compliance obligations.

Section 8.4 describes selection, siting, and sizing of treatment control BMPs, which may be optional or required as part of an alternative compliance plan.

Section 8.5 describes mitigation funds and mitigation programs which may be used as part of an alternative compliance program.

Flow charts for the key steps and decisions points for alternative compliance approaches are shown in **Figure 8.1** and **Figure 8.2**.

Alternative compliance plans are not required for roadway and similarly constrained right-of-way and drainage projects (See Section 2.2.5.1) and are not required for watershed-based projects in South Orange County, as described in Section 2.2.2.2

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Figure 8.1
Alternative Program Flow Chart for North Orange County
Note: Model WQMP sections shown in red.

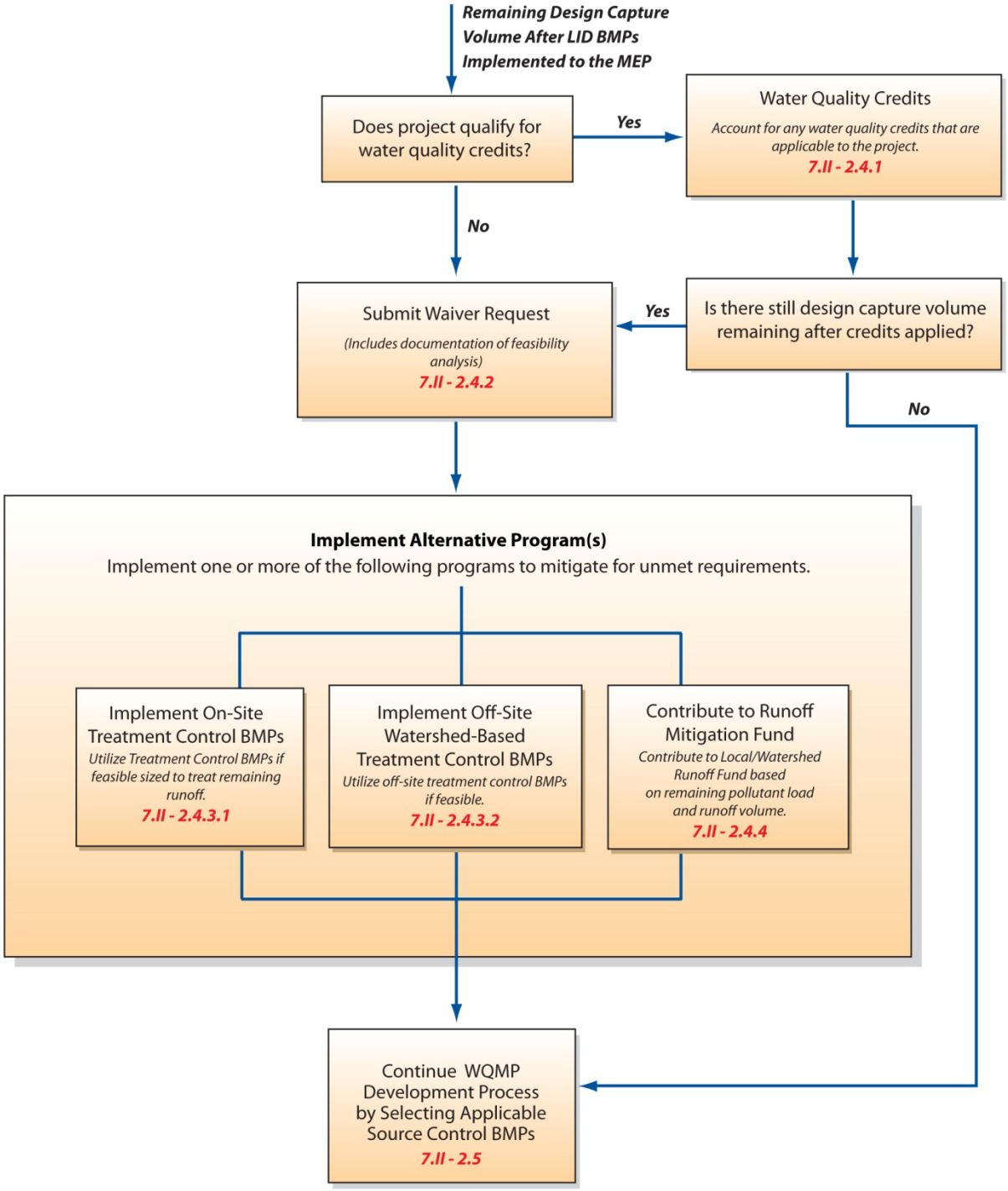

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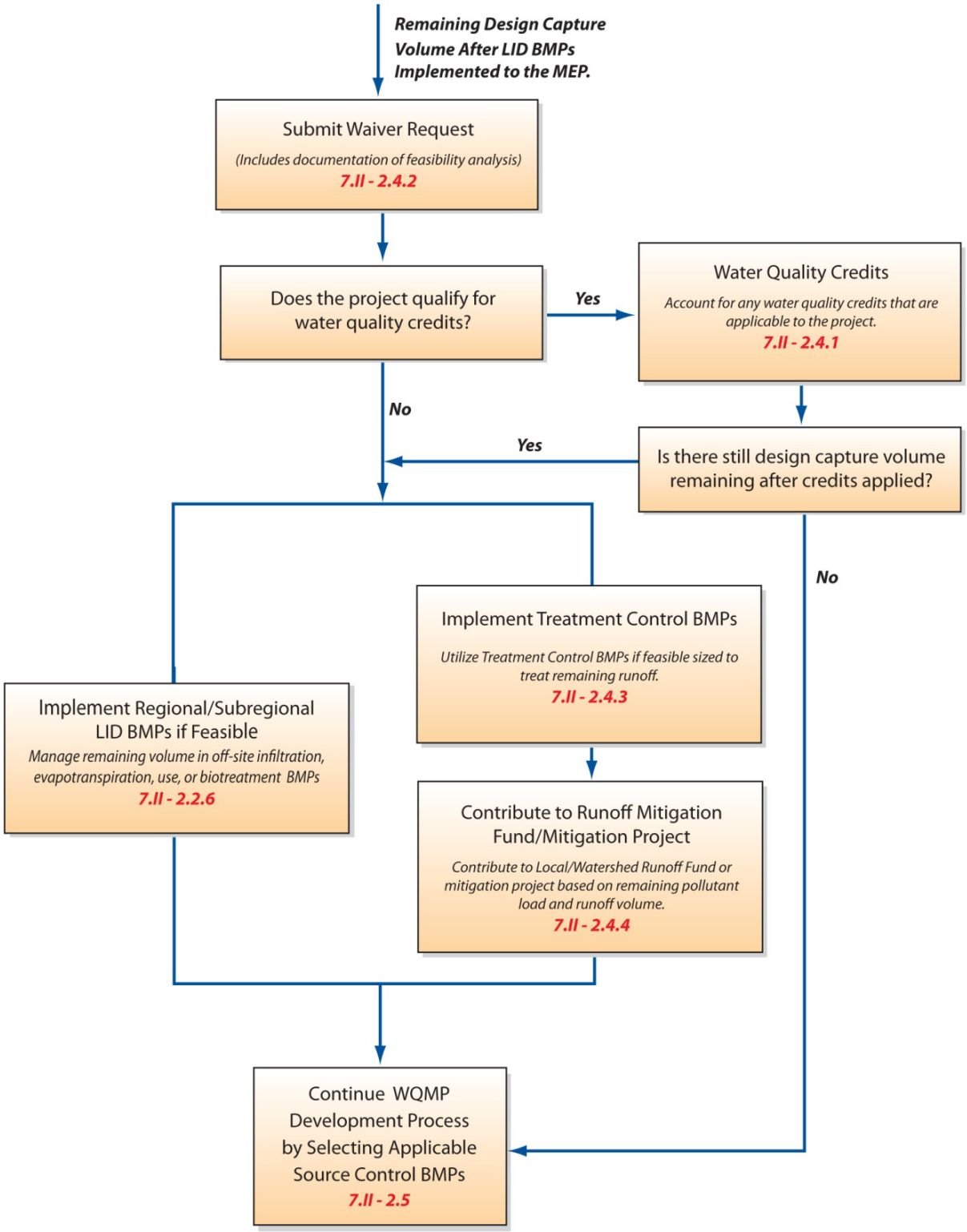
Figure 8.2
Alternative Program Flow Chart for South Orange County
Note: Model WQMP sections shown in red.



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8.1. Alternative Compliance Criteria

An alternative compliance plan shall be developed for any Priority Project that is not able to fully meet LID requirements in one of the following ways:

- Site design and on-site LID BMPs
- Regional or subregional LID projects in North Orange County as defined in Section 2.2.6 of the Model WQMP
- Development projects in South Orange County greater than 100 acres in total project size or smaller than 100 acres in size yet part of a larger common plan of development that is over 100 acres, that have been prepared using watershed and/or sub-watershed based water quality, hydrologic, and fluvial geomorphologic planning principles that implement regional LID BMPs as described in Section 2.2.6 of the Model WQMP.

For Priority Projects requiring an alternative compliance plan, the project proponent shall calculate the remaining LID and treatment control obligations and develop a plan for addressing these through the options listed below. Section 8.1.1 describes the requirements for computing remaining obligations. Some projects may qualify for water quality credits that can be applied to reduce these obligations. For Priority Projects located in North Orange County, credits can taken before applying for a waiver. For Priority Projects located in South Orange County, water quality credits can only be accessed after a waiver has been issued. Water quality credits are discussed in Section 8.2, and waivers are described below in Section 8.3.

If water quality credits are applicable and are sufficient to fully meet the remaining LID and treatment control obligations, no further alternative compliance programs are required. If water quality credits do not fully satisfy the unmet obligations for a project, alternative compliance plans shall be developed to meet the following criteria.

North Orange County project proponents shall develop an alternative compliance plan to address the remaining unmet LID and treatment control requirements, after accounting for water quality credits, through one of the following options:

1) Implement on-site treatment control BMPs. Treatment control BMPs shall be selected and designed to address the pollutants of concern for the project, thereby fulfilling the treatment control requirements. The pollutant removal achieved by the selected treatment control BMPs may be used to fulfill remaining LID requirements based on the effectiveness of treatment control BMPs relative to LID BMPs for the primary pollutant(s) of concern.

   OR

2) Implement watershed-based treatment control BMPs. Watershed-based treatment control BMPs shall be located upstream of Waters of the US and be selected and designed to address the pollutants of concern for the project. The pollutant removal achieved by the selected treatment control BMPs may be used to fulfill remaining LID

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requirements based on the effectiveness of treatment control BMPs relative to LID BMPs for the primary pollutant(s) of concern.

OR

3) Contribute to an urban runoff fund.

OR

4) A combination of 1, 2, and/or 3 to address all remaining performance criteria.

Note: in North Orange County, sub-regional/regional LID BMPs should be considered prior to developing an alternative compliance plan, therefore are not included in this list.

South Orange County project proponents shall develop an alternative compliance plan to address the remaining unmet LID and treatment control requirements, after accounting for water quality credits. The alternative compliance plan shall include the following elements:

1) Implement sub-regional / regional LID solutions if feasible. Sub-regional/regional LID BMPs shall be located upstream of Waters of the US and be selected and designed to address the pollutants of concern for the project. Sub-regional/regional LID BMPs fulfill LID and treatment control obligations for the volume of water treated.

OR

2) Implement on-site structural treatment controls (treatment control BMPs), and

   a) Implement an off-site mitigation project to address all remaining performance criteria,
   b) Contribute to a stormwater mitigation fund to address all remaining performance criteria, or
   c) A combination of (a) and (b).

OR

3) A combination of (1) and (2).

In North Orange County, the use of treatment control BMPs is not required before discharge to Waters of the US if other alternative compliance options are provided to fulfill remaining requirements and beneficial uses of receiving waters are not impaired. If treatment control BMPs are used as an alternative compliance option, the performance of these BMPs should be compared to the performance that would be achieved by LID BMPs to determine the amount of obligations met as described in Section 8.4.6. The performance provided by treatment control BMPs may be demonstrated to fully or partially meet remaining LID obligations.

In South Orange County, sub-regional /regional LID BMPs sized for the remaining portion of the design capture volume can be implemented to fulfill alternative compliance requirements. Alternatively, treatment control BMPs must be incorporated into projects before discharge to Waters of the US, and the project must meet remaining LID obligations though another alternative program. The performance of treatment control BMPs could be compared to the

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Explain how this comparison will be made.

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Explain how this demonstration will be made.

performance that would be achieved by on-site LID BMPs to determine the amount of obligations met.

8.1.1. Calculating Remaining LID and Treatment Control Performance Criteria to be Met by Alternative Methods

For the purposes of developing an alternative compliance program, the remaining ("unmet") portion of the design capture volume is determined based on the difference between the target 80 capture efficiency and the capture efficiency achieved by the LID BMPs provided before entering the alternative program. This section describes the method for calculating the unmet design capture volume.

1) Calculate the capture efficiency achieved upstream of the alternative compliance program. In North Orange County, this may include the effects of on-site LID BMPs and/or sub-regional/regional LID BMPs. In South Orange County, this will only include the effects of on-site LID BMPs. Methods of calculating capture efficiency are provided in **Table 3.7**.

2) Using **Figure 8.3**, find the already-achieved capture efficiency on the horizontal axis and read upward to the line on the chart. Pivot 90 degrees and read to the vertical axis. This is the fraction of the design capture storm depth remaining to be met. Multiply this value by the design capture storm depth for the project (as determined in Section 3.4.2) to determine the remaining storm depth to be managed in the alternative compliance plan.

3) Compute the volume of runoff from the project for the storm depth calculated in (2), by using the hydrologic methods described in Section 2.3.1. This is the remaining volume to be managed, expressed in cubic feet.

Example 8.1: Calculating Remaining LID Design Criteria for Alternative Compliance
Given:
• 85th percentile, 24-hr storm depth = 0.85 inches (Figure 6.2)
• Drainage Area = 1.5 acres
• Imperviousness = 80%
• Upstream LID BMPs achieve 60 percent average annual capture efficiency
Required:
• Compute remaining LID volume transferred to alternative program
Solution:
7) Capture efficiency achieved = 60 percent (given)
8) From **Figure 8.3**, the unmet fraction of the design capture storm depth is 0.47. The unmet design storm depth = 0.47 × 0.85 inches (given) = 0.40 inches

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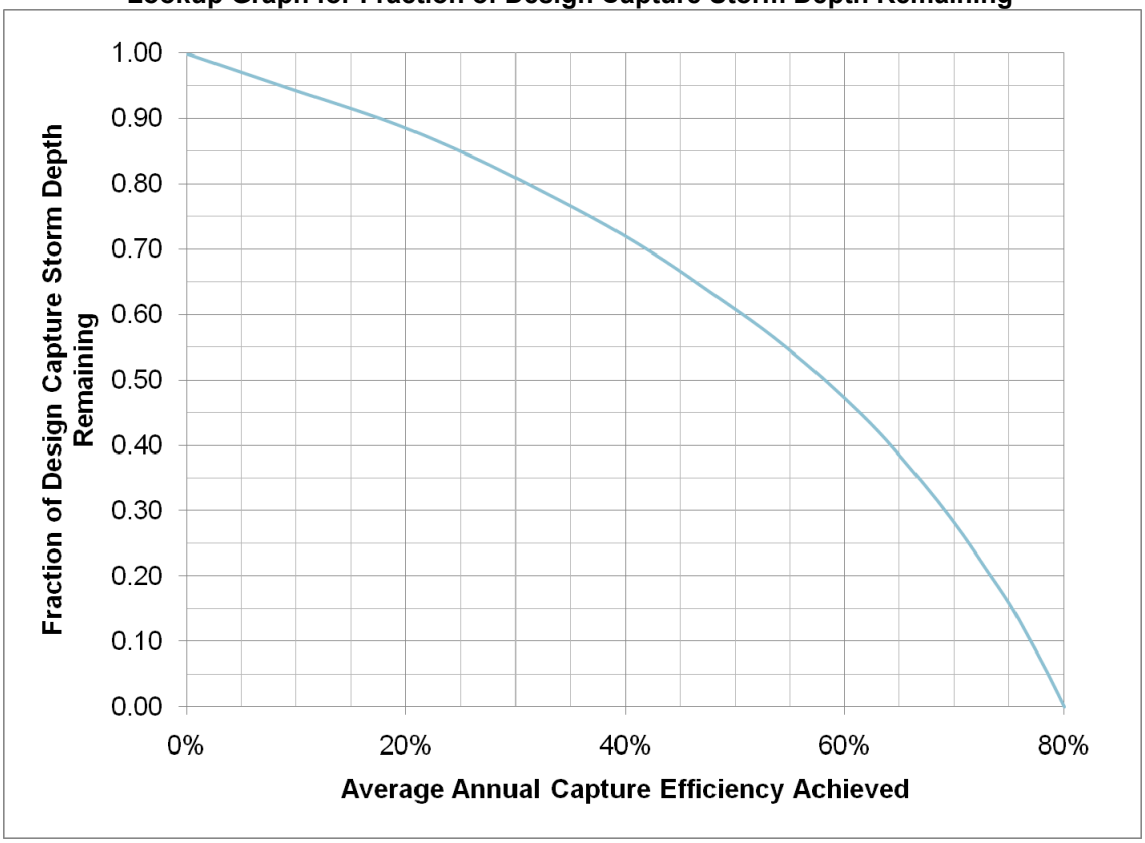
These methods are incorrect.

9) V_{REMAIN} = 1.5 ac × 0.40 inches × (0.8×0.75 + 0.15) × 43,560 sf/ac × 1/12 in/ft = 1,630 cu-ft

This is the volume that must be addressed through alternative compliance programs.

Figure 8.3
Lookup Graph for Fraction of Design Capture Storm Depth Remaining



8.2. Water Quality Credit Programs

Local jurisdictions may develop a water quality credit program that applies to certain types of development projects after they first evaluate the feasibility of meeting LID requirements with on-site LID BMPs (North and South Orange County) and/or sub-regional/regional BMPs (North Orange County only). If it is not feasible to fully meet LID and treatment control obligations through these options, then specific project types can claim water quality credits which reduce project obligations for selecting and sizing other treatment BMPs or participating in other alternative programs. In South Orange County, a waiver must be approved (see Section 8.3) before water quality credits may be claimed. In North Orange County, a project may claim water quality credits, if applicable, after demonstrating through Level 2 Feasibility Analysis (see Section 3.7) that LID requirements cannot be otherwise met.

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8.2.1. Types of Projects Potentially Eligible for Water Quality Credits

Projects potentially eligible for consideration for credits include:

- Redevelopment projects that reduce the overall impervious footprint of the project site;
- Redevelopment projects in an established historic district, historic preservation area, or similar significant city area including core City Center areas (to be defined through mapping);
- Brownfield redevelopment, meaning redevelopment, expansion, or reuse of real property which may be complicated by the presence or potential presence of hazardous substances, pollutants or contaminants, and which have the potential to contribute to adverse ground or surface water quality if not redeveloped;
- Higher density development projects which include two distinct categories (credits can only be taken for one category:
  - Those with more than seven units per acre of development (lower credit allowance);
  - Vertical density developments, for example, those with a Floor to Area Ratio (FAR) of 2, or those having more than 18 units per acre (greater credit allowance);
- Mixed use development, such as a combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that can demonstrate environmental benefits that would not be realized through single use projects (e.g. reduced vehicle trip traffic with the potential to reduce sources of water or air pollution);
- Transit-oriented developments, such as a mixed use residential or commercial area designed to maximize access to public transportation; similar to above criterion, but where the development center is within one half mile of a mass transit center. Such projects would not be able to take credit for both categories, but may have greater credit assigned;
- Live-work developments, a variety of developments designed to support residential and vocational needs together – similar to criteria to mixed use development; would not be able to take credit for both categories; and
- In-fill projects, the conversion of empty lots and other underused spaces into more beneficially used spaces, such as residential or commercial areas.

These types of projects are provided as examples of those for which water quality credits could apply. [1] ~~Other types of projects that provide environmental benefits may also be proposed for consideration.~~

8.2.2. Applying Water Quality Credits to LID and Treatment Control Performance Criteria

Water quality credits are applied to reduce the remaining unmet obligations for LID and treatment control. Unmet obligations are computed as described in Section 8.1.1 and expressed

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Only those categories of projects specified in the Permit or approved by the Executive Officer in the MWQMP are eligible. Other types cannot be added later with this type of open-ended statement.

in terms of a simple volume. Water quality credits are then computed based on the original design capture volume for the project and may fully or partially off-set the remaining unmet volume. The magnitude of this offset credits would be calculated in one of two ways, as described below.

8.2.2.1. Applying Water Quality Credits to Projects Reducing Overall Impervious Footprint

For redevelopment projects that reduce the overall impervious footprint of the project site compared to current use, the volumetric offset provided by water quality credits would be calculated as follows:

1) Calculate an equivalent "existing" design capture volume for the site using the LID performance criteria described in Section 6.4.2.1 and current site imperviousness.

2) Calculate the design capture volume for the site under the proposed development plan.

3) The difference between the volumes calculated in (1) and (2) is equal to the Credit Volume, which may be applied to off-set unmet LID and treatment control obligations.

8.2.2.2. Applying Water Quality Credits to Projects Based on Project Type and Density

For other categories of projects noted in Section 8.2.1, the remaining unmet LID and treatment control performance criteria would be reduced in accordance with the following portions of the original design capture volume, calculated based on the proposed site imperviousness and prior to the application of LID BMPs:

- Historic district, historic preservation area, or similar areas – 10 percent
- Brownfield redevelopment – 25 percent
- Higher density development
  - 7 units/acre – 5 percent
  - Vertical density as defined – 20 percent
- Mixed use development, transit oriented development or live-work development – 20 percent
- In-fill development – 10 percent

If more than one category applies to a particular project, the credit percentages would be additive. Applicable performance criteria depend on the number of LID water quality credits claimed by the proposed project. Water quality credits can be additive up to a 50% reduction (50% reduction maximum) from a proposed project's obligation for sizing treatment control BMPs, contributing to an urban runoff / mitigation fund, or off-site mitigation projects. The volume credit would be calculated as the design capture volume of the proposed condition multiplied by the sum of the percentages claimed above:

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The reductions should be expressed in a tabular format in order to avoid confusion on the use of the numbers. It is not readily apparent if they should be read as 'minus 10 percent' or as 10 percent multiplied by the treatment volume.

$$\text{Credit Volume} = \text{Design Capture Volume} * \sum\text{Credit Percentages Claimed} + \text{Reduction in Design Capture Volume from Existing to Proposed}$$

For example, if a site reduces the impervious cover and falls in one of the eligible categories, both forms of credits could be claimed up to a maximum reduction of 50 percent of the proposed condition design capture volume.

Example 8.2: Applying water quality credits to reduce remaining unmet volume
Given:
• 85th percentile, 24-hr storm depth = 0.85 inches (Figure 6.2)
• Drainage Area = 1.5 acres
• Imperviousness = 80%
• Remaining volume = 1,630 cu-ft
• Vertical density > 18 du/ac = 20% credit
• In-fill development = 10% credit
Required:
• Compute remaining unmet volume after applying water quality credits
Solution:
10) Add all applicable credits = 20% + 10% = 30%
11) Design capture volume (unmitigated) = 1.5 ac × 0.85 inches × (0.8×0.75 + 0.15) × 43,560 sf/ac × 1/12 in/ft = 3,470 cu-ft
12) Credit volume = total credit × original design capture volume = 30% × 3,470 cu-ft = 1,040 cu-ft
13) Remaining volume after credits = 1,630 cu-ft – 1,040 cu-ft = 590 cu-ft
This is the remaining volume that must be addressed through other forms of alternative compliance.

8.2.3. Applying Water Quality Credits to Hydromodification Performance Criteria in North Orange County

To calculate the credit to be applied to the hydromodification control performance criteria in North Orange County, the sum of land-use based percentages determined above would be applied as a reduction to the 2-yr, 24-hour storm depth which is used to calculate performance criteria. Credits for reduction of imperviousness would not be relevant because projects reducing imperviousness do not have hydromodification requirements in North Orange County. Water quality credits are not available for hydromodification control performance criteria in South Orange County.

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8.3. Waivers

Priority Project proponents can apply for a waiver under the conditions described in Section 8.1. Only those Priority Projects that have completed a rigorous feasibility analysis as per the criteria described in the Model WQMP and this TGD, and approved by the RWQCB Executive Officer, may be considered for a waiver. Guidelines for issuing waivers differ from North to South Orange County:

- In North Orange County, a waiver application must be submitted to the local jurisdiction for approval and to the Executive Officer of the Santa Ana RWQCB in writing 30 days prior to approval by the local jurisdiction.

- In South Orange County, a waiver application must be submitted for local jurisdiction approval, which will be reported to the San Diego Regional Water Quality Control Board in the jurisdiction's annual stormwater program report.

Waiver applications shall demonstrate that a rigorous feasibility analysis has been conducted as described in this TGD, ~~or equivalent,~~ and that all potentially feasible BMPs have been considered and provided to the MEP. Note that in watersheds with a RWQCB Executive Officer-approved watershed-based plan that includes specific guidance and support for LID feasibility criteria that allows for off-site measures to be used, a waiver may not be needed.

8.4. Treatment Control BMPs

8.4.1. Introduction

If full implementation of LID BMPs is deemed infeasible and a waiver request has been approved, treatment control BMPs may be required (or optional) as part of an alternative compliance plan, as described in Section 8.1. Treatment control BMPs can be implemented to prevent pollutants of concern from entering receiving waters and thereby fulfill or partially fulfill LID and treatment control requirements for the volume of water treated. In some cases, treatment control BMPs may be stand-alone measures used to meet the remaining performance criteria or may be used in combination with other alternative compliance programs to fulfill unmet obligations. ~~A~~ Process for selecting, siting, and sizing treatment control BMPs is discussed below.

8.4.2. Selection of Treatment Control BMPs

To select a treatment control BMP, each Priority Project shall first identify the primary pollutants of concern, as described in Section 7.II-2.1.2 of the Model WQMP. Treatment control BMPs shall be selected as follows:

- Priority Projects shall select a single or combination of treatment control BMPs that address the project's ~~primary~~ pollutant(s) of concern.

- ~~If during the CEQA process a more refined evaluation of the project identifies that impacts on receiving waters may not be significant and that the project will not cause further exceedance of water quality objectives related to the pollutant(s) for which the~~

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Only feasibility analyses reviewed and approved by the Executive Officer may be used.

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Describe the method for determining whether or not a treatment control BMP addresses a pollutant of concern.

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There are no primary pollutants of concern; there are priority pollutants of concern.

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This process must be fully described for review and approval by the Executive Officer. The process must include identification and timely adoption of thresholds of significance by permittees wishing to employ it. There must also be a nexus between the mitigation/standard condition of approval (the treatment control BMP) and the expected pollutants; and the identification or dismissal of pollutants for a given project must be based on substantial evidence and not conjecture.

~~receiving water is impaired, the project is not be required to use pollutant-specific treatment BMP(s), but shall, at a minimum, use any treatment control BMP or combination of treatment control BMPs that are designed to mitigate pollution.~~

- Priority Projects that are not anticipated to generate a primary pollutant of concern shall select a single or combination of stormwater Treatment Control BMPs that are designed to be effective in reducing pollutants of concern.

Detailed descriptions of available treatment control BMPs are contained in Section 6. Alternative stormwater treatment control BMPs not identified in this document may be approved at the discretion of the local jurisdiction provided the alternative treatment control BMP can be demonstrated to be as effective in the removal of pollutants of concern as other BMPs within this document.

8.4.3. Stormwater Quality Design Volume/Flow Calculations

Section 6.4.2.1 describes the method used to compute the entire design capture volume. Section 8.1.1 describes the method used to compute the remaining volume to be met with alternative compliance programs, and Section 8.2.2 describes the method used to determine reductions to the unmet volume as a result of water quality credits. The volume that remains may be addressed fully or partially by treatment control BMPs consistent with the alternative compliance planning criteria contained in Section 8.1. The following sections describe how a specified unmet volume can be translated to volume-based and flow-based sizing criteria for treatment control BMPs.

8.4.3.1. Volume-based Treatment Control BMPs

Volume-based treatment control BMPs should be sized such that they capture and treat the unmet volume. Volume-based treatment control BMPs should be designed to draw down in 48 hours or less following the end of a storm event.

For example, if as part of an alternative compliance plan, 10,000 cu-ft of remaining volume was designated to be treated by a treatment control BMP, the BMP would be sized with a design volume of 10,000 cu-ft and a 48-hour or less draw down time.

8.4.3.2. Flow-based Treatment Control BMPs

Because unmet volume is expressed in units of volume, sizing criteria must be translated to a flowrate for sizing flow-based treatment control BMPs. This section describes the method by which an unmet runoff volume would be addressed by a flow-based treatment control BMP. ~~It is required~~ that the drainage area to the proposed flow-based treatment control BMP be known.

1) For the catchment to which the flow-based BMP will be applied, convert the unmet volume to an unmet storm depth using the method of back-computing storm depth described in Section 2.3.1 and Example 2.1.

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Number: 1 Author: staff Subject: Cross-Out Date: 7/6/2010 4:24:13 PM

Number: 2 Author: staff Subject: Underline Date: 7/6/2010 4:25:28 PM
Describe the process for determining if a BMP is "effective" in reducing pollutants of concern.

Number: 3 Author: staff Subject: Underline Date: 7/6/2010 4:26:55 PM
Precisely define what constitutes an "alternative treatment control BMP".

Number: 4 Author: staff Subject: Underline Date: 7/6/2010 4:26:21 PM
Describe the process for making this demonstration.

Number: 5 Author: staff Subject: Highlight Date: 7/7/2010 8:46:57 AM
This Section cites Section 2.3.1 and the method there is incorrect.

Number: 6 Author: staff Subject: Replacement Text Date: 7/7/2010 8:52:25 AM
The method requires

Number: 7 Author: staff Subject: Highlight Date: 7/7/2010 8:54:33 AM
This method is incorrect because it is a measure of the runoff volume; the permit requires capture of the storm volume.

2) Divide the back-computed storm depth by the design capture storm depth to yield the unmet fraction of the design storm depth over the tributary area to the BMP. If this value is greater than 1.0, increase the area tributary to the flow-based BMP.

3) Estimate the time of concentration (T_c)of the catchment.

4) Use **Table 8.1**to look up the multiplier based on the calculated T_c. Multiply the looked up value by the remaining fraction of the design capture storm depth to yield the design intensity.

5) Use the hydrologic method described in Section 2.3.2 to compute the design flow.

6) This method can also be used in reverse if necessary.

Table 8.1: Table of Multipliers for Computing Remaining Design Storm Intensity

Time of Concentration, minutes	Multiplier to Convert Remaining Fraction of Design Capture Storm Depth to Design Intensity, in/hr
60	0.15
30	0.18
20	0.19
15	0.21
10	0.23
5	0.26

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Example 8.3: Computing the required design flowrate to mitigate remaining "unmet" volume
Given:
• 85th percentile, 24-hr storm depth = 0.85 inches (Figure 6.2)
• Drainage area to proposed flow-based BMP = 1.5 acres
• Imperviousness of drainage area = 80%
• Time of concentration (T_c) of the drainage area = 15 minutes
• Remaining volume (designated to be managed with the proposed BMP) = 1,200 cu-ft
Required:
• Compute required design flowrate to mitigate the unmet volume
Solution:
14) Equivalent storm depth = 1,200 cu-ft × 12 in/ft/[(0.75×0.8+0.15) ×1.5 ac ×43560 sf/ac] = 0.29 inches
15) Fraction of design capture storm depth = 0.29 inches/0.85 inches = 0.35
16) From **Table 8.1**, the multiplier for T_c of 15 minutes is 0.21 in/hr
17) Design to manage remaining volume = 0.21 in/hr (step 3)× 0.35 (step 2)= 0.074 in/hr
18) Design flow to manage remaining volume = (0.75×0.8+0.15) × 0.07 in/hr ×1.5 ac = 0.083 cfs
This is the design flowrate that must be provided for the 1.5 acre tributary area to address 1,200 cu-ft of remaining volume.

8.4.4. Locate Treatment Control BMPs near Pollutant Sources

Treatment control BMPs shall not be located in Waters of the US, and are required to treat project runoff upstream of Waters of the US if used as part of an alternative compliance program.

8.4.5. Watershed-based Structural Treatment Control BMPs

In North Orange County, watershed-based treatment control BMPs may be implemented off-site for projects that are not able to fully meet LID requirements on-site. These should be located as close as possible to the project site and pollutant sources, and shall not be located within Waters of the US. Pollutant removal shall be accomplished prior to discharge to Waters of the US.

8.4.6. Accounting for Treatment Control BMP Load Reductions in LID Alternative Compliance Plans

This section will describe the method by which load reductions achieved by treatment control BMPs may be applied to fulfill unmet LID obligations.

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8.4.7. Treatment Control BMP Fact Sheets

Treatment control BMP fact sheets are found in Section 6.10. These BMPs may be used to address treatment control requirements and may also be used as pretreatment for LID BMPs

8.5. Urban Runoff Funds / Mitigation Programs

8.5.1. Urban Runoff Funds

For projects granted a waiver, participation in an urban runoff fund or mitigation program may be required as described in Section 8.1. The amount of the contribution will be based on the unmet difference between the combination of the project LID BMP design capture and/or water quality volume and pollutant load reduction that would be achieved through full compliance with LID BMPs and the actual LID design capture and/or water quality volume and pollutant load reduction that can be achieved through the combination of LID practices and treatment control BMPs that can be incorporated in the project.

The role of runoff funds and mitigation programs in satisfying treatment control requirements differs from North to South Orange County as described in Section 8.1:

- In North Orange County, payment into a runoff fund or mitigation program can be an alternative to on-site treatment control or off-site mitigation.
- In South Orange County, payment into a runoff fund or mitigation program is an alternative to off-site mitigation, but does not meet treatment control requirements (treatment controls must also be provided upstream of Waters of the US).

The urban runoff fund or mitigation fund must be expended for water quality improvement or other related projects. Examples of projects eligible for funding through an urban runoff/mitigation fund include, but are not limited to:

- Green street projects
- Retrofit of existing development projects
- Retrofit incentive programs
- Regional/sub-regional BMPs
- Stream restoration
- Other mitigation projects proposed by Permittees

Projects funded through the urban runoff fund or mitigation program process can be administered by individual jurisdictions, jointly by multiple jurisdictions, or by the County, provided they are developed in accordance with the requirements of the Permits. For Priority Projects in North Orange County, projects must be approved by the RWQCB Executive Officer and funds must be expended within two years of receipt of the funds or approval of the projects by the RWQCB Executive Officer, whichever is longer. It may be possible to streamline approval of mitigation projects by obtaining RWQCB Executive Officer approval for a general

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Number: 1 Author: staff Subject: Underline Date: 7/7/2010 9:02:34 AM

There are too many "and" and "and/or" statements (which imply addition) that make this statement incoherent. The reader cannot readily tell if the "and" or "and/or" is supposed to distinguish quantities to be subtracted or indicate quantities that are added. Recommend that a formula be provided.

mitigation program, within which individual projects could be approved by the local jurisdictions. In South Orange County, approvals of funded projects as well as the timeline for completion of funded projects are at the discretion of the local jurisdictions.

8.5.2. Off-Site Mitigation Projects

For Priority Projects granted a waiver, an off-site mitigation project or alternative pollutant-reducing project may be considered. The project should be implemented within the same hydrologic subarea as the proposed project. Off-site mitigation projects outside of the hydrologic subarea but within the same hydrologic unit may be developed for local jurisdiction approval provided that the project proponent demonstrates that mitigation projects within the same hydrologic subarea are infeasible and that the mitigation project will address similar beneficial use impacts as expected from the proposed project's pollutant load types and amount. Off-site project BMPs should be located as close as possible to the project site and should address a similar mix of land uses to that proposed by the project. The off-site project shall not be located within Waters of the US. Off-site mitigation projects may include:

- Green streets projects,
- Existing development retrofit projects,
- Retrofit incentive programs,
- Regional BMPs, and
- Stream restoration.

Other off-site mitigation techniques may be proposed to the local jurisdiction for review and approval.

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Section 9. Operation and Maintenance Planning

The sustained performance of BMPs over time depends on ongoing and proper maintenance. In order for this to occur, detailed operation and maintenance plans are needed that include specific maintenance activities and frequencies for each type of BMP. In addition, these should include indicators for assessing when "as needed" maintenance activities are required.

9.1. Private Project Operation and Maintenance Plans

9.1.1. General

- An O&M Plan must be prepared by the project proponent for the BMPs included as Section 5 of the Project WQMP and the final O&M Plan in the Project WQMP must be submitted to the local jurisdiction prior to permit closeout and the issuance of certificates of use and occupancy. The O&M Plan must describe the designated responsible party to manage the stormwater BMP(s), employee's training program and duties, operating schedule, maintenance frequency, routine service schedule, specific maintenance activities, copies of resource agency permits, and any other necessary activities.
- At a minimum, maintenance agreements shall require the inspection and servicing of all structural BMPs on an annual basis.

The project proponent or Permittee-approved maintenance entity shall complete and maintain O&M forms to document all maintenance requirements. Parties responsible for the O&M Plan shall retain records for at least 5 years. These documents shall be made available to the Permittee for inspection upon request at any time.

As part of the maintenance mechanism selected above, the Permittee shall require the inclusion of a copy of an executed access easement that shall be binding on the land throughout the life of the project, until such time that the stormwater BMP requiring access is replaced, satisfactory to the Permittee.

Project proponents should identify the specific maintenance requirements for each BMP described with the WQMP, the responsible party for performing the maintenance, and the source of funding that will be provided to support the maintenance into perpetuity.

9.1.2. Maintenance Agreements

Maintenance agreements can be an effective tool for ensuring long-term maintenance of on-site BMPs. The most important aspect of creating these maintenance agreements is to clearly define the responsibilities of each party entering into the agreement. Basic language that should be incorporated into an agreement includes the following:

1. Performance of Routine Maintenance

Local governments often find it easier to have a property owner perform all maintenance according to the requirements of a Design Manual. Other communities require that property

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Number: 1 Author: staff Subject: Underline Date: 7/7/2010 9:07:57 AM

This phrase suggests that there is a formatted template available for use by preparers. Provide the template for review.

Number: 2 Author: staff Subject: Underline Date: 7/7/2010 9:10:38 AM

These and similar requirements throughout are not enforceable on the project proponent and successors simply because they appear in this document. Describe how the Permittees will make these requirements enforceable.

owners do aesthetic maintenance (i.e., mowing, vegetation removal) and implement Pollution Prevention Plans, but elect to perform structural maintenance and sediment removal themselves.

2. Maintenance Schedules

Maintenance requirements may vary, but usually governments require that all BMP owners perform at least an annual inspection and document the maintenance and repairs performed. An annual report must then be submitted to the government, who may then choose to perform an inspection of the facility.

3. Inspection Requirements

Local governments may obligate themselves to perform an annual inspection of a BMP, or may choose to inspect when deemed necessary instead. Local governments may also wish to include language allowing maintenance requirements to be increased if deemed necessary to ensure proper functioning of the BMP.

4. Access to BMPs

The agreement should grant permission to a local government or its authorized agent to enter onto property to inspect BMPs. If deficiencies are noted, the government should then provide a copy of the inspection report to the property owner and provide a timeline for repair of these deficiencies.

5. Failure to Maintain

In the maintenance agreement, the government should repeat the steps available for addressing a failure to maintain situation. Language allowing access to BMPs cited as not properly maintained is essential, along with the right to charge any costs for repairs back to the property owner. The government may wish to include deadlines for repayment of maintenance costs, and provide for liens against property up to the cost of the maintenance plus interest.

6. Recording of the Maintenance Agreement

1 An important aspect to the recording of the maintenance agreement is that the agreement be recorded into local deed records. This helps ensure that the maintenance agreement is bound to the property in perpetuity.

2 Finally, some communities elect to include easement requirements into their maintenance agreements. While easement agreements are often secured through a separate legal agreement, recording public access easements for maintenance in a maintenance agreement reinforces a local government's right to enter and inspect a BMP. Examples of maintenance agreements include several available on the web at http://www.stormwatercenter.net/

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Number: 1 Author: staff Subject: Underline Date: 7/7/2010 9:14:40 AM

This sentence is a simple declaration and does not describe any action that the permittees will do. It should be rephrased so that it describes what will be done and by who.

Number: 2 Author: staff Subject: Underline Date: 7/7/2010 9:15:36 AM

This sentence needs to be rephrased to describe what will by done and by who.

9.2 Public Agency Project Operation and Maintenance Plans

Public agency Priority Projects must also prepare an Operation and Maintenance Plan for a New Development or Significant Redevelopment Project and include this in Section 5 of the Project WQMP. The plan must include a description of how the responsibilities for operation and maintenance will be carried out within the Permittee's organization or if any of the responsibilities will be contracted out.

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Appendix I. Isopluvial Map: 85th percentile, 24-hour Storm Depths

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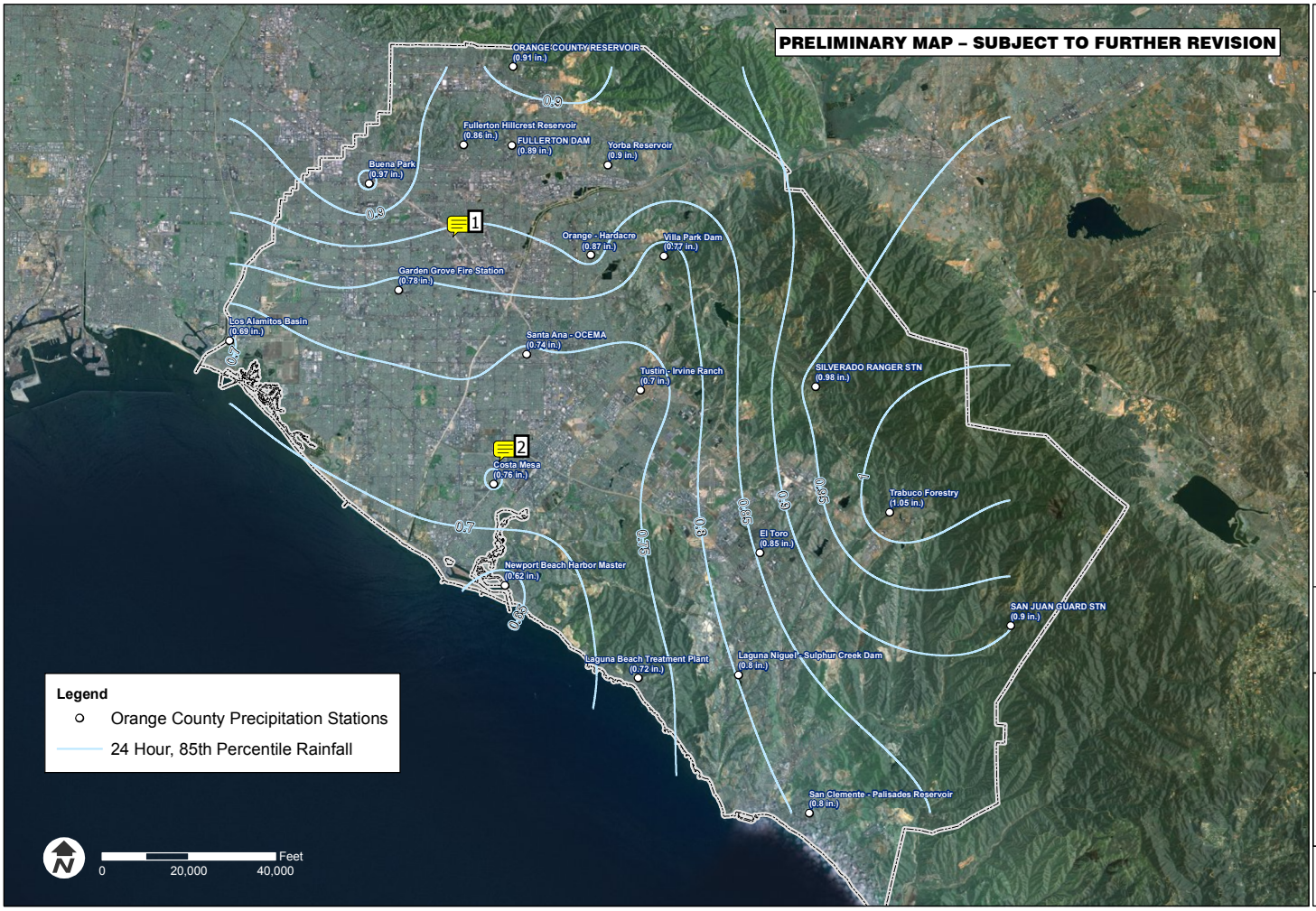

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TITLE
24 HOUR, 85TH PERCENTILE STORM DEPTH

JOB
ORANGE COUNTY TECHNICAL GUIDANCE DOCUMENT
ORANGE CO. CA

SCALE	1" = 20000'
DESIGNED	TFS
DRAWING	JOS
CHECKED	BMP
DATE	05/17/10
JOB NO.	9324-E

PACE
Advanced Water Engineering

FIGURE
1-1

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Number: 1 Author: staff Subject: Sticky Note Date: 7/7/2010 9:17:08 AM

units (inches) need to be indicated for the isopleth values either on the isopleths or the legend

Number: 2 Author: staff Subject: Sticky Note Date: 7/7/2010 9:16:47 AM

The inches of rainfall shown for the precipitation stations should be removed in order to avoid tempting the preparer to use these values instead of the isopleths.

Appendix II. Watershed Maps

Placeholder section for maps in progress. Maps have been submitted to the Santa Ana Regional Water Quality Control Board as a separate report titled: *Hydromodification Susceptibility and Infiltration Feasibility in North Orange County* (5/24/2010).

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Appendix III. Infiltration Rate Evaluation Protocol

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Appendix III. Site Soil Type and Infiltration Testing

III.1. Introduction

Soil characterization and infiltration testing is required in order to properly size and locate stormwater management facilities. The role of soil characterization and infiltration testing differs with the phase of project development:

Site Assessment / Project Planning Phase: Soil characterization or infiltration testing may be conducted to determine if infiltration is a potentially feasible BMP and/or where on the site infiltration is potentially infeasible. The intent of this investigation is to identify if the project site, or a portion of the site, has soils that are clearly unsuitable for infiltration. For those sites or portions of the site where soils are unsuitable, infiltration BMPs can be eliminated from consideration. The intent of this testing is not to prove definitively that infiltration is feasible. Simpler methods may be used to determine infiltration potential at this phase.

Site Planning / Design Phase: Where infiltration BMPs are selected, infiltration testing must be conducted to determine the design infiltration rate of proposed facilities. The required size of the proposed facilities depends significantly on the design infiltration rate; therefore, testing may be required at the preliminary site design phase to facilitate site planning. However, infiltration testing should be conducted as close to the proposed facility as possible, therefore, conducting testing after preliminary site design also has merits. Use of more sophisticated methods at this phase allows better confidence in testing and therefore a lower factor of safety on measured infiltration rates (and therefore smaller facility designs). Factors of safety are discussed in Appendix IV.

Soil characterization and infiltration testing can be considered to fulfill two functions:

1. Determine where infiltration is potentially feasible and must be considered (if other limitations, such as depth to groundwater or contamination, do not restrict infiltration). This role is satisfied through simple infiltration tests, or use of maps and available data.

2. Determine the design infiltration rate for proposed facilities. This function is satisfied through more sophisticated investigation methods, conducted by a qualified professional.

Table III.1 provides allowable methods of investing infiltration rate for each purpose:

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Specify what is meant by "this testing".

Table III.1: Recommended Infiltration Investigation Methods	
Methods for Identifying Areas Potentially Feasible for Infiltration	• Regional/Watershed Infiltration Feasibility Maps AND • Review of available data[1] **OR** • Simple Open Pit Infiltration Test
Methods for Establishing Design Infiltration Rate	• Open pit falling head • Encased falling head • Double-ring infiltrometer • Falling head bore hole test • Other analysis methods ~~at the discretion of the project engineer~~ [1]

[1]Available data is defined in Section III.2 below and does not require additional investigation.

III.2. Methods for Identifying Areas Potentially Feasible for Infiltration

III.2.1. **Use of Regional Maps and "Available Data"**

This section describes a method that satisfies the requirements for infiltration screening of small to medium size projects as defined by the Technical Guidance Document Level 1 Feasibility Criteria (Section 6.2.1). This method uses regionally mapped data coupled with data available through other site investigations to identify locations not potentially feasible for infiltration as a result of low infiltration rate or high groundwater table.

Infiltration constraint maps will be made available as part of Watershed Master Planning efforts, and may otherwise be undertaken for regions of Orange County. These maps will identify constraints, including hydrologic soil group (A,B,C,D), and depth to first groundwater, which should be confirmed through review of available data.

"Available data" is defined as data collected for purposes other than evaluating infiltration rates which is expected to be available as part of nearly all projects subject to New Development and Significant Redevelopment stormwater management requirements in Orange County. Data sources may include:

- Geotechnical investigations

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These methods must be acceptable to the local jurisdiction and should not be left entirely to the discretion of the project engineer.

- Due diligence site investigations
- Other CEQA investigations
- Investigations performed on adjacent sites with applicability to the project site

For projects permitted to utilize this method, additional infiltration testing data is not required to be obtained, however, infiltration testing data which is already available from previous studies may be used.

III.2.2. **Simple Open Pit Infiltration Test**

The Simple Open Pit Infiltration Test is a method which can be used for design of simple stormwater systems to provide a preliminary screening value. This approach cannot be used to find a design infiltration rate. The intent of the Open Pit Test is to determine whether or not the local infiltration rate is potentially adequate for LID infiltration BMPs. This approach does not need to be conducted by a licensed professional.

1. The test should be at the proposed facility location or within the immediate vicinity.
2. Excavate a test hole to a depth 2 feet deeper than the bottom of the infiltration system to account for soil amendment. If the depth of the proposed facility is not known at the time of testing, the excavation should be 6 feet deep. The test hole can be excavated with small excavation equipment or by hand using a shovel, auger, or post hole digger. The hole should be a minimum of 2 feet in diameter and should be sufficient to allow for observation of the water surface level in the bottom of the hole. Remove loose material, as much as possible from the bottom of the hole but avoid compaction of the bottom surface. If a layer hard enough to prevent further excavation is encountered during excavation, or if noticeable moisture/water is encountered in the soil, stop and measure this depth. Proceed with the test at this depth.
3. Fill the hole with water to a height of about 6 inches from the bottom of the hole, and record the exact time. Check the water level at regular intervals (every minute for fast-draining soils to every 10 minutes for slower-draining soils) for a minimum of 1 hour or until all of the water has infiltrated. Record the distance the water has dropped from a fixed reference point such as the the top edge of the hole.
4. The infiltration rate is calculated by dividing the change in water elevation time (inches) by the duration of the test (hours).
5. Repeat this process two more times, for a total of three rounds of testing. These tests should be performed as close together as possible to accurately portray the soil's ability to infiltrate at different levels of saturation. The **third test** provides the best measure of the saturated infiltration rate.

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6. For each test pit required, record all three testing results with the date, duration, drop in water height, and conversion into inches per hour.

III.3. Methods for Establishing Design Infiltration Rate

Allowable methods of establishing design infiltration rate include:

- Open pit falling head (Section III.3.4)
- Encased falling head (Section III.3.5)
- Double-ring infiltrometer (Section III.3.6)
- Falling head bore hole test(Section III.3.7)
- Other analysis methods at the discretion of the project engineer

A qualified professional must exercise judgment in the selection of the infiltration test method. Where satisfactory data from adjacent areas is available that demonstrates infiltration testing is not necessary, the infiltration testing requirement may be waived. Waiver of site specific testing is subject to approval by the local approval authority. Recommendation for foregoing infiltration testing must be submitted in a report which includes supporting data and is stamped and signed by the project geotechnical engineer or project geologist.

III.3.1. **Testing Criteria**

1. Testing must be conducted or overseen by a qualified professional, either a Professional Engineer (PE) or Registered Geologist (RG) licensed in the State of California.
2. The depth of the test must correspond to the facility depth, plus 2 feet to account for soil amendments under the infiltration system. If a confining layer, or soil with a greater percentage of fines, is observed during the subsurface investigation to be within 4 feet of the bottom of the planned infiltration system, the testing should be conducted within that confining layer. The boring log must be continued to a depth adequate to show separation between the bottom of the infiltration facility and the seasonal high groundwater level.
3. Tests must be performed in the immediate vicinity of the proposed facility. Exceptions can be made to the test location provided the qualified professional can support that the strata are consistent from the proposed facility to the test location.
4. Infiltration testing should not be conducted in engineered or undocumented fill.

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III.3.2. **Minimum Number of Required Tests**

- A total of two infiltration tests for every 10,000 square feet of lot area available for new or redevelopment (minimum 2 tests per priority project).
- An additional test for every 10,000 square feet of lot area available for new or redevelopment.
- At least one test for any potential street facility.
- One test for every 100 lineal feet of infiltration facility.
- No more than five tests are required per development (at the discretion of the qualified professional assessing the site, as well as the reviewing agency).

Where multiple types of facilities are used, it is likely that multiple tests will be necessary, since different facility types may infiltrate at different depths and an infiltration test can test only a single soil stratum. It is highly recommended to conduct an infiltration test at each stratum used. Additional testing may be required at the discretion of the local approval authority.

III.3.3. **Factors of Safety**

The method for determination of the factor of safety described in Appendix IV includes, among other factors, a consideration of the testing methods used to measure infiltration rate. The open pit falling head test (see Section III.3.4) is considered the most reliable infiltration testing method if constructed to the recommended dimensions.

III.3.4. **Open Pit Falling Head Procedure**

The open pit falling head procedure is performed in an open excavation and therefore is a test of the combination of vertical and lateral infiltration. The tester and excavator should conduct all testing in accordance with OSHA regulations regarding open pit excavations.

1. Excavate a hole with bottom dimensions of at least 2 feet by 4 feet into the native soil to the elevation 2 feet below the proposed facility bottom to account for amendment of soils under infiltration areas. If a smooth excavation bucket is used, scratch the sides and bottom of the hole with a sharp pointed instrument, and remove the loose material from the bottom of the test hole. The bottom of the hole shall not be compacted and should be as level as possible.

2. Fill the hole with clean water a minimum of 1 foot above the soil to be tested, and maintain this depth of water for at least 4 hours (or overnight if clay soils are present) to presoak the native material. In sandy soils with little or no clay or silt, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.

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State whether or not factors of safety will be required.

3. Determine how the water level will be accurately measured. The measurements should be made with reference to a fixed point. A lath placed in the test pit prior to filling or a sturdy beam across the top of the pit are convenient reference points.

4. After the presaturation period, refill the hole with water to 12 inches above the soil and record the time. For deep holes, it may be necessary to use remote sensing equipment to accurately measure changes in water level. Alternative water head heights may be used for testing provided the presaturation height is adjusted accordingly and the water head height used in infiltration testing is 50 percent or less than the water head height in the proposed stormwater system during the design storm event. Measure the water level to the nearest 0.01 foot (⅛ inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. In faster draining soils (sands and gravels), it may be necessary to shorten the measurement interval in order to obtain a well defined infiltration rate curve. Constant head tests may be substituted for falling head tests at the discretion of the professional overseeing the infiltration testing.

5. Repeat the test. Successive trials should be run until the percent change in measured infiltration rate between two successive trials is minimal (<10 percent). The trial should be discounted if the infiltration rate between successive trials increases. At least three trials must be conducted. After each trial, the water level is readjusted to the 12 inch level. Record results.

6. The average infiltration rate over the last trial should be used to calculate the unadjusted (pre-factor of safety) infiltration rate. The final rate must be reported in inches per hour.

7. Upon completion of the testing, the excavation must be backfilled.

8. For very rapidly draining soils, it may not be possible to maintain a water head above the bottom of the test pit. If the infiltration rate meets or exceeds the flow of water into the test pit, conduct the test in the following manner:

    a) Approximate the area over which the water is infiltrating.

    b) Using a water meter, bucket, or other device, measure the rate of water discharging into the test pit.

    c) Calculate the infiltration rate by dividing the rate of discharge (cubic inches per hour) by the area over which it is infiltrating (square inches) and correcting to units of inches per hour.

III.3.5. **Encased Falling Head Test**

The encased falling head procedure is performed with a 24-inch casing that is embedded approximately 24 inches into the native soil at an elevation 2 feet below the proposed depth of

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the infiltration surface to account for the use of soil amendments below the infiltration system. The goal of this field test is to evaluate the vertical infiltration rate through a 24-inch plug of soil, without allowing any lateral infiltration. The test is not appropriate in gravelly soils or in other soils where a good seal with the casing cannot be established.

1. Embed a solid 6-inch diameter casing into the native soil at the elevation of the proposed facility bottom. Ensure that the embedment provides a good seal around the pipe casing so that percolation will be limited to the 6-inch plug of the material within the casing. This method can also be used when testing within hollow stem augers, provided the driller and tester are reasonably certain that a good seal has been achieved between the soil and auger.

2. Fill the pipe with clean water a minimum of 1 foot above the soil to be tested, and maintain this depth for at least 4 hours (or overnight if clay soils are present) to presoak the native material. Any soil that sloughed into the hole during the soaking period should be removed. In sandy soils with little or no clay or silt, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.

3. To conduct the first trial of the test, fill the pipe to approximately 12 inches above the soil and measure the water level to the nearest 0.01 foot (⅛ inch). Alternative water head heights may be used for testing provided the presaturation height is adjusted accordingly and the water head height used in infiltration testing is 50 percent or less than the water head height in the proposed stormwater system during the design storm event. The level should be measured with a tape or other device with reference to a fixed point. The top of the pipe is often a convenient reference point. Record the exact time.

4. Measure the water level to the nearest 0.01 foot (⅛ inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. In faster draining soils (sands and gravels), it may be necessary to shorten the measurement interval in order to obtain a well defined infiltration rate curve. Constant head tests may be substituted for falling head tests at the discretion of the professional overseeing the infiltration testing. Successive trials should be run until the percent change in measured infiltration rate between two successive trials is minimal. The trial should be discounted if the infiltration rate between successive trials increases. At least three trials must be conducted. After each trial, the water level is readjusted to the 12 inch level. Record results.

5. The average infiltration rate over the last trial should be used to calculate the unadjusted (pre-factor of safety) infiltration rate. The final rate must be reported in inches per hour.

6. Upon completion of the testing, the casing should be pulled and the test pit backfilled.

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III.3.6. **Double Ring Infiltrometer Test**

The double-ring infiltrometer test procedure should be performed in accordance with ASTM 3385-94. The test is performed within two concentric casings embedded and sealed to the native soils. The outer ring maintains a volume of water to diminish the potential of lateral infiltration through the center casing. The volume of water added to the center ring to maintain a static water level is used to calculate the infiltration rate. The double-ring infiltrometer is appropriate only in soils where an adequate seal can be established. The double-ring infiltrometer test should be performed at an elevation 2 feet below the proposed depth of the infiltration surface to account for the use of soil amendments below the infiltration system.

III.3.7. **Falling-Head Borehole Infiltration Test**

The Falling-Head Borehole Infiltration test method should be performed according to United States Bureau of Reclamation procedure 7300-89 (USBR, 1990). The falling-head borehole infiltration test is commonly applied to assess infiltration at greater depths (e.g. 5 - 25 ft). This method has known limitations, but may be the only practicable method for estimating the infiltration rate of dry wells prior to full-scale construction. Dry wells should be tested prior to commissioning to confirm acceptable infiltration rates. Additional dry wells may need to be installed, or additional equalization storage provided to meet design requirements if infiltration measured in the full-scale full-scale test is not adequate.

1) Using a hollow-stem. auger, advance a 6-inch-diameter or greater borehole to a depth of 2 to 5 feet below the anticipated elevation of the proposed drainage structure. Use care not to contaminate the sides of the hole with fines.

2) Install a slotted pipe or well-screen into the hole having a minimum diameter of 2 inches and a minimum 20% open area through the hollow-stem portion of the auger-string. Install the pipe as nearly as is practical to the bottom of the hole. Wrapping the pipe with a highly porous, non-woven , geotextile fabric is an allowable practice.

3) During auger removal, install a gravel-pack of uniform, clean, dry, pervious fine gravel around the slotted pipe. Omission of this step is an allowable practice. However, calculations for permeability must be based upon the original diameter of the borehole, therefore omission of the gravel pack is not recommended.

4) Introduce clean water near the bottom of the hole through the slotted pipe using an in-line, commercially available, flow meter. Prior to the test, field check the accuracy of the flow meter using a suitable container of known volume (i.e., 5 gallon bucket).

5) Raise the water level in the hole until a level consistent with the operating head anticipated in the proposed drainage structure is achieved. Based upon the soil permeability, the subsurface soil profile, and the water supply system available, head levels lower than those anticipated in the drainage structure are permitted.

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6) Adjust the flow rate as needed to maintain the constant head level in the hole at appropriate intervals. In no case shall the interval exceed 10 minutes in length. Minimum required test time is one hour.

7) Continue maintaining the constant head until a stabilized flow rate has been achieved. Consider the flow rate stable when the incremental flow rate required to maintain the head does not vary by more than about 5% between increments. The intent of this section is to achieve a relatively steady-state flow condition between the minimum one hour test time and a maximum test time of 1.5 hours. At the discretion of the on-site engineer or engineering technician, the test may be extended beyond the 1.5 hour maximum.

8) Upon completion of the constant-head period, discontinue flow, and monitor the head level drop in the borehole at appropriate intervals over at least a 30- minute falling-head period.

9) Compute the permeability for the constant head portion of the test using methods outlined in the following: United States Bureau of Reclamation Procedure 73000-89: Performing Field Permeability Testing By The Well Permeameter Method. And USBR Procedure 7305-89: Field Permeability Test (Shallow-Well Permeameter Method). Note: Utilize stabilized flow rates observed near the end of the constant-head period in the permeability calculations.

III.4. References

ASTM D 3385-94, 2003. "Standard Test Method for Infiltration Rate of Soils Field Using Double-Ring Infiltrometer." American Society for Testing Materials, Conshohocken, PA. 10 Jun, 2003.

Caltrans, 2003. "Infiltration Basin Site Selection". Study Volume I. California Department of Transportation. Report No. CTSW-RT-03-025.

City of Portland, 2010. *Appendix F.2: Infiltration Testing.* Portland Stormwater Management Manual, Revised February 1, 2010.

United States Department of the Interior, Bureau of Reclamation (USBR), 1990a, "Procedure for Performing Field Permeability Testing by the Well Permeameter Method (USBR 7300-89)," in Earth Manual, Part 2, A Water Resources Technical Publication, 3rd ed., Bureau of Reclamation, Denver, Colo.

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Appendix IV. Infiltration Rate Factor of Safety Recommendations

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This appears to be missing. Factors of safety must be used unless some compelling argument can be made against them.

Appendix IV. Considerations for Design Infiltration Rate Corrections (Factor of Safety)

The infiltration rate will decline between maintenance cycles as the BMP surface becomes occluded and particulates accumulate in the infiltrative layer. Monitoring of actual facility performance has shown that the full-scale infiltration rate is far lower than the rate measured by small-scale testing. It is important that adequate conservatism is incorporated in the selection of design infiltration rates. The design infiltration rate discussed here is the infiltration rate of the underlying soil, below the elevation to which soil amendments would not be provided.

The factor of safety that should be applied to measured infiltration rates is a function of:

- Suitability of underlying soils for infiltration
- The infiltration system design.

These factors are discussed in the following sections.

IV.1. Site Suitability Considerations

Suitability assessment related considerations include (Table IV.**1**):

- Soil assessment methods – the site assessment extent (e.g., number of borings, test pits, etc.) and the measurement method used to estimate the short-term infiltration rate.
- Predominant soil texture/percent fines – soil texture and the percent of fines can greatly influence the potential for clogging.
- Site soil variability – site with spatially heterogeneous soils (vertically or horizontally) as determined from site investigations are more difficult to estimate average properties for resulting in a higher level of uncertainty associated with initial estimates.
- Depth to seasonal high groundwater/impervious layer – groundwater mounding may become an issue during excessively wet conditions where shallow aquifers or shallow clay lenses are present.

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Table IV.1: Suitability Assessment Related Considerations for Infiltration Facility Safety Factors			
Consideration	**High Concern**	**Medium Concern**	**Low Concern**
Assessment methods (see explanation below)	Use of soil survey maps or simple texture analysis to estimate short-term infiltration rates	Direct measurement of ≥ 20 percent of infiltration area with localized infiltration measurement methods (e.g., infiltrometer)	Direct measurement of ≥ 50 percent of infiltration area with localized infiltration measurement methods or Use of extensive test pit infiltration measurement methods
Texture Class	Silty and clayey soils with significant fines	Loamy soils	Granular to slightly loamy soils
Site soil variability	Highly variable soils indicated from site assessment or limited soil borings collected during site assessment	Soil borings/test pits indicate moderately homogeneous soils	Multiple soil borings/test pits indicate relatively homogeneous soils
Depth to groundwater/ impervious layer	<5 ft below facility bottom	5-10 ft below facility bottom	>10 below facility bottom

Localized infiltration testing refers to methods such as the double ring infiltrometer test (ASTM D3385-88) which measure infiltration rates over an area less than 10 sq-ft, may include lateral flow, and do not attempt to account for heterogeneity of soil. The amount of area each test represents should be estimated depending on the observed heterogeneity of the soil.

Extensive infiltration testing refers to methods that include excavating a significant portion of the proposed infiltration area, filling the excavation with water, and monitoring drawdown. The excavation should be to the depth of the proposed infiltration surface and ideally be at least 50 to 100 square feet.

In all cases, testing should be conducted in the area of the proposed BMP where, based on review of available geotechnical data, soils appear least likely to support infiltration.

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IV.2. Design Related Considerations

Design related considerations include (Table IV.**2**):

- Size of area tributary to facility – all things being equal, risk factors related to infiltration facilities increase with an increase in the tributary area served. Therefore facilities serving larger tributary areas should use more restrictive adjustment factors.

- Level of pretreatment/expected influent sediment loads – credit should be given for good pretreatment by allowing less restrictive factors to account for the reduced probability of clogging from high sediment loading. Also, facilities designed to capture runoff from relatively clean surfaces such as rooftops are likely to see low sediment loads and therefore should be allowed to apply less restrictive safety factors.

- Redundancy – facilities that consist of multiple subsystems operating in parallel such that parts of the system remains functional when other parts fail and/or bypass should be rewarded for the built-in redundancy with less restrictive correction and safety factors. For example, if bypass flows would be at least partially treated in another BMP, the risk of discharging untreated runoff in the event of clogging the primary facility is reduced. A bioretention facility that overflows to a landscaped area is another example.

- Compaction during construction – proper construction oversight is needed during construction to ensure that the bottoms of infiltration facility are not overly compacted. Facilities that do not commit to proper construction practices and oversight should have to use more restrictive correction and safety factors.

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Table IV.2: Design Related Considerations for Infiltration Facility Safety Factors			
Consideration	**High Concern**	**Medium Concern**	**Low Concern**
Tributary area size	Greater than 10 acres.	Greater than 2 acres but less than 10 acres.	2 acres or less.
Level of pre-treatment/ expected influent sediment loads	Pre-treatment from gross solids removal devices only, such as hydrodynamic separators, racks and screens AND tributary area includes landscaped areas, steep slopes, high traffic areas, or any other areas expected to produce high sediment, trash, or debris loads.	Good pre-treatment with BMPs that mitigate coarse sediments such as vegetated swales AND influent sediment loads from the tributary area are expected to be relatively low (e.g., low traffic, mild slopes, disconnected impervious areas, etc.).	Excellent pre-treatment with BMPs that mitigate fine sediments such as bioretention or media filtration OR sedimentation or facility only treats runoff from relatively clean surfaces, such as rooftops.
Redundancy of treatment	No redundancy in BMP treatment train.	Medium redundancy, other BMPs available in treatment train to maintain at least 50% of function of facility in event of failure.	High redundancy, multiple components capable of operating independently and in parallel, maintaining at least 90% of facility functionality in event of failure.
Compaction during construction	Construction of facility on a compacted site or elevated probability of unintended/ indirect compaction.	Medium probability of unintended/ indirect compaction.	Heavy equipment actively prohibited from infiltration areas during construction and low probability of unintended/ indirect compaction.

IV.3. Determining Factor of Safety

Adjust the measured short term infiltration rate using a weighted average of several safety factors using the worksheet shown in Table 6-4 below. The design infiltration rate would be determined as follows:

1. For each consideration shown in Table IV.**1**and Table IV.**2** above, determine whether the consideration is a high, medium, or low concern.

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2. For all high concerns, assign a factor value of 3, for medium concerns, assign a factor value of 2, and for low concerns assign a factor value of 1.

3. Multiply each of the factors by the corresponding weight to get a product.

4. Sum the products within each factor category to obtain a safety factor for each.

5. Multiply the two safety factors together to get the final combined safety factor. If the combined safety factor is less than 2, then use 2 as the safety factor.

6. Divide the measured short term infiltration rate by the combined safety factor to obtain the adjusted design infiltration rate for use in sizing the infiltration facility.

Table IV.3: Infiltration Facility Safety Factor Determination Worksheet

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25		
		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	Tributary area size	0.25		
		Level of pre-treatment/ expected sediment loads	0.25		
		Redundancy	0.25		
		Compaction during construction	0.25		
		Design Safety Factor, $S_B = \Sigma p$			
Combined Safety Factor = S_A x S_B					

Note: The minimum combined adjustment factor shall not be less than 2.0 and the maximum combined adjustment factor shall not exceed 9.0.

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Appendix V. BMP Screening, Prioritization, and Design Worksheets

Placeholder section for worksheets to be developed. List is subject to revision. Worksheets will reflect the recommendations of this manual and upon completion will not substantively modify the content or intent of this TGD.

Worksheet A Project Planning Criteria – a central place to documents all of the project planning criteria that have been developed before entering the site design and BMP selection phase

Worksheet B Level 1 Feasibility– used to document the findings of Level 1 Feasibility Screening question; catalogues any project-specific studies supporting the Level 1 Feasibility Screening process

Worksheet C BMP Prioritization – used to prepare and document the BMP prioritization process for each drainage area or group of similar drainage areas

Worksheet D Level 2 Feasibility– used to document the findings of Level 2 Feasibility Screening and the maximum feasible retained plus biotreated for each drainage area

Worksheet E Simple Sizing Criteria Calculations – used to prepare and document simple sizing criteria calculations per Section 6.4.2.1

Worksheet F Sizing to Achieve Target Average Annual Capture Efficiency for Volume-based, Constant Drawdown BMPs - used to prepare and document sizing criteria calculations per Section 6.4.2.2.

Worksheet G Computing Average Annual Capture Efficiency of Harvest and Use BMPs with Seasonally-Varying Use Rate (Irrigation Demand)6.4.2.5

Worksheet H Sizing to Achieve Target Average Annual Capture Efficiency, Flow-based BMPs 6.4.2.3

Worksheet I Computing Capture Efficiency of Volume-based, Constant Drawdown BMP from Description of System Configuration 6.4.2.4

Worksheet J Hydrologic Source Control Calculations – used to prepare and document the combined effect of hydrologic source controls for each drainage area.

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Provide the worksheets for review.