WATER QUALITY MANAGEMENT PLAN

for the Santa Ana Region of Riverside County

July 29, 2011
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Water Quality Management Plan

for the Santa Ana Region of Riverside County

In compliance with Order No. R8-2010-0033, this WQMP is implemented by the following Co-Permittees in the Santa Ana Region:

Beaumont
www.ci.beaumont.ca.us/

Calimesa
www.cityofcalimesa.net/

Canyon Lake
www.cityofcanyonlake.com

Corona
ci.corona.ca.us/

County of Riverside
All Project applications:
www.countyofriverside.us/

For WQMP questions in unincorporated County areas:
www.rcflood.org

Eastvale
www.eastvalecity.org/

Hemet
www.cityofhemet.org/

Jurupa Valley
www.cityofjurupa.org/

Lake Elsinore
www.lake-elsinore.org/

Menifee
www.cityofmenifee.us/

Moreno Valley
www.ci.moreno-valley.ca.us/

Norco
www.ci.norco.ca.us/

Perris
www.cityofperris.org/

Riverside
www.riversideca.gov/

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www.ci.san-jacinto.ca.us/

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JULY 29, 2011

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EXHIBIT D: ***LID Guidance and Standards for Transportation Projects***

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Start

How to Use the Water Quality Management Plan

Read Chapters 1 and 2 to get a general understanding of the requirements. Then follow the step-by-step instructions in Chapter 3 to prepare your Project-Specific Water Quality Management Plan.

ICON KEY

- ☞ Helpful Tip
- Submittal Requirement
- Terms to Look Up
- 🕮 References & Resources

This Water Quality Management Plan (WQMP) is a guidance document that will help you ensure that your project complies with Santa Ana Regional Water Quality Control Board (Santa Ana Regional Board) requirements for new developments and significant redevelopments. The requirements are complex and technical. Because every project is different, you should begin, if possible, by scheduling a ***pre-application meeting*** with the applicable Co-Permittee staff.

Be sure to use the most recent version of the WQMP, including updates and errata. The most recent version is at www.rcflood.org/NPDES/Developers.aspx. This WQMP may be updated periodically based on the Co-Permittees' experience with implementation of this document. Any updates to this WQMP will be provided in the annual report to the Regional Board. If you are reading the WQMP on a computer, you can use hyperlinks within this document to navigate from section to section, and if you have an internet connection, you can directly access various internet references. The hyperlinks are throughout the text, as well as in "References and Resources" sections (marked by the 🕮 icon) and in the ***Bibliography***.

To use the *WQMP,* start by reviewing ***Chapter One*** to find out whether and how the requirements apply to your project. Chapter One also provides an overview of

the entire process of planning, design, construction, operation, and maintenance leading to compliance.

If there are terms and issues you find puzzling, look for answers in the glossary or in ***Chapter Two***. Chapter Two provides background on key stormwater concepts and water quality regulations, including criteria for the design and selection of Stormwater BMPs.

Then proceed to ***Chapter Three*** and follow the step-by-step guidance to prepare a Project-Specific WQMP for your site. Note that the steps in chapter three reference additional detail in Chapters, four, five and six. A preliminary WQMP is commonly required to be submitted with your application for entitlements and development approvals and must be approved by the Co-Permittee before any approvals or entitlements will be granted. A final Project-Specific WQMP will be required to be submitted and approved prior to issuance of permits.

Chapter Four, the Low Impact Development (LID) Design Guide, includes instructions for preparing and presenting your LID design and calculations. The calculations must be included in your WQMP to show compliance with permit requirements.

As you proceed with design and construction of your project, consult ***Chapter Five*** for guidance on preparing construction documents and overseeing construction of Stormwater BMPs.

In ***Chapter Six*** you'll find a detailed description of the process for ensuring operation and maintenance of your Stormwater BMPs over the life of the project. The chapter includes step-by-step instructions for preparing a Stormwater BMP Operation and Maintenance Plan.

Construction-Phase Controls

Your Project-Specific WQMP is a separate document from the Stormwater Pollution Prevention Plan (SWPPP). A SWPPP provides for *temporary* measures to control discharges of sediment and other pollutants *during* construction at sites that disturb one acre or more, whereas a WQMP is required to address discharges from the post-construction use of the site.

Throughout each Chapter, you'll find references and resources to help you understand the regulations, complete your WQMP, and design your project to be protective of water quality to the Maximum Extent Practicable.

☐ PLAN AHEAD TO AVOID THE THREE MOST COMMON MISTAKES

The most common (and costly) errors made by applicants for development approvals with respect to stormwater compliance are:

1. Not planning for compliance early enough. You should think about your strategy for compliance with WQMP requirements before completing a conceptual site design or sketching a layout of subdivision lots (Chapter 3). It is highly recommended that the project team (civil engineers, planners, architects, landscape architects, etc.) meet and confer at project inception to discuss design strategies that meet the requirements herein.

2. Assuming ***proprietary Stormwater BMPs***, or ***Treatment Control BMPs*** will be adequate for compliance. Low Impact Development BMPs that maximize infiltration, harvest and use, evapotranspiration and/or bio-treatment, are now required for nearly all projects. See chapter 2 for criteria affecting what Stormwater BMPs can be used on a project.

3. Not planning for long-term maintenance of Stormwater BMPs, and inspections / verifications by the Copermittee. Consider who will own and who will maintain the BMPs in perpetuity and how they will obtain access, and identify which arrangements are acceptable to your Co-Permittee (Chapter 6).

Chapter 1

Policies and Procedures

Determine if your project requires a Project-Specific Water Quality Management Plan (WQMP), and review the steps to compliance.

ICON KEY

- ☞ Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

Projects Requiring a WQMP

☞ *Before continuing using this document, it is highly encouraged that you use the 'Locate your Watershed' tool available at*

www.rcflood.org/npdes

to verify if your project is within the Santa Ana Watershed.

☐ PRIORITY DEVELOPMENT PROJECTS

The MS4 Permit (see chapter 2) requires that a WQMP be prepared for all projects within the Santa Ana Region of Riverside County, that meet the 'Priority Development project' categories and thresholds listed in Table 1-1. Additionally, the WQMP Applicability Checklist provided in Exhibit E, can be used as a means to document a conclusion that a project is, or is not subject to the WQMP requirements. Note some thresholds are defined by square footage of impervious area; others by land area of development; others by area disturbed. Exhibit F includes a WQMP Applicability Checklist that can be used to document a determination that a project meets, or does not meet the classification as a 'Priority Development project'.

For public projects implemented by a Co-Permittee, see the "Requirements for Public Projects" section later in this chapter.

If your project is not a 'Priority Development project', a Project-Specific WQMP is generally not required. However, Co-Permittee staff may choose to require Project-Specific WQMPs for projects not within the categories in Table 1-1, based

on local staff's assessment of the potential for the proposed project to impact stormwater quality.

When determining whether WQMP requirements apply, a "project" should be defined consistent with CEQA definitions of "project." That is, the "project" is the whole of an action which has the potential for adding or replacing or resulting in the addition or replacement of roofs, pavement, or other impervious surfaces "Whole of an action" means the project may not be segmented or piecemealed into small parts if the effect is to reduce the quantity of impervious area for any part to below the applicable threshold.

TABLE 1-1. Priority Development Projects

Category	Threshold	Notes
Commercial and/or Industrial Projects	**10,000 SF**	Projects that create 10,000 square feet (SF) or more impervious surface collectively over the project site.
Residential subdivisions	**10,000 SF**	Residential subdivisions that require a Final Map and create or authorize creation of 10,000 SF or more impervious surface collectively over the project site. Includes detached single-family home subdivisions, multi-family attached subdivisions, condominiums, apartments, etc.
Mixed Use Projects	**10,000 SF**	Projects that create 10,000 SF or more impervious surface collectively over the project site.
Automotive Repair Shops	**0 SF**	Projects with SIC codes 5013, 5014, 5541, 7532-7534, 7536-7539. For these project types, a WQMP is required regardless of project size.
Restaurants	**5,000 SF**	Projects that have 5,000 SF or more "land area of development"
Hillside Developments	**5,000 SF**	Developments disturbing 5,000 SF or more and located on areas with known erosive soil conditions or where the natural slope is 25% or more.
Developments adjacent to, or that discharge directly into Environmentally Sensitive Areas	**2,500 SF**	Developments of 2,500 SF or more impervious surface. "Directly" means situated within 200 feet of the ESA, "discharging directly" means outflow from a drainage conveyance system that is composed entirely of flows from the subject development or redevelopment site, and not commingled with flows from adjacent lands.
Parking Lots	**5,000 SF**	Parking lots that are 5,000 square feet or more of impervious surface exposed to stormwater. A parking lot is a land area or facility for the temporary parking or storage of motor vehicles.
Retail Gasoline Outlets	**5,000 SF**	Projects that are 5,000 square feet or more, or with a projected average daily traffic of 100 or more vehicles per day.
Significant Redevelopment Projects	**5,000 SF**	Addition or replacement of 5,000 SF or more impervious surface on an already developed site. Does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of the facility, or emergency redevelopment activity required to protect public health and safety. See also the 50% rule discussion below.

☐ THE "50% RULE" FOR ALL SIGNIFICANT RE-DEVELOPMENT PROJECTS

Projects that will expand or modify a previously developed site may be required to retrofit the ***existing site*** for compliance with this WQMP (including runoff from existing areas not otherwise being modified as part of the current project). For sites adding or replacing more than 5,000 square feet of impervious area:

- If the proposed project results in an increase of, or replacement of, 50% or more of the impervious surface of an existing developed site, then the entire existing developed site must be addressed through the WQMP design.

- Where the project will result in an increase of less than 50% of the existing impervious surface area, and the existing development was not subject to WQMP requirements, the treatment requirement applies only to the addition or replacement impervious area, and not to the entire developed site.

Co-Permittee staff will determine case-by-case when and how the "50% rule" applies. Note that when determining whether the 50% rule applies to a project, impervious areas that are removed and replaced are counted (that is, no credit is given for removal of existing impervious square footage). Requirements to mitigate a ***hydrologic condition of concern*** (HCOC) use the developed condition of a previously developed site as a baseline. Removal of existing impervious square footage may be credited when determining whether runoff rates or durations will increase.

Requirements for Public Projects

☐ PERMITTEE TRANSPORTATION PROJECTS

In accordance with Finding II.G.18 in the MS4 Permit, a Project-Specific WQMP is not required for Permittee street road and highway capital projects. Instead, as described in Permit Provision XII.F.1, the Permittees are required to develop and implement 'standardized design and post-construction BMP guidance to reduce the discharge of Pollutants from such projects to the MEP'. This guidance, referred to as '*Low Impact Development Guidance and Standards for Transportation Projects*' is included as Exhibit D to this WQMP.

Refer to Exhibit D to determine if the proposed project is indeed a 'Transportation Project'. If it is, follow the instructions in Exhibit D for designing and documenting the deployment of LID Principles and Stormwater BMPs on the project. If it is not a 'Transportation Project', follow the guidance for 'other public projects' below.

☐ OTHER PUBLIC PROJECTS

Public projects, other than Transportation Projects as discussed above, that are implemented by a Permittee may be required to prepare a Project-Specific WQMP if the project is similar in nature to the Priority Development projects described in Table 1-1, and if the project meets the thresholds described therein. Grandfathering of Public Projects is addressed in DAMP Section 5.1.

Compliance Process at a Glance

For the applicant for development project approval, compliance follows these general steps:

1. Discuss WQMP requirements during a pre-application meeting with Co-Permittee staff, if possible.

2. Review the instructions in this WQMP before you prepare your tentative map, preliminary site plan, drainage plan, and landscaping plan.

3. When required by the Co-Permittee, prepare a preliminary Project-Specific WQMP and submit it with your application for discretionary approvals (entitlements).

4. Following any discretionary approval, initiate your final Project-Specific WQMP as part of your plan to complete your detailed project design, incorporating the LID Principles and Stormwater BMPs committed to in your preliminary Project-Specific WQMP.

5. In a table on your grading or improvement plans, list each stormwater facility, and the plan sheet where it appears.

6. Prepare the final Project-Specific WQMP, incorporating a draft Stormwater Facility Operation and Maintenance Plan and submit it with your application for grading plans, improvement plans, and building permits. Execute legal documents assigning responsibility for operation and maintenance of Stormwater BMPs. All Co-Permittees require legal agreements and financial commitments for operation and maintenance be recorded prior to recordation of a final map or parcel or Certificate of Occupancy if a map is not required.

> **Local Requirements**
> Individual Co-Permittees may have requirements that differ from, or are in addition to, this WQMP. See Co-Permittee for local requirements.

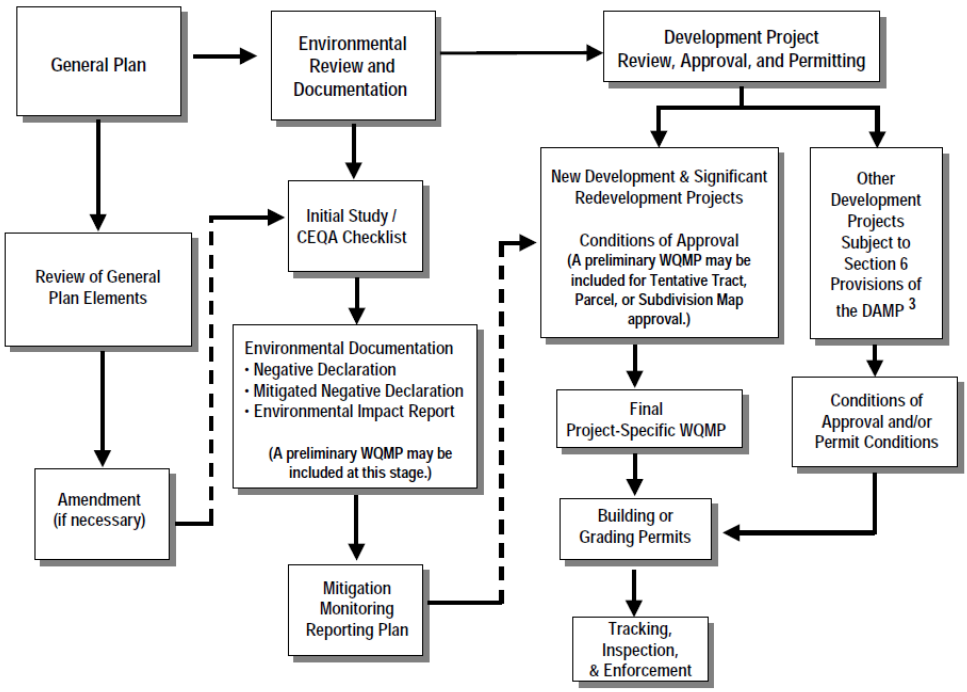
7. Maintain Stormwater BMPs during and following construction.

8. Following construction, submit a final Stormwater Facility Operation and Maintenance Plan and formally transfer responsibility for maintenance to the owner or permanent occupant. Typically the Co-Permittees will require the final Stormwater Facility Operation and Maintenance Plan prior to issuance of Certificate of Occupancy.

9. The occupant or owner must maintain records of stormwater facility maintenance, and submit to Co-Permittee inspections of Stormwater BMPs. Where Co-Permittees allow or require self-certifications, the occupant or owner must certify Stormwater BMPs are properly maintained and submit reports, prepared and certified by a P.E., to the Co-Permittee staff upon their request. Certification by the Co-Permittee may be required.

Preparation of a complete and detailed Project-Specific WQMP is the key to cost-effective stormwater compliance and expeditious review of your project. Instructions for preparing a Project-Specific WQMP are in Chapter 3.

FIGURE 1-1: Development Process Flow Chart



WQMP Requirements for Projects in Progress

Requirements for preparing Project-Specific WQMPs have been in place for all applicable projects submitted to the Co-Permittee after December 31, 2004. The 2010 MS4 Permit however includes new / additional requirements for WQMPs that are reflected in this revised WQMP document. The following guidance describes how these new requirements are required to be applied to projects that have already begun the process for securing approvals from the Co-Permittee.

Pre-Approved Projects. Projects that have a Co-Permittee approved preliminary project-specific WQMP and have received discretionary approvals prior to the date the Regional Board approves this revised WQMP, will be grandfathered into compliance based on their already-approved project-specific WQMP. For all projects for which a map or permit for discretionary approval is sought after that date, the following minimum requirements apply:

- Consistent with MS4 Permit section XII.L., projects approved within 45 days of approval of this revised WQMP by the Regional Board, will continue to comply with the WQMP dated January 22, 2009.

- Consistent with MS4 Permit section XII.L., beginning 45 days from the date of Regional Board approval of this revised WQMP, project-specific WQMPs will be required to meet the new LID and HCOC requirements herein to the MEP.

- As described in XII.E.1, beginning six months after the date of Regional Board approval of this revised WQMP, all projects that meet the criteria of Table 1-1, will be required to prepare a project-specific WQMP that fully meets the requirements of this revised WQMP.

If you believe your project may be grandfathered, check with the Co-Permittee to verify applicable requirements. Each Co-Permittee individually determines how and when projects will be allowed to be grandfathered pursuant to each Co-Permittee's Local Implementation Plan (LIP).

WQMP Requirements for Phased Projects

Co-Permittee staff may require as part of an application for approval of a phased development project a preliminary Project-Specific WQMP, as discussed below, which describes and illustrates, in broad outline, how the drainage for the entire project will comply with the WQMP requirements. The level of detail in the preliminary WQMP shall be consistent with the scope and level of detail of the development approval being considered. A more detailed final Project-Specific WQMP for the entire project, or multiple final project specific WQMPs for individual phases of the entire project, will be submitted with applications for

subsequent recordation, grading or building permits as appropriate. The obligation to install Stormwater BMPs for the entire project is met if BMPs are constructed with the requisite capacity to serve the entire project, even if certain phases of the project may not have BMP capacity located within that phase. Stormwater BMPs with sufficient capacity to serve the phase(s) addressed by the final WQMP must be functional prior to issuance of occupancy permits, or certificates of use (or equivalent), even if those Stormwater BMPs are located in a later (or future) phase of the project.

Types of Project-Specific WQMPs

☐ PRELIMINARY PROJECT-SPECIFIC WQMP REQUIREMENTS

If a discretionary approval would entitle construction of new or replaced improvements which, individually or in aggregate, would exceed the thresholds in Table 1-1, then the applicant must prepare a ***preliminary Project-Specific WQMP***. The level of detail in a preliminary Project-Specific WQMP will depend upon the level of detail known about the overall project design at the time project approval is sought..

For example, if approval of a tentative tract map application would entitle site improvements that individually or in aggregate would exceed the thresholds for Priority Development projects in Table 1-1, the applicant should prepare a preliminary Project-Specific WQMP. If particular plans for individual lots have not been identified, the preliminary Project-Specific WQMP should nevertheless identify the type, size, location, and final ownership of Stormwater BMPs adequate to serve new roadways and any common areas, and to also manage runoff from an expected reasonable estimate of the square footage of future roofs, driveways, and other impervious surfaces on each individual lot. The Co-Permittee will then condition approval of the map on implementation of a final Project-Specific WQMP that is in substantial conformance with the approved preliminary Project-Specific WQMP prior to grading / building permits.

> ***Local Requirements***
> Individual Co-Permittees may have requirements that differ from, or are in addition to, this WQMP. Check with the applicable Co-Permittee.

If a Co-Permittee deems it necessary, the future improvements on one or more lots may be limited by a deed restriction or dedication of an appropriate easement, to suitably restrict the future building of structures at each stormwater facility location.

In general, it is recommended ***Stormwater BMPs not be located on individual single-family residential lots***, particularly when those BMPs manage runoff from streets, or from common areas. However, local requirements vary. Most often, it is better to locate Stormwater BMPs on one or more separate, jointly owned parcels.

If a subdivision map being proposed is purely to subdivide land, and the discretionary approval does not entitle particular improvements to be made on the

subdivided parcels that, in aggregate, would exceed the thresholds in Table 1-1, a WQMP may not be required, at the discretion of the Co-Permittee. For example, if a 30-acre parcel zoned for rural residential is to be subdivided into two 15-acre rural residential parcels, and any known or proposed improvements on either 15-acre parcel would not be classified as a Priority Development project per Table 1-1, then, at the discretion of the Co-Permittee, a preliminary Project-Specific WQMP may not be required at the time of the discretionary approval of the subdivision map. As the subdivision map did not create entitlements for specific improvements that exceed the thresholds in Table 1-1, subsequent proposals for improvements on either or both of the parcels will be subject to discretionary approvals, and conditions for preparation of a Project-Specific WQMP as applicable.

☐ *FINAL PROJECT-SPECIFIC WQMP REQUIREMENTS*

A final Project-Specific WQMP shall be submitted and approved by the Co-Permittee for all Priority Development projects prior to the issuance of any building or grading permit, and the final Project-Specific WQMP shall be in substantial conformance with any preliminary WQMP submitted and approved by the Co-Permittee during the land use entitlement process.

Chapter 2

Concepts and Criteria

Technical background and explanations of policies and design requirements.

ICON KEY
Helpful Tip
Submittal Requirement
Terms to Look Up
References & Resources

The Santa Ana Regional Board first issued a municipal stormwater NPDES Permit (MS4 Permit) to Riverside County, its cities within the Santa Ana Region, and the Riverside County Flood Control and Water Conservation District in 1990. Collectively those agencies are referred to as "Co-Permittees". The MS4 Permit mandates that the Co-Permittees develop and implement a comprehensive program to prevent stormwater pollution. That program now includes measures to prevent pollution from municipal facilities and operations, identification and elimination of illicit discharges to storm drains, business inspections, public outreach, construction site inspections, monitoring and studies of stream health, and control of runoff pollutants from new developments and redevelopments, as well as implementation of programs aimed at specific pollutants (nutrients and pathogens) in some sub-watersheds.

The 2010 MS4 Permit mandates a Low Impact Development (LID) approach to stormwater treatment and management of runoff discharges for new development and significant redevelopment projects. This chapter explains the technical background of the Permittees' approach to implementing the LID requirements.

Water-Quality Regulations and Concepts

The MS4 Permit requires the Permittees to condition development approvals with incorporation of specified stormwater controls. The Co-Permittees' annual report to the Regional Water Board includes a list of treatment control BMPs approved, constructed, and/or operating during the year.

The MS4 Permit requires that applicable new development and redevelopment projects:

- Design the site to minimize imperviousness, detain runoff, and infiltrate, reuse or evapotranspirate runoff where feasible.
- Cover or control sources of stormwater pollutants.
- Use LID to infiltrate, evapotranspirate, harvest and use, or treat runoff from impervious surfaces.
- Ensure runoff does not create a hydrologic condition of concern.
- Maintain Stormwater BMPs.

☐ *MAXIMUM EXTENT PRACTICABLE (MEP)*

Clean Water Act Section 402(p)(3)(iii) sets the standard for control of stormwater pollutants as "maximum extent practicable," but doesn't define that term. As implemented, "maximum extent practicable" is ever-changing and varies with conditions. In general, to achieve the MEP standard, Co-Permittees must employ whatever best management practices (BMPs) are technically feasible (that is, are likely to be effective) and are not cost prohibitive.*

Many stormwater controls, including LID, have proven to be practicable in most development projects. To achieve fair and effective implementation, criteria and guidance for those controls must be detailed and specific—while also offering the right amount of flexibility or exceptions for special cases. The MS4 Permit includes various standards, including hydrologic criteria, which the Regional Board has found to provide "maximum extent practicable" control.

☐ *BEST MANAGEMENT PRACTICES*

Clean Water Act Section 402(p) and USEPA regulations (40 CFR 122.26) specify a municipal program of "management practices" to control stormwater pollutants. ***Best Management Practice (BMP)*** refers to any kind of procedure or device designed to minimize the quantity of pollutants that enter the ***Municipal Separate Storm Sewer System*** **(MS4)**.

* "Definition of Maximum Extent Practicable," memo by Elizabeth Jennings, Senior Staff Counsel, State Water Resources Control Board, February 11, 1993.

☐ LOW IMPACT DEVELOPMENT

Low Impact Development (LID) comprises a set of technologically feasible and cost-effective approaches to stormwater management and land development that combine a hydrologically functional site design with Pollution Prevention measures to compensate for land development impacts on hydrology and water quality. LID techniques mimic the site's predevelopment hydrology by using site design techniques that store, infiltrate, evapotranspire, bio-treat, bio-filter, bio-retain or detain runoff close to its source.

☐ CEQA

The Co-Permittees, when acting as a CEQA Lead Agency for a project requiring a CEQA document, must identify at the earliest possible time in the CEQA process the resources under the jurisdiction by law of the Regional Board which may be affected by the project. The preliminary WQMP should identify the need for any CWA Section 401 certification. The Co-Permittees should coordinate project review with Regional Board staff pursuant to the requirements of CEQA. Upon request by Regional Board staff, this coordination shall include the timely provision of the discharger's identity and their contact information and the facilitation of early consultation meetings. A preliminary WQMP supports the CEQA process and provides documentation to support a checklist for an Initial Study and Negative Declaration or Mitigated Negative Declaration, or serves as the basis for the water quality section of an EIR. It should also serve as the basis for the Lead Agency and Responsible Agency to conclude that the MEP standard is being bet by serving as the basis that selected BMPs will not have the potential to cause significant effects and/or that the effects have been mitigated, and "are not significant with mitigation".

> **CEQA**
> For useful information on the integration of CEQA review and implementation of Low Impact Development design to achieve stormwater NPDES compliance, see the Governor's Office of Planning and Research Technical Advisory, "CEQA and Low Impact Development Stormwater Design." (2009)

☐ TMDL

A TMDL, or 'Total Maximum Daily Load' is the maximum amount of a Pollutant that the Regional Board has established can be discharged into a waterbody from all sources (point and non-point) and still maintain Water Quality Standards. Under CWA Section 303(d), TMDLs must be developed for all waterbodies that do not meet Water Quality Standards after application of technology-based controls. The Santa Ana Watershed Region of Riverside County has two adopted TMDLs. A Bacterial Indicator TMDL for the Middle Santa Ana River (Reach 3 as defined in the Basin Plan), and a Nutrient TMDL for Lake Elsinore and Canyon Lake. As part of each of those TMDLs the Co-Permittees are required to develop and implement a plan to address the Final Water Quality Based Effluent Limits. For the Middle Santa Ana River Bacterial Indicator TMDL, this "plan" is referred to as the Comprehensive Bacteria Reduction Plan (CBRP) and for the Lake

Elsinore and Canyon Lake Nutrient TMDL, this "plan" is referred to as the Comprehensive Nutrient Reduction Plan (CNRP).

The CBRP developed by the Co-Permittees was submitted to the Regional Board for approval on June 28, 2011, and the CNRP will be submitted by December 31, 2011. These documents describe specific actions the Co-Permittees have taken or will be taking to achieve compliance with the Urban Waste Load Allocations. As these documents are approved by the Regional Board, any actions committed to that relate to development projects will be reflected in an update to this WQMP as applicable.

Potential Impacts of Development

☐ IMPERVIOUSNESS

Schueler (1995) proposed ***imperviousness*** as a "unifying theme" for the efforts of planners, engineers, landscape architects, scientists, and local officials concerned with urban watershed protection. Schueler argued (1) that imperviousness is a useful indicator linking urban land development to the degradation of aquatic ecosystems, and (2) imperviousness can be quantified, managed, and controlled during land development.

Imperviousness has long been understood as the key variable in urban hydrology. Peak runoff flow and total runoff volume from small urban catchments is usually calculated as a function of the ratio of impervious area to total area ***(rational method)***. The ratio correlates to the composite runoff factor, usually designated "C". Increased flows resulting from urban development tend to increase the frequency of small-scale flooding downstream.

Imperviousness has two major components: rooftops and transportation (including streets, highways, and parking areas). The transportation component is usually larger and is more likely to be ***directly connected*** to the storm drain system.

The effects of imperviousness can be mitigated by disconnecting impervious areas from the drainage system and by making drainage *less* efficient—that is, by encouraging retention and detention of runoff near the point where it is generated, more closely mimicking pre-project runoff flows and durations. Retention and detention reduce peak flows and volumes and allow pollutants to settle out or adhere to soils instead of being transported downstream.

☐ WATER QUALITY IMPACTS

Urban runoff from a developed site has the potential to contribute pollutants, including oil and grease, suspended solids, metals, gasoline, pesticides, and pathogens to the stormwater conveyance system and receiving waters. These pollutants may originate as airborne dust, be washed from the atmosphere during

rains, or may be generated locally by automobiles and outdoor work activities present at the site. For the purposes of identifying stormwater pollutants of concern and associated Treatment BMPs, pollutants can be grouped in nine general categories as follows:

- ***Sediments*** are soils or other surficial materials that are eroded and then transported or deposited by the action of wind, water, ice, or gravity. Excessive discharge of sediments to waterbodies and streams can potentially increase turbidity, clog fish gills, reduce spawning habitat, lower young aquatic organism survival rates, smother bottom dwelling organisms, and/or suppress aquatic vegetation growth.

- ***Nutrients*** are inorganic substances, such as nitrogen and phosphorus. They commonly exist in the form of mineral salts that are either dissolved or suspended in water. Primary potential sources of nutrients in urban runoff are fertilizers and eroded soils. Excessive discharge of nutrients to waterbodies and streams can cause excessive aquatic algae and plant growth. Such excessive production, referred to as cultural eutrophication, may lead to excessive decay of organic matter in the waterbody, loss of oxygen in the water, release of toxins in bed sediment, and/or the eventual death of aquatic organisms and fish kills.

- ***Metals*** are raw material components in both metal products, as well as non-metal products. Primary potential sources of metal pollution in stormwater are typically commercially-available metals and non-metal products such as fuels, adhesives, paints, and other coatings. Metal pollutants may include cadmium, chromium, copper, lead, mercury, and zinc. Lead and chromium have been used as corrosion inhibitors in primer coatings and cooling tower systems. Metals that naturally occur in soil are typically not toxic at low concentrations. However, at higher concentrations, certain metals can be toxic to aquatic life. Humans can be impacted from contaminated groundwater resources, and bioaccumulation of metals in fish and shellfish. Environmental concerns, regarding the potential for release of metals to the environment, have already led to restricted metal usage in certain applications.

- ***Toxic Organic Compounds*** are natural or synthetic carbon-based molecules that may be found in pesticides, solvents, and hydrocarbons. Organic compounds can, at certain concentrations, indirectly or directly constitute a hazard to life or health. When rinsing off objects, toxic levels of solvents and cleaning compounds can inadvertently be discharged to storm drains. Dirt, grease, and grime retained in the

cleaning fluid or rinse water may also adsorb levels of organic compounds that are harmful or hazardous to aquatic life.

- ***Trash*** (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic matter (such as leaves, grass cuttings, and food waste) may impact the recreational value or other beneficial uses of a waterbody and/or aquatic habitat. Excess organic matter that may have been introduced as trash can create a high biochemical oxygen demand in a stream and thereby lower its water quality.

- ***Oxygen-Demanding Substances*** includes biodegradable organic material as well as chemicals that react with dissolved oxygen in water to form other compounds. Proteins, carbohydrates, and fats are examples of biodegradable organic compounds; compounds such as ammonia and hydrogen sulfide are examples of oxygen-demanding compounds. The oxygen demand of a substance can lead to depletion of dissolved oxygen in a waterbody and the possible development of septic conditions.

- Primary sources of ***oil and grease*** are petroleum hydrocarbon products, motor products from leaking vehicles, esters, oils, fats, waxes, and high molecular-weight fatty acids. Introduction of these pollutants to the waterbodies can occur due to the wide uses and applications of some of these products in municipal, residential, commercial, industrial, and construction areas. Elevated oil and grease content can decrease the aesthetic value of the waterbody, as well as the water quality.

- ***Bacteria and Viruses*** are environmentally-ubiquitous microorganisms that thrive under certain ecological conditions. Their proliferation is often from natural or uncontrollable sources but can also be caused by the transport of animal or human fecal wastes from a watershed. Water containing excessive bacteria and viruses, can alter the aquatic habitat and create a harmful environment for humans and aquatic life.

- ***Pesticides*** (including herbicides) are chemical compounds commonly used to control nuisance growth or prevalence of organisms. Excessive or inappropriate application of a pesticide may result in runoff that may be toxic to aquatic life.

LID BMPs have been shown in studies throughout the country to be very highly effective and reliable at treating a wide range of pollutants that can be found in urban runoff, including those listed above, and those subject to adopted TMDLs in Riverside County (Bacteria and Nutrients). As such, the LID BMPs required in

this WQMP are expected to treat any discharges of urban-sourced 303(d) listed pollutants from subject projects, to an impaired waterbody on the 303(d) list, such that the discharge from the project would not cause or contribute to an exceedance of Receiving Water Quality Objectives. Further, as described under 'TMDLs' above, to the extent that the CBRP and/or the CNRP include specific additional actions that Co-Permittees will take on development projects, this WQMP will be amended to reflect those actions.

☐ HYDROMODIFICATION IMPACTS

The change in rainfall-runoff relationships resulting from impervious areas on the site is referred to Hydromodification. In some stream systems, excessive Hydromodification can cause erosion of stream banks and beds, transport of fine sediments, and disruption of aquatic habitat.

Once altered, natural streams and their ecosystems may not be able to be fully restored, however, it may be possible to minimize further degredation. Managing runoff from a single development site may seem inconsequential, but by changing the way most sites are developed (and redeveloped), we may be able to protect existing stream ecosystems in urban and urbanizing areas.

Hydrology for NPDES Compliance

☐ DESIGN STORM FOR WATER QUALITY

Most runoff, and therefore most of the potential for conveyance of pollutants, is produced by frequent storms of small or moderate intensity and duration. Accordingly, Stormwater BMPs are designed to treat smaller storms and the first flush of larger storms. NPDES Permit Provision XII.D.4 identifies two sets of criteria for sizing Stormwater BMPs—volume-based and flow-based.

For ***volume-based*** Stormwater BMPs, including LID BMPs, NPDES Permit Provision XII.D.4.a. references three specific sizing methodologies that the Permittees can choose from. Two of the methodologies included on that list are the ***WEF Method*** (ASCE) and the ***California BMP Method*** (CASQA). Both of those methods are based on continuous simulation of runoff from a hypothetical one-acre area entering a basin designed to draw down in 24 hours. The simulation is iterated to find the unit basin size that treats about 80% of the total runoff during the simulation period.

Consistently, the largest storm event for which all runoff is captured by this unit basin storage size is approximately the ***85th percentile 24-hour storm event***, which is the third method specifically identified in the MS4 Permit.

To simplify design calculations (that is, to avoid the need to perform continuous simulation for design of all BMPs), ***this event is taken as the "design storm" for this WQMP.***

An isohyetal map showing the 85th percentile 24-hour storm depth, at different locations throughout western Riverside County, based on long-term rainfall data, is provided in Exhibit A.

The Design Capture Volume can then calculated based on the following equation:

,

Where:

DCV = Design Capture Volume (ft^3)
D_{85} = the Design Storm depth
C = composite rational method runoff factor for the Drainage Management Area (unitless)
A_{TRIB} = area tributary to the BMP (acres)

The LID BMPs discussed in Chapter 4 of this guidance are to be sized according to this Design Capture Volume.

For ***flow-based*** treatment control BMPs, the NPDES Permit specifies the rational method be used to determine flow. The rational method uses the equation:

> ***NOTE***
> The LID BMP Design Handbook (Exhibit C) includes calculation sheets that can be used to calculate and document the 'Design Capture Volume', and the Design Flow Rate. These should be documented as described in Chapter 4 herein.

Where:

Q_{BMP} = the Design Flow Rate (cfs)
i = rainfall intensity (0.2 inches/hour)
C = composite rational method runoff factor for the Drainage Management Area (unitless)
A_{TRIB} = area tributary to the BMP (acres)

☐ *HYDROLOGIC CONDITIONS OF CONCERN (HCOC)*

To avoid causing Hydromodification impacts, applicants for development approvals for projects ***disturbing an acre or more*** must also evaluate whether the project would cause a HCOC to exist. In addition to incorporating applicable LID BMPs to ensure water quality treatment of runoff, applicants may be required to provide additional LID Principles or LID BMPs to avoid creating an HCOC or to mitigate any HCOC which is created.

A project does not cause an HCOC if any of the following conditions is met:

- The project disturbs less than one acre and is not part of a common plan of development.

- The volume and the time of concentration of runoff for the post-development condition is not significantly different from the pre-development condition for 2-year, 24-hour return frequency storms, as may be achieved through site design and treatment control BMPs (a difference of 5% or less is not considered significant).

- All downstream conveyance channels to an adequate sump (for example, Prado Dam, Lake Elsinore, Canyon Lake, Santa Ana River, or other lake, reservoir, or naturally erosion resistant feature) that will receive runoff from the project are engineered and regularly maintained to ensure design flow capacity, and no sensitive stream habitat areas will be adversely affected.

- All downstream conveyance channels to an adequate sump that will receive runoff from the project are not identified in hydromodification sensitivity maps prepared by the Permittees*, and no sensitive stream habitat areas will be adversely affected.

If an HCOC exists, it may be mitigated by using on-site or off-site LID Principles and LID BMPs to address potential erosion or habitat impact and/or by mimicking the pre-development hydrograph with the post-development hydrograph for a 2-year, 24-hour return frequency storm. Generally, the HCOC are not significant if the post-development hydrograph is no more than 10% greater than the pre-development hydrograph. In cases where excess volume cannot be infiltrated or captured and used, discharge from the site must be limited to a flow rate no greater than 110% of the pre-development 2-year, 24-hour peak flow.

Low Impact Development (LID)

☐ TYPES AND BENEFITS

Stormwater is increasingly being managed through Low Impact Development (LID) ☙. The Low Impact Development Manual for Southern California (CASQA, 2010) describes two types of LID:

- ***LID Principles*** which are site design concepts that prevent or minimize the causes (or drivers) of project impacts, and help mimic the pre-development hydrologic regime. LID Principals should be implemented to the MEP on all sites.

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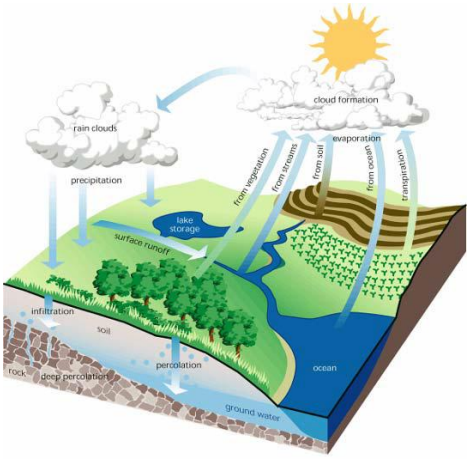
* Hydromodification Sensitivity Maps for the Santa Ana Region will be developed by the Permittees by January 29, 2012.

- ***LID BMPs*** which help mitigate otherwise unavoidable impacts; i.e. where implementation of LID Principals cannot fully address the design capture volume, LID BMPs must be implemented.



There are many potential benefits associated with the use of LID. Foremost, LID BMPs, tend to retain runoff thus reducing the amount of potentially polluted runoff that can be transported to our waterways. Additionally, LID BMPs have the advantage of supplementing the physical processes of interstitial settling and adsorption—common to all media filters—with additional complexation and adsorption to the biofilms that are developed, and for those that include vegetation, additional pollutant removal through uptake through the plant roots. In addition, LID BMPs that integrate amended soils and/or vegetation benefit from the biological activity of bacteria, insects, and worms, which helps renew and maintain the media, increasing reliability and eliminating the need for frequent maintenance or re-setting of the filtration layers. LID BMPs also act as "sponges," absorbing the amount of runoff from small storm events and some of the runoff from larger events and retaining it so as to ***maximize infiltration and evapotranspiration***. This, in turn helps the post-development site's hydrologic regime mimic the pre-development hydrology.

In addition to stormwater management, LID implementation can result in environmental, economic, and community benefits.

<u>Potential Environmental Benefits</u>

- Improved water quality
- Maintenance of predevelopment runoff volume and discharge
- Groundwater recharge
- Terrestrial and aquatic habitat preservation
- Reduced potable water demand
- Recycling and beneficial reuse
- Reduction in urban heat island effect

<u>Potential Economic Benefits</u>

- Reduced construction and maintenance costs
- Improved marketability

- Energy cost reduction and water conservation

Potential Community Benefits

- Improved aesthetic value
- Provides "green job" opportunities
- Educational opportunities

☐ REQUIREMENTS AND PRIORITIZATION

The MS4 Permit requires implementation of both LID Principles and LID BMPs (as discussed above) through the following provisions:

> **XII.E.3.**
> The Co-Permittees shall require that New Development and Significant Redevelopment projects include Site Design BMPs during the development of the project-specific WQMP. The design goal shall be to maintain or replicate the pre-development hydrologic regime through the use of design techniques that create a functionally equivalent post-development hydrologic regime through site preservation techniques and the use of integrated and distributed infiltration, retention, detention, evapotranspiration, filtration and treatment systems.

and

> **XII.E.7.**
> To reduce Pollutants in Urban Runoff, address Hydromodification, and manage Urban Runoff as a resource to the MEP, the revised WQMP shall specify preferential use of Site Design BMPs that incorporate LID techniques, where feasible, in the following manner (from highest to the lowest priority):
>
> a. Preventative measures (these are mostly non-structural measures, e.g., preservation of natural features to a level consistent with the MEP standard; minimization of Urban Runoff through clustering, reducing impervious areas, etc.) and
>
> b. Mitigation measures (these are structural measures, such as, infiltration, harvesting and use, bio-treatment, etc.).

Additionally, Provision XII.D.7.b. of the MS4 Permit requires this WQMP to include an updated list of Treatment Control BMPs, including an evaluation of effectiveness based on national, statewide, or regional studies. It is now widely

accepted that LID BMPs provide highly effective and reliable stormwater treatment for a wide range of potential stormwater pollutants, including 303(d) listed pollutants. Further, Provision XII.E.2 of the MS4 Permit requires the use of LID BMPs that infiltrate, harvest and use, evapotranspire, biotreat and/or detain runoff. The LID BMPs listed in Chapter 4 infiltrate, harvest and use, and evapotranspire runoff to the extent feasible, and provide highly effective biotreatment for the remaining runoff, resulting in robust pollutant-removal performance with low maintenance requirements. Consistent with MS4 Permit Provision XII.E.4, this WQMP promotes green infrastructure/LID techniques including, but not limited to the following:

a. Landscaping designs that promote longer water retention and evapotranspiration such as 1 foot depth of compost/top soil in commercial and residential areas on top of 1 foot of non-compacted subsoil, concave landscape grading to allow runoff from impervious surfaces, and water conservation by selection of water efficient native plants, weather-based irrigation controllers, etc.

b. Allow permeable surface designs in low traffic roads and parking lots.

c. Allow natural drainage systems for street construction and catchments (with no drainage pipes) and allow vegetated ditches and swales where feasible.

d. Require landscape in parking lots to provide treatment, retention or infiltration.

e. Reduce curb requirements where adequate drainage, conveyance, treatment and storage are available.

f. Allow no curbs, curb cuts and/or stop blocks in parking areas and residential streets with low traffic.

g. Use of green roof, rain garden, and other green infrastructure in urban/suburban area.

h. Allow rainwater harvesting and use.

i. Narrow streets provide alternatives to minimum parking requirements, etc. to facilitate LID where acceptable to public safety departments.

j. Consider vegetated landscape for stormwater treatment as an integral element of streets, parking lots, playground and buildings.

LID BMP Prioritization

In addition to requiring implementation of LID BMPs as described above, the MS4 Permit also prioritizes which LID BMPs should be used first.

> ***XII.E.2.***
>
> - Projects subject to the WQMP requirements must 'Infiltrate, harvest and use, evapotranspire and/or bio-treat the Design Capture Volume'.
>
> - A properly engineered and maintained bio-treatment system may be considered only if infiltration, harvesting and use and evapotranspiration cannot be feasibly implemented at a project site'.
>
> - Any portion of [the design capture volume] that is not infiltrated, harvested and used, evapotranspired, and/or biotreated shall be treated and discharged in accordance with the requirements set forth in Section XII.G [alternatives and in-lieu programs]

XII.E.2. further states that:

> It is recognized that LID principles are not universally applicable and they are dependent on factors such as: soil conditions including soil compaction and permeability, groundwater levels, soil contaminants (Brownfield development), space restrictions (in-fill projects, redevelopment projects, high density development, transit-oriented developments), highest and best use of Urban Runoff (to support downstream uses), etc.

Therefore, to ensure that the most effective BMPs are used on each project, MS4 Permit Provision XII.G.1. requires the Permittees to develop technically-based feasibility criteria for LID BMPs. These feasibility criteria are identified in the sections below.

☐ *RETENTION VS BIOTREATMENT*

The NPDES Permit requires that the design capture volume be first infiltrated, evapotranspirated, or harvested and reused; and when such retention methods are infeasible the remainder of the volume can be biotreated. The intent behind these prioritization requirements is to have as much runoff as possible retained onsite, so as to reduce the volume of urban runoff and pollutant loads entering Receiving

Waters. In cases where such retention practices are feasible, they can provide a significant benefit to runoff quality, and help the project mimic the pre-development hydrologic regime.

BMPs solely reliant on retention practices (infiltration, harvesting and use, or evapotranspiration) however, require a high level of confidence in the long-term reliability of water demand, the infiltration characteristics of the underlying soils, and of evapotranspiration rates, to ensure timely drawdown of the storage volume. It is impracticable to accurately predict, in many cases, whether the required drawdown will occur, as actual infiltration and evapotranspiration rates vary widely and are inherently unpredictable, and non-potable water usage rates must be consistent throughout the year, including the wet season.

The MS4 Permit's retention prioritization requirements discussed above however, make no explicit mention that this retention storage must be recovered so that subsequent runoff events can be managed. Without a demand criterion however, it would be possible that a facility could be designed to capture the design control volume, but with insufficient demand for timely drawdown this condition would cause health concerns through vector and mosquito breeding, and excessive overflows and bypasses of the facility, and — the intent of the Water Board in this regard would not be fulfilled.

When appropriately designed, LID Biotreatment BMPs, such as shown in the LID BMP Design Handbook, also inherently meet the goal of capturing the required volume of urban runoff, and infiltrating and evapotranspiring that volume to the extent feasible given site soils and other conditions. In highly permeable soils, infiltration will meet or exceed the required design capture volume; in less permeable soils the proportion infiltrated will be smaller and the remaining proportion will either be evapotranspired or receive biotreatment. Such LID Biotreatment BMPs will achieve the *maximum* feasible level of infiltration and evapotranspiration and achieve the *minimum* feasible (but highly biotreated) discharge to the storm drain system. LID Biotreatment BMPs also provide a higher level of confidence that the captured volume will be drained within an acceptable timeframe.

A retrofit project being implemented by the District is constructing and testing bioretention BMPs and will directly monitor and quantify the volume reduction benefits of those BMPs over the next several years. Additionally*, a recent analysis of the monitored inflow and outflow data contained in the International Stormwater BMP Database showed an average long-term volume reductions on the order of 40% for biofllters, 30% for extended detention basins, and 60 % for bioretention areas. These values represent the average of observed total volume

* Adapted from the Orange County Technical Guidance Document, 2011

reductions through infiltration and transpiration during entire monitoring studies. Total volume reductions during a study were calculated based on comparison of the total inflow volume and outflow volumes measured over the duration of each study (including multiple — up to 65 storm events). As these analyses utilized long-term observed volume reductions over a series of storm events, they provide a benchmark for comparing the performance of LID BMPs (infiltration, harvest and use, and evapotranspiration) against the performance of LID Biotreatment BMPs, which under some circumstances, may provide a similar level of retention plus offer other pollutant treatment mechanisms.

This analysis shows that while LID Biotreatment BMPs are not designed to fully retain the DCV, on an average basis they are capable of providing substantial volume reductions, on the order of half of the water that is captured and managed. This analysis further shows that a well-designed LID Biotreatment BMP that has been designed to capture 80% of average annual stormwater runoff (see discussion on Design Capture Volume) and has been designed to achieve maximum feasible volume reduction would be expected to achieve total long-term volume reduction on the order of 40% of long-term runoff volume. This means that a designer, faced with a LID Retention BMP with a long-term performance of 40% retention or less could substitute the LID Retention BMP with a LID Biotreatment BMP that is capable of carrying 100% of the DCV without impairing the overall performance of the site's system of BMPs. This is because roughly 40% of the DCV will be incidentally infiltrated or evapotranspirated by the LID Biotreatment BMP — roughly equal or better than the low-performing LID Retention BMP. Therefore, it is appropriate to designate 40% retention as a minimum threshold for eliminating the mandatory selection and use of a specific LID retention measure in favor of using LID Bioretention BMPs that achieve a comparable or greater level of retention for the system as a whole. This threshold must not be used to reduce the site's overall level of retention.

Highest and Best Use:

Finding II.G.14. states that:

Consideration of "highest and best use" of the discharge should also be considered. For example, Lake Elsinore is evaporating faster than runoff from natural precipitation can recharge it. Requiring infiltration of 85% of runoff events for projects tributary to Lake Elsinore would only exacerbate current water quality problems associated with Pollutant concentration due to lake water evaporation. In cases where rainfall events have low potential to recharge Lake Elsinore (i.e. no hydraulic connection between groundwater to Lake Elsinore, or other factors), requiring infiltration of Urban Runoff from projects is counterproductive to the overall watershed goals. Project proponents, in these cases, would be allowed to discharge Urban Runoff, provided they used equally effective filtration-based BMPs.

As a significant portion of the San Jacinto sub-watershed that drains to Lake Elsinore is expected to develop or re-develop over time, most urban areas will be subjected to the LID requirements identified in the MS4 Permit, including the 'Tier 1' requirement to retain runoff. The CNRP that will be submitted to the Regional Board on December 31, 2011, will further assess potential negative impacts of retention upon the beneficial uses of Lake Elsinore. The final form of the CNRP may include specific exceptions to retention within this sub-watershed. As such time that the CNRP is approved by the Regional Board, this WQMP will be amended as necessary to reflect such requirements.

☐ *LID INFILTRATION*

In many areas of Riverside County soils will support infiltration BMPs. There are however several factors that affect their feasibility that must be considered before utilizing such BMPs. Some of the factors will require a licensed Geotechnical Engineer to verify, as identified in the sub-sections below.

Groundwater Protection:

The MS4 Permit Provision XII.D.8. states minimum requirements to protect groundwater when BMPs that infiltrate stormwater are used. The requirements apply to "treatment control BMPs utilizing infiltration" but not to "BMPs not designed to primarily function as infiltration devices." Infiltration trenches and infiltration basins are designated here to be "treatment control BMPs utilizing infiltration".

☞ In accordance with XII.D.8., infiltration BMPs cannot be used if the BMPs location meets any of the scenarios below. Verification of this information can be done using past geotechnical investigations for the site, or using publically available information. If those sources are unavailable, a licensed Geotechnical Engineer may be required.

- ☐ Areas of known soil or groundwater contamination (unless with written authorization from the Regional Board Executive Officer)
- ☐ Located less than 100 feet horizontally from any water supply well
- ☐ Located so that the bottom of the BMP is less than 10 feet above the "historic high groundwater mark," except in areas where groundwater does not support beneficial uses

☞ In accordance with XII.D.8., infiltration BMPs cannot be used in the following locations unless adequate pretreatment is provided:

- ☐ Gas stations
- ☐ Large commercial parking lots
- ☐ Areas of industrial or light industrial activity
- ☐ Areas subject to high vehicular traffic (25,000 or greater average daily traffic)
- ☐ Car washes; nurseries, or other areas with pollutant sources that could pose a high threat to water quality, as determined by Co-Permittee staff

☞ BMPs meeting the definition of a Class V injection well must not be placed in areas subject to vehicular repair or maintenance activities. Infiltration BMPs designed pursuant to the LID BMP Design Handbook will generally not be classified as a Class V injection well.

Slope / Structural Stability:

☞ Infiltration BMPs shall not be used in locations or in soils that may create a public safety or structural concern, such as but not limited to slope or structural in-stability, landslides, mudslides, liquefaction or other geotechnical concerns. Such a determination must be in accordance with the recommendations of a licensed Geotechnical Engineer. In such a scenario, other LID BMPs would be required, and an impermeable barrier may be required so the facility is "flow through" and all biotreated runoff is under-drained away from the facility.

Infiltration Characteristics:

BMPs entirely reliant on infiltration (such as infiltration basins or infiltration trenches) require a high level of confidence in the long-term reliability of the infiltration characteristics of the underlying soils. Adequate long-term infiltration capacity is the determining factor as to whether an infiltration BMP will be effective for the protection of water quality.

'In-Situ' tested infiltration rates (i.e. the Saturated Hydraulic Conductivity) however are known to vary widely both spatially and temporally. At a given point in time, it is not uncommon to find that the tested infiltration rates at one location can be an order of magnitude different from another test conducted a matter of feet away – even within the same BMP footprint. Additionally it is known that the infiltration rate is typically reduced after construction of the project (compared to exploratory / feasibility testing performed before construction) due to grading, cut and fill conditions; and that the infiltration rate continues to further degrade over time due to unavoidable / inadvertent clogging of the native soils.

The risk is that if the actual long-term infiltration rates within the BMP are too low, excessive ponding may occur, which has two negative effects: 1) mosquitos and other vectors may begin breeding, and 2) subsequent rainfall events may bypass the BMP, resulting in untreated runoff being discharged from the site and potential impacts to waterbodies.

To avoid creation of nuisance or vector conditions in accordance with MS4 Permit Provision XII.K.1., a maximum drawdown time of 72 hours has been established. To ensure that over the life of the BMP the actual drawdown time does not exceed 72 hours, and based on the typical infiltration basin depth of 5 feet, the minimum long-term post-development infiltration rate must be at least 0.83 inches per hour (5ft * 12 / 72 hours = 0.83 inches/hour).

As discussed above however, the long-term post-development infiltration rates can be much lower than the initial (pre development) infiltration rates that are measured for feasibility testing. As such infiltration testing requirements have incorporated a minimum factor of safety of 2 for infiltration BMPs. Incorporating the established minimum factor of safety, the tested pre-development infiltration rates (Ksat) must be greater than 1.6 inches per hour to be assured that over the life of the BMP that nuisance or vector conditions will not be created. This will also ensure that the BMP will be adequately drained for back-to-back storms.

Accordingly the following feasibility criteria have been developed to ensure that the most effective BMPs are deployed:

- ☞ If the average 'in-situ' tested saturated hydraulic conductivity (K_{SAT}) for the site is less than 1.6 inches per hour, infiltration BMPs shall not be used. Infiltration testing needs to be performed using approved methodologies, such as those identified in the LID BMP Design Handbook.

- ☞ If the project meets the following criteria:

Residential	Commercial, Institutional	Industrial
Less than 10 acres and less than 30 DU	Less than 5 acres and less than 50,000 SF Impervious	Less than 2 acre and less than 20,000 SF Impervious

Then the project is considered a small project. If the small project is underlain with Hydrologic Soils Group (HSG) "D" soils according to available regional soils maps, and no available data for the site is conflicting with such a designation, 'in-situ' testing of infiltration rates may not be required, at the discretion of the Co-Permittee. In this case, infiltration BMPs shall not be used.

☞ If the BMP would be placed in a fill condition, and the infiltration surface of the BMP cannot extend down into native soils, or if the BMP would be placed in a cut condition, and there is no practicable way to verify infiltration rates at the final BMP elevation, infiltration BMPs shall not be used.

☞ If the geotechnical investigation, performed by a licensed engineer, discovers other site-specific factors that would preclude effective infiltration, such as, but not limited to, clay lenses or restrictive layers, infiltration BMPs are not required in those areas.

☐ *LID HARVEST AND USE*

Harvesting and use may be employed on any site where it can be shown there is sufficient reliable and timely demand for non-potable water, subject to the following criteria:

Water Rights

☞ If harvesting and using stormwater runoff would negatively impact downstream water rights, Harvest and Use BMPs are not required.

Reclaimed Water Use

Utilizing reclaimed water where available inherently reduces the amount of treated municipal effluent discharged to waterbodies. Further, utilizing the capacity of the reclaimed water system, where available, has a significantly larger benefit for offsetting potable water supply than stormwater harvest and use systems. If reclaimed water is available to the site, the use of reclaimed water will take precedence over the harvest and use of stormwater runoff.

- ☞ If reclaimed water will be used on the project, there is no need to further evaluate the feasibility of harvest and use. Document the use of reclaimed water in your Project-Specific WQMP.*

Criteria

The evaluation of the feasibility of harvest and use is performed for three potential categories of use: toilet flushing, irrigation, and other on-site non-potable uses.

For evaluation of ***toilet flushing***, flush volumes and use rates from the literature have been combined with a long-term continuous simulation to develop a minimum demand, referred to as the Toilet Users To Impervious Area (TUTIA) ratio, that would be required to achieve the minimum 40% long-term retention of runoff. See Table 2-1 below, as well as the discussion of Retention vs. Biotreatment above.

- ☞ If the proposed project does meet or exceed this minimum demand, implementing this harvest and use BMP would be less effective than a Bioretention BMP, and as such, this harvest and use BMP would not be required for the project.

For evaluation of ***irrigation***, typical evapotranspiration and water demands have been combined with a long-term continuous simulation, to develop a minimum ratio of Effective Impervious Area To Irrigated Area (EIATIA) that would be required to achieve the minimum 40% long-term retention of runoff. See Table 2-2 below, as well as the discussion of Retention vs. Biotreatment above.

- ☞ If the proposed project cannot meet or exceed this ratio, implementing this harvest and use BMP would be less effective than a bioretention BMP, and as such this harvest and use BMP would not be required for the project.

For evaluation of ***other non-potable uses*** for which minimum ratios as described above have not been developed, such as industrial uses or washing, a long-term continuous simulation of precipitation intensity and frequency has been performed to develop a table of minimum demands that would be required to achieve the minimum 40% long-term retention of runoff. See Table 2-3 below, as well as the discussion of Retention vs. Biotreatment above.

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* Non-agricultural irrigation using recycled water must comply with the statewide permit for Landscape Irrigation Using Recycled Water and the State Department Health guidelines.

- ☞ If the proposed project cannot meet or exceed these minimum demands, implementing this Harvest and use BMP would be less effective than a Bioretention BMP, and as such this harvest and use BMP would not be required for the project.

Storage of a smaller volume of runoff for later use. Even if the available demand is less than the minimum required, incidental harvesting of stormwater runoff is encouraged for water conservation and environmental stewardship purposes, however:

- ☞ Such incidental harvesting of stormwater runoff is not required and may not be credited toward addressing the Design Capture Volume or to address HCOCs.

Minimum demands

The following tables and figures provide minimum demands to provide for reuse of 40% of the total runoff. Data presented in the tables were generated based upon a continuous simulation analysis and demand factors consistent with similar analyses prepared for the Orange County WQMP.

TABLE 2-1. Harvest and Use Data for Toilet Use

Project type	**Residential**	**Retail / office commercial**	**Industrial**	**Schools**
Basis of Use Type	*Resident*	*Employee (non-visitor)*	*Employee (non-visitor)*	*Employee (non-student)*
Design capture storm depth, in	**Minimum toilet users per tributary impervious acre for partial capture (tu/ac)**			
0.50	85	114	142	24
0.55	93	123	158	26
0.60	101	132	172	29
0.65	108	141	185	31
0.70	116	150	198	33
0.75	123	159	208	35
0.80	131	167	219	37
0.85	138	176	229	39
0.90	145	184	238	40
0.95	152	193	247	42
1.00	159	201	255	43
1.05	166	209	263	44
1.10	172	217	271	45
1.15	179	225	278	46
1.20	185	233	285	47

[A]*Unit demands used in analysis:*

Residential = 9.3 gal/resident/day
Retail/office = 7 gal/employee/day
Industrial = 5.5 gal/employee/day
Schools = 33 gal/employee/day

TABLE 2-2. Harvest and Use Data for Irrigation Use

General landscape type	Conservation Design: K_L=0.35	Active Turf Areas: K_L=0.70
Design Capture Storm Depth, in	Minimum required irrigated area per tributary impervious acre for partial capture (ac/ac)[C]	
0.50	0.26	0.22
0.55	0.52	0.35
0.60	0.79	0.47
0.65	1.05	0.60
0.70	1.32	0.72
0.75	1.59	0.85
0.80	1.85	0.98
0.85	2.12	1.10
0.90	2.38	1.23
0.95	2.65	1.35
1.00	2.92	1.48
1.05	3.18	1.60
1.10	3.45	1.73
1.15	3.71	1.85
1.20	3.98	1.98

[A]ET data from the CIMIS station at U.C. Riverside used for this analysis

TABLE 2-3. Harvest and Use Data for other non-potable uses*

Design capture storm depth, in	Wet season demand required for minimum partial capture, gpd per impervious acre
0.50	781
0.55	869
0.60	947
0.65	1,018
0.70	1,089
0.75	1,147
0.80	1,204
0.85	1,259
0.90	1,310
0.95	1,359
1.00	1,403
1.05	1,448
1.10	1,490
1.15	1,530
1.20	1,568

*Design storm capture = 0.5 in was calculated using Lake Matthews rainfall; 0.7 in with Lake Elsinore rainfall; 1.0 in with Temecula rainfall. Other values were linearly interpolated/extrapolated.

☐ *LID BIOTREATMENT*

Experience has shown implementation of LID Biotreatment BMPs is feasible on nearly all development sites with sufficient advance planning. When appropriately designed, LID Biotreatment BMPs, such as provided herein, particularly when designed in accordance with the LID BMP Design Handbook, also inherently meet the goal of capturing the required volume of urban runoff, and infiltrating and evapotranspiring that volume to the extent feasible given site soils and other conditions. In highly permeable soils, infiltration will meet or exceed the required design capture volume; in less permeable soils the proportion infiltrated will be smaller and the remaining proportion will either be evapotranspired or receive biotreatment. Such LID BMPs will achieve the *maximum* feasible level of infiltration and evapotranspiration and achieve the *minimum* feasible (but highly biotreated) discharge to the storm drain system.

Projects where LID Biotreatment may not always be feasible generally fall into one of the following two categories:

- ☞ Portions of sites which are not being developed or redeveloped, but which must be retrofit to meet treatment requirements in accordance with the "50% rule."

- ☞ Sites smaller than one acre approved for lot-line to lot-line development or redevelopment as part of a Co-Permittee's effort to preserve or enhance a pedestrian-oriented "smart-growth" type of urban design.

If neither of these categories apply, but you believe specific conditions on your site preclude the use of LID, you may submit, in the preliminary Project-Specific WQMP, a detailed site-specific examination and determination that on-site implementation of LID is infeasible. Site-specific determinations shall be certified by a Professional Civil Engineer registered in the State of California, and must be approved by the Co-Permittee. Such site-specific determinations are expected to rarely be necessary; as such if your project has truly extenuating circumstances and you plan to submit a site-specific determination, it is highly recommended to discuss this with Co-Permittee staff early on.

In these special situations, where it may still be feasible to treat runoff from one or more drainage management areas with LID, LID shall be used for the maximum amount of the project's impervious area that is feasible. For impervious areas of the project where the Co-Permittee has approved a site-specific determination that LID BMPs are not feasible, other Treatment BMPs approved by the Co-Permittee must be implemented to achieve the same level of compliance.

☐ OTHER CONSIDERATIONS

Table 2-4 provides the recommended percentage of a project site that is required to be made available for LID BMPs. The project may provide more area for LID BMPs if desired. Table 2-4 is intended to be used as follows:

- If, in order to manage the entire DCV, the percentage of the site that would have to be made available for LID BMPs exceeds the project-type specific minimum criteria shown in the table, then the remaining volume must be addressed with other Treatment Control BMPs, Credits, Urban Runoff fund contributions, or waivers.

- If the percentage of the site provided for LID BMPs is lower than the value shown in Table 2-4 and the DCV cannot be fully managed, a reviewer can request that additional area be made available for BMPs in the site design until either the percentage of the site in Table 2-4 is provided or the entire DCV is managed, whichever is less.

Table 2-4. Recommended effective area[1] required to be made available for LID BMPs (% of site)

Project Type	New Development	Redevelopment
SF/MF Residential < 7 du/ac	10%	5%
SF/MF Residential 7 – 18 du/ac	7%	3.5%
SF/MF Residential > 18 du/ac	5%	2.5%
Mixed Use, Commercial/Industrial w/ FAR < 1.0	10%	5%
Mixed Use, Commercial/Industrial w/ FAR 1.0 – 2.0	7%	3.5%
Mixed Use, Commercial/Industrial w/ FAR > 2.0	5%	2.5%
Podium (parking under > 75% of project)	3%	1.5%
Zoning allowing development to property lines	2%	1%
Transit Oriented Development[3]	5%	2.5%
Parking	5%	2.5%

[1] "Effective area" is defined as area which 1) is suitable for a BMP (for example, if infiltration is potentially feasible for the site based on infeasibility criteria, infiltration must be allowed over this area) and 2) receives runoff from impervious areas.
[2] Criteria for site design are only required to be met if the Project WQMP seeks to demonstrate that the full DCV cannot be feasibly managed on-site.
[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

☐ HYDROLOGIC CONDITIONS OF CONCERN AND BMP DESIGN

To help prevent Hydromodification impacts, Provision XII.E.9 of the MS4 Permit specifies requirements for identifying and mitigating hydrologic conditions of concern (HCOCs). HCOC requirements are separate from, but overlap, the LID requirements of Provision XII.E.2.

Control approaches have evolved over time, with efforts first focused on managing peak flow rates, and have now shifted to matching the volume and timing of an event hydrograph. This can be accomplished through the use of Structural BMPs designed to control the post-construction runoff hydrograph from the site. The LID Design process described in this document will significantly reduce, and in some cases eliminate entirely, any potential HCOCs from a project.

In-stream measures, such as grade control structures, can also be used to prevent excess erosion due to increased flow durations. While on-site measures should always be considered first, in-stream measures can be desirable where stream channels are already degraded due to hydromodification caused by existing development.

Selection of Permanent Source Control BMPs

Based on identification of potential pollutants of concern associated with various types of facilities, the Stormwater Pollutant Sources/Source Control Checklist (Exhibit B) of summarizes source controls associated with each facility type. This approach ensures appropriate BMPs are applied to potential sources of each pollutant of concern.

References and Resources

- *The Importance of Imperviousness* (Tom Scheuler, 1995)
  Site Planning for Urban Stream Protection, available from the Center for Watershed Protection)
- California Stormwater BMP Handbooks
- Southern California LID Manual
- *Urban Runoff Quality Management,* Water Environment Federation and American Society of Civil Engineers, 1998. ISBN 1-57278-039-8 ISBN 0-7844-0174-8.
- *Stormwater Infiltration,* Bruce K. Ferguson, 1994. ISBN 0-87371-987-5
- RWQCB Water Quality Control Plan for the Santa Ana River Basin (Basin Plan)
- Clean Water Act Section 402(p)
- 40 CFR 122.26(d)(2)(iv)(A)(2) – Stormwater Regulations for New Development
- *Restoring Streams in Cities* (Riley, 1998)
- *Stream Restoration: Principles, Processes, and Practices*
  (Federal Interagency Stream Restoration Working Group, 1998, revised 2001)
- *Municipal Handbook, Rainwater Harvesting Policies* (USEPA, 2008)
- *Green Roofs for Stormwater Runoff Control* (USEPA, 2009a)
- *Porous Pavements* (Ferguson, 2005)
- *Orange County WQMP and TGD, with errata, 2011*
- *CASQA LID Guidance Manual for Southern California*

Chapter 3

Preparing Your Project-Specific WQMP

Step-by-step assistance to document compliance.

Your Project-Specific WQMP will demonstrate your project complies with all applicable requirements in the MS4 Permit — to minimize imperviousness, retain or detain stormwater, slow runoff rates, incorporate required source controls, treat stormwater prior to discharge from the site, control runoff volumes if required, and provide for operation and maintenance of Stormwater BMPs.

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

Every Co-Permittee listed at the beginning of this document requires a Project-Specific WQMP for every applicable project. The Project-Specific WQMP must be submitted with your application for discretionary approvals and must have sufficient detail to ensure the stormwater design, site plan, and landscaping plan are congruent. The level of detail will vary based on what is known about the project at the time that discretionary approvals are sought. Even a preliminary Project-Specific WQMP must demonstrate that adequate area is being set aside to meet the BMP requirements of the WQMP. Submitting a complete and thorough Project-Specific WQMP will facilitate quicker review and fewer cycles of review.

Your Project-Specific WQMP will consist of a report, an exhibit, and reference to the long-term maintenance plan.

Co-Permittee staff may use a checklist, such as the one provided in Exhibit F:

• Step by Step

Plan and design your stormwater controls integrally with the site planning and landscaping for your project. It's best to start with general project requirements and preliminary site design concepts; then prepare the detailed site design, landscape design, and Project-Specific WQMP simultaneously. ***This will help ensure that your site plan, landscape plan, grading plan and Project-Specific WQMP are congruent.***

> ***WQMP Template***
> For use in preparing and documenting your WQMP compliance, a Project-Specific WQMP template will be made available upon approval of this WQMP.

The following step-by-step procedure should optimize your design by identifying the best opportunities for stormwater controls ***early in the design process.***

The recommended steps are:

1. Assemble needed information.
2. Identify site opportunities and constraints.
3. Follow the LID design guidance in Chapter 4 to analyze your project for LID and to develop and document your drainage design.
4. Document any Alternative Compliance
5. Specify source controls using the table in Exhibit B.
6. Plan for ongoing maintenance of Stormwater BMPs.
7. Complete the Project-Specific WQMP.

Co-Permittee staff may recommend you prepare and submit a preliminary Project-Specific WQMP prior to formally applying for planning and zoning approvals. Your preliminary Project-Specific WQMP should incorporate a conceptual plan for site drainage, including self-treating and self-retaining areas and the location and approximate sizes of any Stormwater BMPs. This additional up-front design effort will save time and avoid potential delays later in the review process.

Step 1: Assemble Needed Information

To perform the LID design, the designer needs to know the following site characteristics:

- ***Existing natural hydrologic features*** and natural resources, including any contiguous natural areas, wetlands, watercourses, seeps, or springs.

- ***Existing site topography***, including contours of any slopes of 4% or steeper, general direction of surface drainage, local high or low points or depressions, and any outcrops or other significant geologic features.

- ***Zoning***, including requirements for ***setbacks*** and ***open space***.

- Soil types (including ***hydrologic soil groups***) and depth to groundwater, which may determine whether infiltration is a feasible option for managing site runoff. Depending on site location and characteristics, and on the selection of Stormwater BMPs, site-specific information (e.g. from boring logs or geotechnical studies) may be required.

- ***Existing site drainage.*** For undeveloped sites, this should be obtained by inspecting the site and examining topographic maps and survey data. For previously developed sites, site drainage and connection to the municipal storm drain system can be located from site inspection, municipal storm drain maps, and plans for previous development.

- Existing ***vegetative cover*** and ***impervious areas***, if any.

Step 2: Identify Constraints & Opportunities

Review the information collected in Step 1. Identify the principal constraints on site design and selection of LID BMPs as well as opportunities to reduce imperviousness and incorporate LID Principles into the site and landscape design. For example, ***constraints*** might include impermeable soils, high groundwater, groundwater pollution or contaminated soils, steep slopes, geotechnical instability, high-intensity land use, heavy pedestrian or vehicular traffic, utility locations, or safety concerns. ***Opportunities*** might include existing natural areas, low areas, oddly configured or otherwise unbuildable parcels, easements and landscape amenities including open space and buffers (which can double as locations for bioretention BMPs), and differences in elevation (which can provide hydraulic head).

☐ NARRATIVE OVERVIEW

Prepare a brief ***narrative*** describing site opportunities and constraints. This narrative will help you as you proceed with LID design and explain your design decisions to others.

The MS4 Permit further requires that LID retention BMPs (Infiltration or Harvest and Use) be used unless it can be shown that those BMPs are infeasible. It is therefore important that your narrative identify and justify if there are any constraints that would prevent the use of those categories of LID BMPs.

☐ HARVEST AND USE ASSESSMENT

An assessment of the feasibility of harvesting and use of stormwater runoff is required for all projects, *except:*

- Where reclaimed water will be used for the non-potable water demands for the project, or where downstream water rights may be impacted by harvest and use (see harvest and use discussion in Chapter 2).

- Where it can be shown that the LID design can reliably infiltrate or evapotranspire the Design Capture Volume. (see the infiltration assessment below). In such a case, harvest and use can still be implemented for the Design Capture Volume if desired, but it would not be required if the Design Capture Volume will be infiltrated or evapotranspired.

If neither of the above criteria apply, follow the steps below to assess the feasibility of:

- Irrigation use
- Toilet use
- Other non-potable uses (i.e. industrial use)

To perform these assessments, follow the following steps:

1) Document the following potential demands for the site, as applicable:

    a. ***The total area of irrigated landscape***. It will be necessary to determine the type of landscaping that will be implemented on the site. For the purposes of this assessment, landscaping will either be a 'Conservation Design' (Low water use, native species, etc), or 'Active Turf areas' (higher water use species such as conventional sod). Determine the irrigated landscape area in acres.

    b. ***The expected number of toilet users***. This should be based on the average number of daily toilet users during the wet season and should account for any periodic shut downs/lapses in occupancy (e.g., for vacations, maintenance, or other reasons).

    c. ***Other non-potable water demands***. Identify any other on-site non-potable demand (in gallons per day) that is anticipated on an *average daily basis* during the wet season. Sources of demand should only be included if they are reliably and consistently present during the wet season.

2) Identify the planned ***total of all impervious areas*** on the proposed project from which runoff might be feasibly captured and stored. Depending on the configuration of buildings and other impervious areas on the site, you may consider the site as a whole, or parts of the site, to evaluate reasonable scenarios for capturing and storing runoff and directing the stored runoff the potential use(s) identified in Step 1 above. Identify the total impervious area in acres.

3) Enter the design storm depth for the project site (see Exhibit A) into the left column of Tables 2-1 through 2-3 in Chapter 2 to determine, respectively: a) the minimum number of toilet users per tributary impervious acre (TUTIA) and b) the minimum square footage of effective irrigated area per tributary impervious acre (EIATIA), and c) the minimum demand for other non-potable uses per tributary impervious acre.

4) Multiply the unit values obtained from Step 3 by the total of impervious areas from Step 2, to develop the minimum demand that would be required for the various forms of harvest and use to be feasible on the project. Then compare minimum demand values to the anticipated demands identified in Step 1.

   ☞ If the any of the anticipated demands exceed the applicable minimum values, Harvest and Use will be required to be used for applicable drainage management areas, before LID biotreatment can be used. Such drainage management areas shall be identified as self-retaining.

   ☞ If all of the anticipated demands are less than the applicable minimum values, Harvest and Use is not required, however, other Retention LID BMPs, such as infiltration must be assessed and where applicable used – before LID Biotreatment BMPs can be used.

☐ *INFILTRATION ASSESSMENT*

An assessment of the feasibility of utilizing infiltration BMPs is required for all projects, *except:*

- Where there is a 'Higher and Best Use' for stormwater runoff. (see infiltration discussion in Chapter 2).

- Where it can be shown that harvest and use BMPs can be feasibly implemented to address the Design Capture Volume. (see the harvest and use assessment above). In such a case, infiltration BMPs can still be

implemented for the Design Capture Volume if desired, but it would not be required if the Design Capture Volume will be harvested and used.

If neither of the two above criteria apply, perform a site-specific evaluation of the feasibility of Infiltration BMPs using each of the applicable criteria identified in Chapter 2. If one or more of the infiltration criteria indicate that infiltration is not feasible for the site, the other remaining infiltration criteria do not need to be assessed.

- ☞ If any of the groundwater protection requirements identified in Chapter 2 are not met, infiltration BMPs will not be required in those areas. Harvest and Use must be assessed before Biotreatment BMPs can be used.

- ☞ If the geotechnical report identifies areas where infiltration of stormwater would cause public safety risks, such as described in Chapter 2, infiltration BMPs are not required in those areas. Harvest and use must be assessed for those areas before Biotreatment BMPs can be used.

- ☞ If the evaluation of infiltration characteristics on the site indicate that the minimum infiltration criteria identified in Chapter 2 cannot be met, infiltration BMPs are not required. Harvest and use must be assessed for those areas before Biotreatment BMPs can be used.

- ☞ If none of the above feasibility criteria indicate that infiltration BMPs are not feasible, infiltration BMPs will be required to the MEP, unless harvest and use is used, before LID Biotreatment can be used.

Step 3: Prepare and Document Your LID Design

Use the LID Design Guide (Chapter 4) to analyze your project for LID, design and document drainage, and select and specify preliminary design details for LID BMPs. When done, return and continue to step 4.

Step 4. Specify Source Control BMPs

Some everyday activities – such as trash recycling/disposal and washing vehicles and equipment – can generate pollutants that tend to find their way into storm drains. These pollutants can be minimized by applying ***source control BMPs***.

Source control BMPs include ***permanent***, structural features that may be required in your project plans—such as roofs over and berms around trash and recycling areas—and ***operational*** BMPs, such as regular sweeping and "housekeeping," that must be implemented by the site's occupant or user. The maximum extent practicable standard typically requires both types of BMPs. In general, operational BMPs cannot be substituted for a feasible and effective permanent BMP.

Use the following procedure to specify source control BMPs for your site:

☐ ***IDENTIFY POLLUTANT SOURCES***

Review the first column in the ***Pollutant Sources/Source Control Checklist*** (Exhibit B). Check off the potential sources of pollutants that apply to your site.

☐ ***NOTE LOCATIONS ON PROJECT-SPECIFIC WQMP EXHIBIT***

Note the corresponding requirements listed in Column 2 of the Pollutant Sources/Source Control Checklist (Exhibit B). Show the location of each pollutant source and each permanent source control BMP in your Project-Specific WQMP Exhibit.

☐ ***PREPARE A TABLE AND NARRATIVE***

Check off the corresponding requirements listed in Column 3 in the Pollutant Sources/Source Control Checklist (Exhibit B). Now, create a table using the format in Table 3-1. In the left column, list each potential source on your site (from Exhibit B, Column 1). In the middle column, list the corresponding permanent, Structural BMPs (from Columns 2 and 3, Exhibit B) used to prevent pollutants from entering runoff. Accompany this table with a narrative that explains any special features, materials, or methods of construction that will be used to implement these permanent, Structural BMPs.

TABLE 3-1. Format for Table of Permanent and Operational Source Control Measures

Potential source of runoff pollutants	*Permanent source control BMPs*	*Operational source control BMPs*

☐ ***IDENTIFY OPERATIONAL SOURCE CONTROL BMPS***

To complete your table, refer once again to the Pollutant Sources/Source Control Checklist (Exhibit B, Column 4). List in the right column of your table the operational BMPs that should be implemented as long as the anticipated activities continue at the site. Co-Permittee stormwater ordinances require that applicable source control BMPs be implemented; the same BMPs may also be required as a condition of a use permit or other revocable discretionary approval for use of the site.

References and Resources

- Exhibit B, Stormwater Pollutant Sources/Source Control Checklist
- NPDES Permit Provision XII.D.7.a.
- *Start at the Source*, Section 6.7: Details, Outdoor Work Areas
- *California Stormwater Industrial/Commercial Best Management Practice Handbook*
- *Urban Runoff Quality Management* (WEF/ASCE, 1998) Chapter 4: Source Controls

Step 5: Stormwater Facility Maintenance

As required by NPDES Permit Provision XII.K., the Co-Permittee will periodically verify that Stormwater BMPs on your site are maintained and continue to operate as designed.

To make this possible, your Co-Permittee will require that you include in your Project-Specific WQMP:

1. A means to finance and implement facility maintenance in perpetuity.

2. Acceptance of responsibility for maintenance from the time the BMPs are constructed until responsibility for operation and maintenance is legally transferred. A warranty covering a period following construction may also be required.

3. An outline of general maintenance requirements for the Stormwater BMPs you have selected.

Your local Co-Permittee will also require that you prepare and submit a detailed Stormwater BMP Operation and Maintenance Plan that sets forth a maintenance schedule for each of the Stormwater BMPs built on your site. An agreement assigning responsibility for maintenance and providing for inspections and certification may also be required.

Details of these requirements, and instructions for preparing a Stormwater BMP Operation and Maintenance Plan, are in Chapter 6.

References and Resources

- *Chapter 6*
- Operation, Maintenance, and Management of Stormwater Management Systems (Watershed Management Institute, 1997)

Step 6: Project-Specific WQMP Exhibit, Report & O&M Plan

Your Project-Specific WQMP should document the information gathered and decisions made in Steps 1-5. Submittal of a clear, complete, well-organized WQMP will make it possible for agency staff reviewers to confirm your design meets minimum requirements.

☐ COORDINATION WITH SITE, ARCHITECTURAL, AND LANDSCAPING PLANS

Before completing your Project-Specific WQMP exhibit and report, ensure your stormwater control design is fully coordinated with the site plan, grading plan, and landscaping plan being proposed for the site.

Information and presentations submitted to design review committees, planning commissions, and other decision-making bodies must incorporate relevant aspects of the stormwater design. In particular, ensure:

- Curb elevations, elevations, grade breaks, and other features of the drainage design are consistent with the delineation of DMAs.
- The top edge (overflow) of each bioretention facility is level all around its perimeter—this is particularly important in parking lot medians.
- The resulting grading and drainage design is consistent with the design for parking and circulation.

- Bioretention BMPs and other BMPs do not create conflicts with pedestrian access between parking and building entrances.
- Vaults and utility boxes will be accommodated outside BMPs and will not be placed within BMPs in a manner that interferes with their maintenance and operation.
- The visual impact of stormwater BMPs, including bioretention BMPs at building foundations and any terracing or retaining walls required for the stormwater control design, is shown in renderings and other architectural drawings.
- Landscaping plans, including planting plans, show locations of BMPs, and the plant requirements are consistent with the engineered soils and conditions in the BMPs.
- Renderings and representation of street views incorporate any stormwater BMPs located in street-side buffers and setbacks.
- Any potential conflicts with local development standards have been identified and resolved.

Review Chapter 5, Structural BMP Construction, to anticipate additional requirements for construction of BMPs.

☐ CERTIFICATION

The WQMP must include the following certification language: "The selection, sizing, and preliminary design of stormwater treatment and other control measures in this plan meet the requirements of Regional Water Quality Control Board Order R8-2010-0033 and any subsequent amendments." The Co-Permittee may require that your Project-Specific WQMP be certified by a licensed civil engineer.

☐ CONSTRUCTION PLAN WQMP CHECKLIST

When you submit construction plans for Co-Permittee review and approval, the plan checker will compare that submittal with your Project-Specific WQMP. To facilitate the plan checker's comparison and speed review of your project, create a Construction WQMP Checklist for your project.

TABLE 3-2. Format for Construction Plan WQMP Checklist

Project-Specific WQMP Page #	*BMP Identifier and Description*	*See Plan Sheet #s*

Here's how:

1. Create a table similar to Table 3-2. Number and list each measure or BMP you have specified in your Project-Specific WQMP in Columns 1 and 2 of the table. Leave Column 3 blank. Incorporate the table into your Project-Specific WQMP.

2. When you submit construction plans, ***duplicate the table*** (by photocopy or electronically). Now fill in Column 3, identifying the plan sheets where the BMPs are shown. List all plan sheets on which the BMP appears. Submit the updated table with your construction plans so that the plan checker can quickly locate the stormwater BMPs that were committed to in the WQMP.

Note that the updated table—or Construction Plan WQMP Checklist—is ***only a reference tool*** to facilitate comparison of the construction plans to your Project-Specific WQMP. Co-Permittee staff can advise you regarding the process required to propose changes to the approved Project-Specific WQMP.

See Chapter 5 for details of construction information to be included in construction plans.

☐ PREPARE AN OPERATIONS AND MAINTENANCE PLAN

Follow the guidance in Chapter 6 to develop a Stormwater BMP Operations and Maintenance Plan.

☐ PROJECT-SPECIFIC WQMP TEMPLATE

A Project-Specific WQMP template will be made available upon approval of this WQMP.

☐ EXAMPLE PROJECT-SPECIFIC WQMPS

Check with the Co-Permittee to determine if example Project-Specific WQMPs are available for your review. Your Project-Specific WQMP will reflect the unique character of your own project and should meet the requirements identified in this *WQMP*. Co-Permittee staff can assist you to determine how specific requirements apply to your project.

Chapter 4

Low Impact Development Design Guide

Guidance for designing and documenting your Low Impact Development (LID) design, including LID Principles and stormwater BMPs

Your Project-Specific WQMP—to be submitted with your application for planning and zoning approvals (entitlements)—must show how your project will comply with the applicable LID, and HCOC standards in the MS4 Permit.

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

This will require careful documentation of:

- Pervious and impervious areas in the planned project.
- Drainage from each of these areas.
- Locations, sizes, and types of proposed stormwater BMPs.

This LID Design Guide will help you:

- ***Analyze your project*** and identify and select options for meeting LID requirements as well as HCOC requirements, if they apply.
- ***Design and document drainage*** for the whole site and document how that design meets the WQMP's stormwater treatment and flow-control criteria.

- ***Specify preliminary design details*** and integrate your LID drainage design with your paving and landscaping design.

This procedure is intended to facilitate, not substitute for, creative interplay among site design, landscape design, and drainage design. ***Several iterations may be needed*** to optimize your drainage design as well as aesthetics, circulation, and use of available area for your site. The procedure accounts for how runoff from each delineated area is managed and results in a space-efficient, cost-efficient LID design for meeting WQMP requirements on most developments.

Step 1: Optimize the Site Layout

To minimize stormwater-related impacts and minimize the number of stormwater BMPs that must be used, apply the following LID Principles to the layout of newly developed and redeveloped sites. Putting thought upfront about how best to organize the elements of the project on the site can help you to significantly reduce your impact on the environment and on stormwater runoff. Analyze your preliminary site layout concepts, and look for opportunities to accomodate the following LID Principles within your site layout. Having performed this analysis and optimized the layout for LID will come in handy during the remaining steps.

☐ PRESERVE EXISTING DRAINAGE PATTERNS

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.

Minimize unnecessary site grading that eliminates small depressions, which can provide storage of small storm volumes. Where possible, add additional depression "micro" storage throughout the site's landscaping. This is referred to in Step 3 as 'self retaining areas'. Mild gradients can be used to extend the time of concentration, which reduces peak flows and increases the potential for additional infiltration. While of course risk of serious flooding must be minimized, the persistence of temporary "puddles" during storms is beneficial to infiltration.

- ☐ Where possible, conform the site layout along natural landforms, avoid excessive grading and disturbance of vegetation and soils, and preserve or replicate the site's natural drainage features and patterns.

- ☐ Set back development from creeks, wetlands, and riparian habitats.
- ☐ Use both existing and proposed site drainage patterns as a natural design element, rather than using expensive impervious conveyance systems. Use depressed landscape areas, vegetated buffers, and bioretention areas as amenities and focal points within the site and landscape design.

☐ *PROTECTION EXISTING VEGETATION AND SENSITIVE AREAS*

Identify any areas containing dense vegetation or well-established trees, and try to 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 areas, such as streams and floodplains should also be avoided.

- ☐ Define the development envelope and protected areas, identifying areas that are most suitable for development and areas that should be left undisturbed.
- ☐ Establish set-backs and buffer zones surrounding sensitive areas.
- ☐ Preserve significant trees and other natural vegetation where possible.

☐ *PRESERVE NATURAL INFILTRATION CAPACITY*

A key component of LID is taking advantage of a site's natural infiltration and storage capacity. A site survey and geotechnical investigation can help to define areas with high potential for infiltration and surface storage. Look for opportunities to locate stormwater BMPs in any highly pervious areas. Doing so will maximize infiltration and limit the amount of runoff generated.

- ☐ Concentrate development on portions of the site with less permeable soils, and preserve areas that can promote infiltration.

☐ *MINIMIZE IMPERVIOUS AREA*

As discussed in Chapter 2, imperviousness can be tied to various environmental impacts due to stormwater. Look for opportunities to minimize impervious cover through identification of the smallest possible land area that can be practically impacted or disturbed during site development.

- ☐ Limit overall coverage of paving and roofs. This can be accomplished by designing compact, taller structures, narrower and shorter streets and sidewalks, clustering buildings and sharing driveways, smaller parking lots (fewer stalls, 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, such as for overflow parking.

- ☐ Inventory planned impervious areas on your preliminary site plan. Identify where ***permeable pavements***, such as crushed aggregate, turf block, unit pavers, pervious concrete, or pervious asphalt could be substituted for impervious concrete or asphalt paving. This will help minimize the amount of runoff that may need to be addressed through Stormwater BMPs.

- ☐ Consider green roofs. Green roofs are roofing systems that provide a layer of soil/vegetative cover over a waterproofing membrane. A green roof mimics pre-development conditions by filtering, absorbing, and evapotranspiring precipitation to help mitigate the effects of an otherwise impervious rooftop. Green roofs with growing media 4 inches or deeper are considered 'self retaining areas' as defined in Step 3, and do not produce increased runoff or runoff pollutants (i.e., any runoff from a green roof requires no further treatment or hydrograph controls).

☐ ***DISPERSE RUNOFF TO ADJACENT PERVIOUS AREAS***

Look for opportunities to direct runoff from impervious areas to adjacent landscaping or other pervious areas. This is sometimes referred to as minimizing Directly Connecting Impervious Areas (DCIA).

- ☐ Direct roof runoff into landscaped areas such as medians, parking islands, planter boxes, etc. and/or areas of pervious paving. Instead of having landscaped areas raised above the surrounding impervious areas, design them as depressed areas that can receive stormwater from adjacent impervious pavement. For example, a lawn or garden depressed 3"-4" below surrounding walkways or driveways provides a simple but quite functional landscape design element. This is referred to as 'areas draining to self retaining areas' in Step 3 below.

- ☐ Detain and retain runoff throughout the site. On flatter sites, stormwater BMPs may be interspersed in landscaped areas 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 LID BMPs in lower areas. Low retaining walls may also be used to create terraces that can accommodate LID BMPs. Wherever possible, direct drainage from landscaped slopes offsite and not to impervious surfaces like parking lots.

Step 2: Delineate Drainage Management Areas

This first step is key to successfully implementing your LID design. The procedure begins with careful delineation of pervious areas and impervious areas (including roofs) throughout the site and then dividing the ***entire project area*** into individual, discrete Drainage Management Areas (DMAs). Typically, lines delineating DMAs follow grade breaks and roof ridge lines. The exhibit, tables, text, and calculations in your Project-Specific WQMP will illustrate, describe, and account for runoff from each of these areas.

Establish separate DMAs for each surface type (e.g., landscaping, pervious paving, or roofs). Each DMA must be assigned a single hydrologic soil group and runoff factor. Assign each DMA a unique code and determine its size in *square feet*. During Step 6, these DMAs can be combined to individual downstream Stormwater BMPs. The total area of your site should total the sum of all of your DMAs, plus the areas of any Stormwater BMPs.

Step 3: Classify and Tabulate DMAs, and Determine Runoff Factors

Next, determine how drainage from each DMA will be handled. Each DMA will be classified as one of the following four types:

A. Self-treating areas.

B. Self-retaining areas (also called "zero-discharge" areas).

C. Areas that drain to self-retaining areas.

D. Areas that drain to BMPs.

The first three types of DMAs: Self-Treating, Self-Retaining, and draining to Self-Retaining, are ways to account for successful implementation of the LID Principles discussed in Step 1. Areas addressed by LID Principles are self-mitigating and do not require any further mitigation measures. Further, there is no requirement for operation and maintenance inspections for these areas.

The fourth type of DMA is a way to document the specific areas within the site layout that require additional mitigation measures through LID BMPs.

As was mentioned in Step 1:

> As more LID Principles are implemented on the site, more of the site will become self-mitigating, resulting in less area that must be mitigated through structural LID BMPs.

☐ TYPE 'A': SELF-TREATING AREAS

Self-Treating Areas are natural or landscaped areas that do not drain to Stormwater BMPs, but rather drain directly off site or to the storm drain system, rather than having their runoff comingle with runoff from the project's impervious surfaces. Examples include upsloped undeveloped areas which are ditched and drained around a development, and landscaped slopes that drain off-site to an existing public street or storm drain. In general, self-treating areas include no impervious areas, unless the impervious area is very small (e.g. 5 % or less of the self-treating area) and slopes are gentle enough (e.g. less than 5 %) to ensure runoff from impervious areas will be absorbed into the vegetation and soil. In addition, Consistent with XII.E.5, any local requirements implemented pursuant to AB1881 will help ensure that irrigation systems are appropriately designed to avoid excessive irrigation within landscaped areas.

Tabulate self-treating areas in the format shown in Table 4-1.

TABLE 4-1. FORMAT FOR TABULATING Self-Treating Areas (Type 'A' DMA)

DMA Type / ID	*Area (square feet)*
A/1	*1,235*
A/2	

☐ TYPE 'B': SELF-RETAINING AREAS

Self-Retaining Areas are areas designed to retain the design storm rainfall without producing any runoff. The technique works best on flat, heavily landscaped sites. It may be used on mild slopes if there is a reasonable expectation that the design storm rainfall event would produce no runoff.

To create self-retaining areas in flat areas or on terraced slopes, either berm the area or depress the grade into a concave cross-section so that there is a reasonable expectation that these areas will retain the design storm rainfall. Grade slopes, if any, toward the center of the pervious area. Self-retaining areas are not recommended for soils that are not expected to be freely draining, so as not to create vector or nuisance conditions. Compaction within self-retaining areas should be mimimized or avoided entirely where possible.

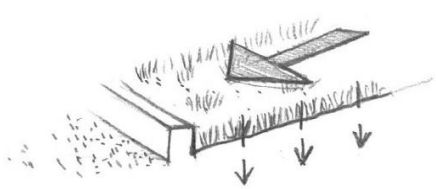

FIGURE 4-1. SELF-TREATING AREAS are entirely pervious and drain directly off-site or to the storm drain system.

Inlet elevations of area drains, if any, should be clearly specified to be 3 inches or more above the low point to *allow* ponding. In setting elevations, account for mulch or other landscaping cover that could reduce available ponding depth. Construction documents shall ***clearly specify the required elevation(s)*** of any area drain inlets.

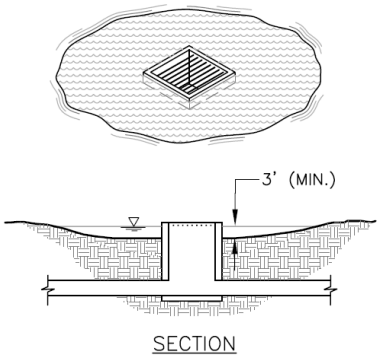

FIGURE 4-2. SELF-RETAINING AREAS. Berm or depress the grade to retain at least the design storm rainfall and set inlets of any
area drains at least 3 inches above low point to allow

Pervious pavements (e.g., crushed stone, porous asphalt, or pervious concrete, permeable pavers) can be self-retaining when constructed with a gravel base course four or more inches deep. This will ensure an adequate proportion of rainfall is infiltrated into native soils (including clay soils) rather than producing runoff. Consult with a qualified (geotechnical) engineer regarding infiltration rates, pavement stability, and suitability for the intended traffic.

Drainage from ***green roofs*** is considered to be self-retained, however, an emergency overflow should be provided for extreme events. Where possible, drainage from green roofs should be routed to landscaping rather than being tied directly into storm drains.

Areas draining to ***harvest and use*** are self retaining areas, if BMPs with the required storage volumes are provided and reliable demand pursuant to Chapter 2 is documented, in the Project-Specific WQMP.

Tabulate self-retaining areas in the format shown in Table 4-2.

TABLE 4-2. FORMAT FOR TABULATING Self-Retaining Areas (Type 'B' DMAs)

Self-retaining area				*Use when areas are draining to the Self-retaining area*		
DMA Type / ID	*Post-project surface type*	*Area (square feet)* ***[A]***	*Storm Depth (inches)* ***[B]***	*Runoff Received from DMA Type / ID*	*[A] from table 4-3 =* ***[C]***	*Required Retention Depth (inches)* ***[D]***
B/1	*Planter*	*604*	*0.8*	*C/1, C/2*	*1180*	*2.4*
B/2	*Pervious patio*	*2,149*	*0.8*	*C/3*	*1946*	*1.5*
B/3	*Planter*	*1677*	*0.8*	*N/A*	*N/A*	*0.8*

☐ TYPE 'C': AREAS DRAINING TO SELF-RETAINING AREAS

Runoff from impervious or partially pervious areas can be managed by routing it to self-retaining areas. For example, roof downspouts can be directed to lawns, and parking areas can be drained to landscaped areas.

For *impervious* areas such as pavements that drain to a self-retaining area, the maximum ratio, based upon past modeling efforts in California, is 2 parts impervious area for every 1 part pervious area.

For *partially* pervious areas draining to a self-retaining area the maximum ratio is:

(Tributary Area **:** Self-retaining Area)

TABLE 4-3. RUNOFF FACTORS for draining partially pervious areas into Self-retaining areas.

Surface	*Runoff factor*
Roofs	1.0
Concrete or Asphalt	1.0
Pervious Concrete*	0.1

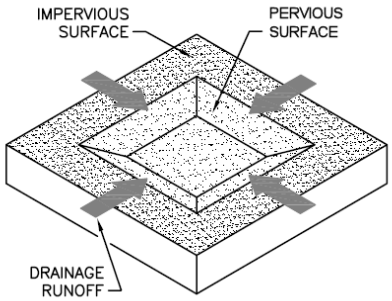

FIGURE 4-3. RELATIONSHIP OF IMPERVIOUS TO PERVIOUS area for Self-retaining areas.

Porous Asphalt*	0.1
Grouted Unit Pavers	1.0
Solid Unit Pavers Set in Sand*	0.2
Open and Porous Pavers*	0.1
Crushed Aggregate*	0.1
Turfblock*	0.1
Landscape *	0.1

* When not designed as a self-retaining area.

The drainage from the tributary area must be directed to and dispersed within the self-retaining area, and the entire area must be designed to retain the design storm rainfall without flowing off-site. For example, if the ratio of 2 parts impervious area into 1 part pervious area is used, and the design storm is 1 inch, then the pervious area must absorb 3 inches of water over its surface before overflowing to an off-site drain (one inch of rainfall for the self-retaining area itself, plus 1 inch for each of the 2 parts of tributary impervious area).

Special Case

For impervious surfaces draining onto pervious pavements, higher ratios (5:1 or greater) can be used **IF** the pervious pavement is designed in accordance with the LID BMP Design Handbook. In this case, the area will be considered an **'area draining to a BMP'**, and will be subject to post-construction BMP inspections.

Prolonged ponding is a potential problem at higher impervious/pervious ratios. In your design, ensure that the pervious area soils can handle the additional run-on and are sufficiently well-drained.

Tabulate areas draining to self-retaining areas in the format shown in Table 4-4. Check to be sure the total amount of (square feet of tributary area × runoff factor) for all DMAs draining to a receiving self-retaining area is no greater than a 2:1 ratio.

TABLE 4-4. FORMAT FOR TABULATING Areas Draining to Self-Retaining Areas (Type 'C' DMAs)

DMA Type / ID	*Area (square feet)*	*Post-project surface type*	*Runoff factor*	*Product (Area x runoff factor)[A]*	*Receiving self-retaining DMA name /ID*	*Receiving self-retaining DMA Area (square feet) [B]*	*Ratio [A]/[B]*
C/1	*1100*	*Roof*	*1*	*1100*			
C/2	*800*	*Pervious Walkway*	*0.1*	*80*			
				1180	*B/1*	*604*	*1.95*
C/3	*1946*	*Driveway*	*1*	*1946*	*B/2*	*2,149*	*0.91*

☐ TYPE 'D': AREAS DRAINING TO BMPS

Areas draining to BMPs are areas that could not be fully mitigated through LID Principles and will instead drain to an LID BMP designed to mitigate water quality impacts from that area, and HCOC where necessary.

More than one drainage management area can drain to a single LID BMP, however, one drainage management area may not drain to more than one BMP. See Figures 4-4 and 4-5.

Where possible, ***design site drainage so only impervious roofs and pavement drain to BMPs***. This yields a simpler, more efficient design, with minimized LID BMP requirements, and also helps protect BMPs from becoming clogged by sediment.

If it is necessary to include landscaping, or other pervious surfaces within the area draining to a BMP, list each surface as a separate DMA. A runoff factor is applied to account for the reduction in the quantity of runoff.

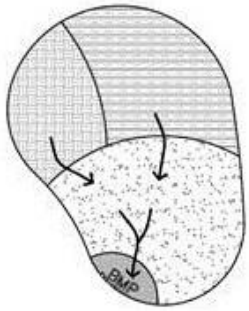

FIGURE 4-4. MORE THAN ONE
Drainage Management Area can drain to a single BMP.

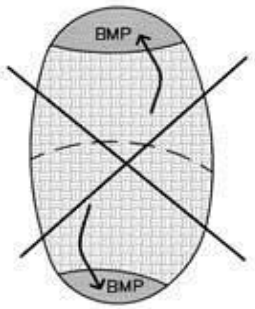

FIGURE 4-5. ONE DRAINAGE
Drainage Management Areas cannot drain to more than one BMP.
Use a grade break to divide the DMA into two

Tabulation of Type 'D' DMAs: "Areas draining to BMPs" is done in Step 5 below.

Step 4: Select and Lay Out LID BMPs on Site Plan

☐ ***SELECTING LID BMPS***

Below is a list of types of LID BMPs:

- ***Cisterns,*** which are used to facilitate capturing stormwater runoff for later use. Review the assessment of constraints and opportunities in Step 2 to determine the applicability of this BMP to the project.

- ***Infiltration BMPs***, which can be used only where soils are highly permeable. Review the assessment of constraints and opportunities in Step 2 to determine the applicability of this BMP to the project.

- ***Pervious Pavement**** can be either pervious asphalt and concrete surfaces, or permeable modular block. Unlike traditional pavements that are impermeable, porous pavements reduce the volume and peak

* When pervious pavement is designed primarily as a site design feature (i.e. it doesn't receive runoff from more than 2 parts tributary impervious area to 1 part pervious pavement), the Pervious pavement is considered a self-retaining area as described in Step 3. If additional area is drained onto the pervious pavement beyond the 2:1 ratio, the pervious pavement will be required to be constructed in accordance with a Co-Permittee approved stormwater BMP design that allows for greater ratios, (such as the LID BMP Design Handbook). In this case, pervious pavement is considered a LID BMP.

of stormwater runoff as well as mitigate pollutants from stormwater runoff.

- ***Bioretention BMPs***, which can be configured as free-form areas, or planters to integrate with your landscape design. Bioretention BMPs are feasible on all soil types and distinguished from Biotreatment BMPs (below) by the fact that their design will process the design capture volume entirely through a biologically active soil media, and by the fact that they inherently maximize both infiltration and evapotranspiration of runoff. See also discussion of Bioretention vs Biotreatment in Chapter 2. Bioretention BMPs can be used near building foundations and other locations where infiltration to native soils is not allowed by incorporation of an impermeable liner.

- ***Biotreatment BMPs***, which can be used only where soils are relatively impermeable (measured K_{SAT} < 0.3"/hr.) These BMPs are distinguished from bioretention BMPs in that they do not process the entire design capture volume through a soil media, however they still provide similar functions and benefits to bioretention BMPs by incorporation of features that provide for natural biological processes while still maximizing opportunities for infiltration and evapotranspiration. Examples of Biotreatment BMPs include extended detention basins, bioswales, and constructed wetlands. Consult the Co-Permittee to determine approved Biotreatment BMPs.

Descriptions, illustrations, designs, and design criteria for the LID BMPs described herein can be found in the LID BMP Design Handbook. The Co-Permittees may have their own designs for these same BMPs, or may specify other BMPs that applicants may use.

Review the constraints and opportunities identified in Step 2 of Chapter 3, and select from the applicable BMPs in Table 4-5. See the notes in the table regarding requirements for use. Also see Figure 4-6 for guidance.

FIGURE 4-6. INFILTRATION AND HARVEST AND USE FEASIBILITY FLOW CHART

TABLE 4-5. LID BMP SELECTION

LID BMP Type	A	B	C	D
	Is Harvest and Use feasible? (see step 2)	K_{SAT}> 1.6"/hr., and No restrictions on infiltration (see step 2)	0.3"/hr. < K_{SAT} < 1.6"/hr., or Unpredictable or unknown	K_{SAT} < 0.3"/hr.
Cisterns	✓			
Infiltration Systems		✓		
Permeable Pavement*		✓		
LID Bioretention		✓	✓	✓
LID Biotreatment				✓

Notes for Table 4-5:

See also Figure 4-6 for guidance in selecting appropriate BMPs

Column A: Harvest and Use BMPs may be used where it can be shown that there is sufficient demand for harvested water. See step 2.

Column B: Selections from this column may be used in locations where the saturated hydraulic conductivity of underlying soils is at least 1.6" per hour and no restrictions on infiltration apply to these locations. (See step 2)

Column C: Selections in this column may be used in locations where the measured saturated hydraulic conductivity of underlying soils is between 0.3" and 1.6" per hour or where, in accordance with recommendations of a licensed geotechnical engineer, the post-development saturated hydraulic conductivity is uncertain or unknown or cannot be reliably predicted because of soil disturbance or fill, anisotropic soil characteristics, presence of clay lenses, or other factors.

Column D: Selections in this column may be used in locations where the saturated hydraulic conductivity of underlying soils is 0.3" per hour or less. See Chapter 2 for more information. .

* Permeable Pavement, when designed with a maximum of a 2:1 ratio of impervious area to pervious pavement areas, or less, is considered a self retaining area, and is not considered an LID BMP for the purposes of this table. This table focuses on the 'special case' included in the discussion of 'areas draining to self retaining areas' above, where a project proponent can choose to design the pervious pavement as an LID BMP in accordance with an approved design, such as the LID BMP Design handbook, and in return drain additional impervious area onto the pervious pavement beyond the (2:1 ratio).

☐ *LAYING OUT YOUR LID BMPS*

Finding the right location for LID BMPs on your site involves a careful and creative integration of several factors:

- To make the most efficient use of the site and to maximize aesthetic value, ***integrate BMPs with site landscaping***. Many local zoning codes may require landscape setbacks or buffers, or may specify that a minimum portion of the site be landscaped. It may be possible to locate some or all of your site's Stormwater BMPs within this same area, or within utility easements or other non-buildable areas.

- Bioretention BMPs must be ***level or nearly level*** all the way around. When configured in a linear fashion (similar to swales) bioretention BMPs may be gently sloped end to end, but opposite sides must be at the same elevation. BMPs on steeper slopes must be terraced or provided with check dams.

- For effective, low-maintenance operation, ***locate BMPs so drainage into and out of the device is by gravity flow.*** Most BMPs require 3 feet or more of ***head***.

- LID BMPs require excavations 3 or more feet deep, which can ***conflict with underground utilities***.

- If the property is being subdivided now or in the future, the facility should be in a ***common, accessible area.*** In particular, ***avoid locating BMPs on private residential lots***. Even if the facility will serve only one site owner or operator, make sure the facility is located for ready access by inspectors from the local Co-Permittee and the local mosquito and vector control agency.

- The facility must be accessible to equipment needed for its maintenance. ***Access requirements for maintenance*** will vary with the type of facility selected. Bioretention BMPs will typically need access for the same types of equipment used for landscape maintenance.

To complete your analysis, include in your Project-Specific WQMP a brief ***narrative*** documenting the site layout and site design decisions you made. This will provide background and context for how your design meets the quantitative LID design criteria. Once you have laid out the BMPs, calculate the square footage you have set aside on your site plan for each BMP.

Step 5: Calculate Minimum LID BMP Sizes

LID BMPs must be sized to address the Design Capture Volume. For Bioretention BMPs, some simplifying geometric assumptions have been established for sizing these BMPs, and a uniform sizing factor of 0.04 has been established, as described below. For other LID BMPs, a BMP-specific design must

be performed to ensure that the Design Capture Volume will be addressed. The LID BMP design Handbook contains sizing worksheets for many types of LID BMPs, however, project proponents should verify with the Co-Permittee regarding specific geometries and sizing calculations required and/or approved by the Co-Permittee.

DMA Type / ID	*DMA Area (square feet)*	*Post-project surface type*	*DMA Runoff factor*	*DMA Area × runoff factor*	*LID BMP Name / Identifier*			
					BMP Sizing factor	*Minimum Area (square feet)*	*Proposed Area on Plans (square feet)*	
Total				*[A]*	*[B]*	*[A] × [B]*		***LID BMP Area***

***** Maintain a completed design procedure sheet for each LID BMP

TABLE 4-6. FORMAT FOR PRESENTING CALCULATIONS for LID BMPs based on an area sizing factor

TABLE 4-7. FORMAT FOR PRESENTING CALCULATIONS for LID BMPs based on an available design sheet

DMA Type / ID	*DMA Area (square feet)*	*Post-project surface type*	*DMA Runoff factor*	*DMA Area x runoff factor*	*LID BMP Name / Identifier*		
					PERMEABLE PVMT / PERM-1		
					Design Storm Depth (in)	*Design Capture Volume (cubic feet)*	*Proposed Volume on Plans * (cubic feet)*
Total				*[A]*	*[B]*	*([A] x [B])/ 12*	

* Obtained from design procedure sheet in LID BMP Design Handbook. Maintain a completed design procedure sheet for each LID BMP

Step 6: Determine if BMP Area and Volume are Adequate

Sizing and configuring BMPs is typically an iterative process. After computing the minimum BMP area using Steps 1–6, review the site plan to determine if the reserved BMP areas are sufficient for all of Type 'D' DMAs – "Areas Draining to BMPs".

If so, the planned BMPs will meet the WQMP sizing requirements for Water Quality, continue to Step 8 (Skip step 7).

If not, revise the plan accordingly. Revisions may include:

- Reducing the overall imperviousness of the project site.
- Changing the grading and drainage to redirect some runoff toward other BMPs which may have excess capacity.
- Making tributary landscaped DMAs self-treating or self-retaining (may require changes to grading).

- Expanding BMP surface area.

If you believe it is infeasible to address all required Type 'D' DMAs with LID BMPs, continue to Step 7.

Note revisions to square footage of an BMP typically require a corresponding revision to the square footage of the surrounding or adjacent DMA.

Step 7: Document any Alternative Compliance

As discussed in Chapter 2, LID is expected to be feasible on virtually all projects. Where LID has been demonstrated to be infeasible consistent with the criteria defined in Chapter 2, other Treatment Control BMPs must be used to achieve the same level of compliance.

☐ STORMWATER CREDITS

MS4 Permit Section XII.G.4 allows for the Co-Permittees to establish, where feasible and practicable, a water quality credit system for alternatives to infiltration, harvesting and use, evapotranspiration, and other LID and Hydromodification requirements specified above.

For certain types of development projects, LID BMPs may be more difficult to incorporate due to the nature of the development, but the development practices may provide other environmental benefits to communities. For example, infiltration BMPs may not be allowed on a Brownfield redevelopment site where infiltrated stormwater could cause an adverse impact to groundwater supply, but redevelopment of the site would be expected to have other environmental benefits such as accelerated site clean-up. Alternatively, a redevelopment project could be implemented in a way that reduces the overall impervious footprint of the project site rather than increasing it.

Projects potentially eligible for consideration for water quality credits include:

- Redevelopment projects that reduce the overall impervious footprint of the project site.

- 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 WQ if not redeveloped (http://www.epa.gov/brownfields/overview/glossary.htm).

- 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 (e.g. bus, rail, light rail or commuter train station). Such projects would not be able to take credit for both categories, but may have greater credit assigned.

- Developments with dedication of undeveloped portions to parks, preservation areas and other pervious uses.

- Regional treatment systems with a capacity to treat flows from all upstream developments.

- Offsite mitigation or dedicated mitigation areas within the same watershed.

- Developments in highly urbanized areas such as a city center area.

- Developments in historic districts or historic preservation areas.

- 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.

- In-fill projects, the conversion of empty lots and other underused spaces into more beneficially used spaces, such as residential or commercial areas, as defined by the local jurisdiction.

This provision does not exempt the project proponent from first conducting the investigations to determine if it is feasible to fulfill the full LID requirements through a combination of LID Principles and LID BMPs consistent with the permit hierarchy.

Applying Water Quality Credits

To determine the amount of credit a project would qualify for, the first step is to calculate the Design Capture Volume that would need to be satisfied in the absence of any credits. Any credits would then be taken as a reduction to this remaining volume. For all categories of projects noted above, the remaining volume to be treated or mitigated would be reduced in accordance with portions of the DCV shown in Table 4-8.

Table 4-8. Water Quality Credits for Applicable Project Categories

Project Category	Water Quality Credit (% of DCV) [1]
Redevelopment projects that reduce the overall impervious footprint of the project site	Percentage of site imperviousness reduced
Historic district, historic preservation area, or similar areas	10%
Brownfield redevelopment	25%
Higher density development, 7 units/acre or more	5%
Higher density development, vertical density	20%
Mixed use development, transit oriented development or live-work development	20%
In-fill development	10%

1) Maximum total of water quality credits for a project is 50 %

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.

☐ *TREATMENT CONTROL BMPS*

Treatment Control BMPs provide treatment mechanisms for pollutants in runoff, but do not sustain significant biological processes. To achieve the same level of compliance consistent with Section XII.G.1., Treatment Control BMPs must be selected to treat pollutants of concern with a high or medium effectiveness. Additionally, Treatment Control BMPs must not be constructed within Receiving Waters.

Pollutants of Concern

Identifying the pollutants of concern for the selection of Treatment Control BMPs involves:

- Identifying the proximate Receiving Waters to the discharge point(s) of the project that are listed in the most recent version of the Water Quality Control Plan for the Santa Ana River Basin. http://waterboards.ca.gov/santaana/water_issues/programs/basin_plan/

- Reviewing the 303(d) listings for those proximate Receiving Waters. http://waterboards.ca.gov/santaana/water_issues/programs/tmdl/303d.shtml, and identifying any pollutants being addressed by an adopted TMDL. http://waterboards.ca.gov/santaana/water_issues/programs/tmdl/.

- Reviewing the potential pollutants generated by the project, using information such as, but not limited to Table 4-9 below, and identify those pollutants that are also on the 303(d) list or have adopted TMDLs. Pollutants that are listed on Table 4-9 for the development type, and also are on the 303(d) list or have adopted TMDLs, are considered ***Pollutants of Concern***. Table 4-9 may be updated by the Permittees periodically based on updated studies and information. Any updates will be reported in the applicable annual report to the Regional Board.

Table 4-9. Potential Pollutants Generated by Land Use Type

Priority Development Project Categories and/or Project Features	General Pollutant Categories							
	Pathogens (Bacteria/ Virus)	Metals	Nutrients	Pesticides	Toxic Organic Compounds	Sediments	Trash & Debris	Oil & Grease
Detached Residential Development	P	N	P	P	N	P	P	P
Attached Residential Development	P	N	P	P	N	P	P	P(2)
Commercial/Industrial Development	P(3)	P	P(1)	P(1)	P(5)	P(1)	P	P
Automotive Repair Shops	N	P	N	N	P(4, 5)	N	P	P
Restaurants (>5,000 ft²)	P	N	N	N	N	N	P	P
Hillside Development (>5,000 ft²)	P	N	P	P	N	P	P	P
Parking Lots (>5,000 ft²)	P(6)	P	P(1)	P(1)	P(4)	P(1)	P	P
Retail Gasoline Outlets	N	P	N	N	P	N	P	P

P = Potential
N = Not Potential
(1) A potential pollutant if non-native landscaping exists or is proposed on-site; otherwise not expected.
(2) A potential pollutant if the project includes uncovered parking areas; otherwise not expected
(3) A potential pollutant is land use involves animal waste
(4) Specifically petroleum hydrocarbons
(5) Specifically solvents
(6) Bacterial indicators are routinely detected in pavement runoff

Selection and Sizing

Treatment Control BMPs must be selected that have a high or medium effectiveness at treating the pollutants of concern. For Treatment Control BMPs identified in a Co-Permittee approved design manual, the effectiveness identified for those particular BMP designs can be referenced. For other Treatment Control BMPs, high or medium effectiveness designation must be substantiated by independent third-party 'in-situ' testing of the specific Treatment Control BMPs being considered, such as provided on the references included in the BMP Performance Report Library, located at:

http://rcflood.org/NPDES/BMPPerformance.aspx

There are two design sizing standards for Conventional Treatment BMPs. Depending on their design, they will be either Volume-Based or Flow-Based, and sized to the Design Capture Volume, or the Design Flow Rate, respectively. These methodologies are discussed further in Chapter 2. Treatment Control BMPs must be sized to treat any unmet volume after claiming applicable water quality credits, if available. Document that all 'areas draining to BMPs' have been fully addressed

either using LID (using the tables in Step 5), or Treatment Control BMPs using the table below.

TABLE 4-10. FORMAT FOR PRESENTING CALCULATIONS for **TREATMENT CONTROL BMPs**

DMA Name	*DMA Area (square feet)*	*Post-project surface type*	*DMA Runoff factor*	*DMA Area × runoff factor*	*BMP Name / Identifier*		
					BMP Sizing factor	*Minimum Flow or Volume (cfs or cubic feet)*	*Proposed Flow or Volume****
			Total	*[A]*	*[B]**	*[A] x [B]***	

** For Flow-Based Treatment Control BMPs [B]= 0.2 inches/hour, for Volume-Based Treatment Control BMPs [B]= the Design Storm Depth (inches)*
*** for Flow-Based BMPs, divide this result by 43560, for Volume-Based BMPs, divide this result by 12*
**** Completed design sheets must be included in your Project-Specific WQMP showing the design method and details*

Once any applicable DMAs have been fully addressed using Treatment Control BMPs in accordance with the above requirements, continue to step 7.

☐ WAIVERS

If the site-specific determination demonstrates that the cost of BMP implementation greatly outweighs the pollution control benefits, the Co-Permittee may grant a waiver of the BMPs. All waivers, along with waiver justification documentation, will be submitted to the RWQCB Executive Officer for approval in writing within 30 days prior to approval by the Co-Permittee.

All projects receiving such an approved waiver will be required to participate in an Alternative or In-Lieu program developed or approved by the Co-Permittee, such as a fund for water quality improvement projects, or a water quality credit system. Note that such funds or systems may or may not be available for specific Co-Permittees or for specific projects, and in such cases, waivers may not be allowed.

☐ URBAN RUNOFF FUND

MS4 Permit Section XII.G.2 allows for the Co-Permittees to, collectively or individually, propose to establish an Urban Runoff fund to be used for urban water quality improvement projects within the same watershed that is funded by contributions from developers granted waivers. At this time, such a program has

not been developed. If such programs are developed in the future, they will be incorporated into a revised WQMP.

Step 7: Hydrologic Condition of Concern Analysis

Once you have determined that the LID design is adequate to address the treatment requirements (Step 6), you will need to assess if the proposed LID Design may still create a HCOC. Review the criteria identified in Chapter 2.

Figure 4-7 shows the process for ensuring compliance with HCOC requirements.

To determine if the proposed project's creates HCOC, the project engineer must compute pre and post development hydrology for a 24-hour design storm event with a 2-year return period. Acceptable methodologies for performing this hydrologic analysis include:

- Riverside County Hydrology Manual.
- Technical Release 55 (TR-55): Urban Hydrology for Small Watersheds (NRCS 1986), or derivatives thereof such as the Santa Barbara Urban Hydrograph Method.
- Other methods acceptable to the Co-Permittee.

Where the hydrologic analysis confirms that an HCOC exists, you may then need to reassess the LID design described in Steps 1 through 6 and revise the design as needed to mitigate any potential HCOC. Once any HCOC or Hydromodification requirements have been met, proceed to Step 8.

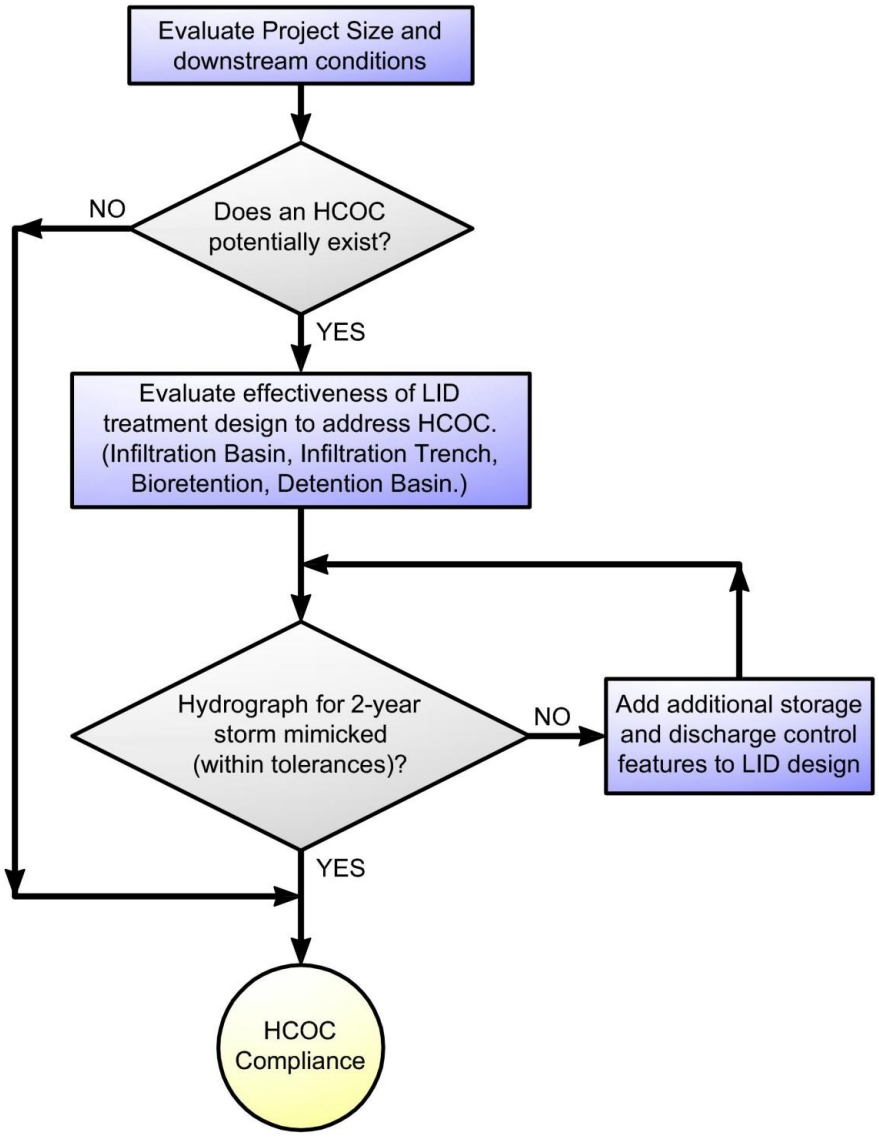

FIGURE 4-7. HCOC Criteria Specific to the Santa Ana Region

Step 8: Complete Your Summary Report

Present your LID BMP sizing calculations in tabular form. Adapt the following format as appropriate to your project. Coordinate your presentation of DMAs and calculation of minimum LID BMP sizes with the Project-Specific WQMP exhibit (labeled to show delineation of DMAs and locations of BMPs) and with your Project-Specific WQMP report, which should incorporate a brief description of each DMA and each LID BMP.

Tabulate and sum the total area of all DMAs and BMPs listed and show it is equal to the total project area. ***This step may include adjusting the square footage of some DMAs to account for area used for BMPs.***

Format:

Project Name:

Project Location:

APN or Subdivision Number:

Total Project Area (square feet):

Design Capture Volume at Project Site:

I. Self-treating areas:

[INSERT TABLE(S) FOR SELF-TREATING AREAS]

II. Self-retaining areas:

[INSERT TABLE(S) FOR SELF-RETAINING AREAS]

III. Areas draining to self-retaining areas:

[INSERT TABLE(S) FOR AREAS DRAINING TO SELF-RETAINING AREAS]

IV. Areas draining to LID BMPs:

[INSERT TABLE(S) FOR AREAS DRAINING TO LID BMPs]

V. Treatment Control BMPs (If applicable)

[INSERT ANY TABLE(S) FOR AREAS DRAINING TO TREATMENT CONTROL BMPs]

Step 9: Specify Preliminary Design Details

In your preliminary Project-Specific WQMP, describe your Stormwater BMPs, including any LID or Treatment Control BMPs in sufficient detail to demonstrate the area, volume, and other criteria of each can be met within the constraints of the site.

Ensure these details are consistent with preliminary site plans, landscaping plans, and architectural plans submitted with your application for planning and zoning approvals.

The LID BMP Design Handbook includes standard configurations and details that are available for the LID BMPs referenced in this WQMP. ***The information in the Handbook must be adapted and applied to the conditions specific to the development project.*** Local planning, building, and public works officials have final review and approval authority over the project design.

Keep in mind that proper and functional design of LID Principles and Stormwater BMPs is the responsibility of the applicant. Effective operation of BMPs throughout the project's lifetime will be the responsibility of the property owner.

Chapter 5

Structural Best Management Practices Construction

Guidance for preparing construction documents and overseeing construction of Stormwater BMPs

Details of how Stormwater BMPs are constructed can be critical to ensuring they work properly. A misplaced inlet, an overflow at the wrong elevation, or the wrong soil mix can make a LID BMP ineffective even before it comes on-line, and could result in delays to project approvals and additional expense.

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

Your ***Project-Specific WQMP*** must contain enough detail to demonstrate your planned LID Principles and Stormwater BMPs are feasible and are coordinated with the project site plan, architectural renderings, landscape design, and other information submitted with your application for development approvals. ***Additional detail*** as described in this section, must be shown on plans submitted with applications for building and grading permits. During construction and at completion, Co-Permittee inspectors will check the work against the approved plans.

The LID BMP Design Handbook includes details, many of which are critical to proper functioning of the BMP. This chapter describes specific items to be checked during review of construction documents and during construction.

LID Principles and LID BMPs have been routinely incorporated into development projects for only a few years. The community of land development professionals and Co-Permittee staff continue to compile and analyze "lessons learned" from their experience. The following guidance is based on those lessons.

What to Show on Construction Plans

With few exceptions, the plan set should include separate sheets specifically incorporating the Stormwater BMPs described in the Project-Specific WQMP. The information on these sheets must be carefully coordinated and made consistent with grading plans, utility plans, landscaping plans, and (in many cases) architectural plans. Consider including the grading plan (screened) as background for the stormwater sheets. It may also be appropriate to show portions of the roofing plan wherever roof ridges define DMAs. Additionally, utilizing different colors with associated legends will help reviewers differentiate the different details shown on the construction plans with respect to grading and runoff management.

Design Note

Use surface drainage, such as valley gutters or trench drains, to keep drainage within a few inches below top of pavement. Or use a "bubble up" to bring drainage back up closer to the surface.

☐ GRADING IS KEY

Co-Permittee staff will typically require plans showing the outline of each bioretention facility or other treatment BMP, along with the delineation of DMAs. Call out elevations, including the following:

- At curb cut inlets, show elevations for top of paving, top of curb, and top of the bioretention soil layer.
- At overflow grates, show the grate elevation and the adjacent top of soil elevation.
- Call out elevations of piped inlets.

Show how DMAs follow grade breaks, consistent with the grading plan and the Project-Specific WQMP.

☐ SHOW HOW RUNOFF MOVES

As needed for clarity, show the direction of runoff flow across roofs and pavement and into Treatment BMPs. For runoff conveyed via pipes or channels, show locations, slopes, and elevations at the beginning and end of each run.

For roof drainage, show the routing of roof leaders. Use drawings or notes to make clear how drainage from leaders is routed under walkways, across pavement, through drainage pipes, or by other means to reach the BMP.

Show pipes or channels connecting the BMP underdrain and overflow to the site drainage system, municipal storm drain system, or other approved discharge point. Call out slopes and key elevations.

☐ ***SHOW BMPS IN CROSS-SECTION***

Use one or more cross-section drawings to illustrate details and key BMP elevations, including bottom of excavation, top of gravel layer, top of soil layer, edge treatments, inlet elevations, overflow grate elevations, rim elevations, locations of rock for energy dissipation, moisture barriers, and other information. Call out specifications or refer to specifications elsewhere for gravel (Class 2 perm) and soil mix.

Items to Be Inspected During Construction

Successful construction of BMPs requires attention to detail during ***every stage*** of the construction process, from initial layout to rough grading, installation of utilities, construction of buildings, paving, landscaping, and final clean-up and inspection.

Construction project managers need to understand the purpose and function of BMPs and know how to avoid common missteps that can occur during construction. For LID BMPs, the following operating principles should be noted at a pre-construction meeting.

- Runoff flow from the intended tributary drainage management area must flow into the facility.
- The surface reservoir must fill to its intended volume during high inflows.
- Runoff must filter rapidly through the filtration/soil layer.
- Filtered runoff must infiltrate into the native soil to the extent feasible (or allowable).
- Remaining runoff must be captured and drained to a storm drain or other approved location.

See the model construction inspection checklist on the following pages.

Model BMP CONSTRUCTION CHECKLIST

LAYOUT (to be confirmed prior to beginning excavation)

- ❒ Square footage of the facility meets or exceeds minimum shown in Project-Specific WQMP
- ❒ Site grading and grade breaks are consistent with the boundaries of the tributary Drainage Management Area(s) (DMAs) shown in the Project-Specific WQMP
- ❒ Inlet elevation of the facility is low enough to receive drainage from the entire tributary DMA
- ❒ Locations and elevations of overland flow or piping, including roof leaders, from impervious areas to the facility have been laid out and any conflicts resolved
- ❒ Rim elevation of the facility is laid out to be level all the way around, or elevations are consistent with a detailed cross-section showing location and height of interior dams
- ❒ Locations for vaults, utility boxes, and light standards have been identified so that they will not conflict with the facility
- ❒ Facility is protected as needed from construction-phase runoff and sediment

EXCAVATION (to be confirmed prior to backfilling or pipe installation)

- ❒ Excavation conducted with materials and techniques to minimize compaction of soils within the facility area
- ❒ Excavation is to accurate area and depth
- ❒ Slopes or side walls protect from sloughing of native soils into the facility
- ❒ Moisture barrier, if specified, has been added to protect adjacent pavement or structures.
- ❒ Native soils at bottom of excavation are ripped or loosened to promote infiltration

OVERFLOW OR SURFACE CONNECTION TO STORM DRAINAGE
(to be confirmed prior to backfilling with any materials)

- ❒ Overflow is at specified elevation (typically no lower than two inches below facility rim)
- ❒ No knockouts or side inlets are in overflow riser
- ❒ Overflow location selected to minimize surface flow velocity (near, but offset from, inlet recommended)
- ❒ Grating excludes mulch and litter (beehive or atrium-style grates with ¼" openings recommended)
- ❒ Overflow is connected to storm drain via appropriately sized piping

UNDERGROUND CONNECTION TO STORM DRAIN/OUTLET ORIFICE
(to be confirmed prior to backfilling BMP with any materials)

- ❒ Perforated pipe underdrain (PVC SDR 35 or approved equivalent) is installed with holes facing down
- ❒ Perforated pipe is connected to storm drain (treatment only)
- ❒ Underdrain pipe is at elevation shown in plans. In facilities allowing infiltration, preferred elevation is above native soil but low enough to be covered by at least 2 inches of Class 2 perm; in bioretention facilities that are sealed or with liners, preferred elevation is as near bottom as possible
- ❒ Cleanouts are in accessible locations and connected via sweeps
- ❒ Structures (arches or large diameter pipes) for additional surface storage are installed as shown in plans and specifications and have the specified volume

(continued)

Model BMP CONSTRUCTION CHECKLIST (CONTINUED)

DRAIN ROCK/SUBDRAIN (to be confirmed prior to installation of soil mix)

- ❒ Rock is installed as specified. Class 2 permeable, Caltrans specification 68-1.025 recommended, or 4"-6" pea gravel is installed at the top of the crushed rock layer
- ❒ Rock is smoothed to a consistent top elevation. Depth and top elevation are as shown in plans
- ❒ Slopes or side walls protect from sloughing of native soils into the facility
- ❒ No filter fabric is placed between the subdrain and soil mix layers

SOIL MIX (FOR BIORETENTION FACILITIES)

- ❒ Soil mix is as specified. Quality of mix is confirmed by delivery ticket or on-site testing as appropriate to the size and complexity of the facility
- ❒ Mix installed in lifts not exceeding 12"
- ❒ Mix is not compacted during installation but may be thoroughly wetted to encourage consolidation
- ❒ Mix is smoothed to a consistent top elevation. Depth of mix (18" min.) and top elevation are as shown in plans, accounting for depth of mulch to follow and required reservoir depth

IRRIGATION

- ❒ Irrigation system is installed so it can be controlled separately from other landscaped areas. Smart irrigation controllers and drip emitters are recommended
- ❒ Spray heads, if any, are positioned to avoid direct spray into outlet structures

PLANTING

- ❒ Plants are installed consistent with approved planting plan
- ❒ Any trees and large shrubs are staked securely
- ❒ No fertilizer is added; compost tea may be used
- ❒ No native soil or clayey material are imported into the facility with plantings
- ❒ 1"-2" mulch may be applied following planting; mulch selected to avoid floating
- ❒ Final elevation of soil mix maintained following planting
- ❒ Curb openings are free of obstructions

FINAL ENGINEERING INSPECTION

- ❒ Drainage Management Area(s) are free of construction sediment and landscaped areas are stabilized
- ❒ Inlets are installed to provide smooth entry of runoff from adjoining pavement, have sufficient reveal (drop from the adjoining pavement to the top of the mulch or soil mix, and are not blocked
- ❒ Inflows from roof leaders and pipes are connected and operable
- ❒ Temporary flow diversions are removed
- ❒ Rock or other energy dissipation at piped or surface inlets is adequate
- ❒ Overflow outlets are configured to allow the facility to flood and fill to near rim before overflow
- ❒ Plantings are healthy and becoming established
- ❒ Irrigation is operable
- ❒ Facility drains rapidly; no surface ponding is evident
- ❒ Any accumulated construction debris, trash, or sediment is removed from facility
- ❒ Certification Statement from design professional that all treatment control BMPs have been constructed in accordance with the approved plans and specs.

Chapter 6

Operation & Maintenance of Stormwater BMPs

How to prepare a customized Stormwater BMP Operation & Maintenance Plan for the BMPs on your site.

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

Stormwater NPDES Permit Provision XII.K.5 requires each Co-Permittee verify Stormwater BMPs are adequately maintained. Co-Permittees must report the results of inspections to the Water Board annually.

Stormwater BMPs you install as part of your project will be incorporated into the Co-Permittee's verification program. This is a six-stage process:

1. Determine ***who will own*** the facility and be responsible for its maintenance in perpetuity and document this in your Project-Specific WQMP. The Project-Specific WQMP must also identify the means by which ongoing maintenance will be assured (for example, a maintenance agreement that runs with the land). Appropriate documentation regarding BMP recordation should be provided.

2. Identify typical maintenance requirements, allow for these requirements in your project planning and preliminary design, and document the typical maintenance requirements in your Project-Specific WQMP.

3. Prepare an ***Operation and Maintenance Plan*** (O&M Plan) for the site incorporating detailed requirements for ***each treatment and flow-control facility***. Typically, a draft O&M Plan must be submitted with the building permit application, and a final O&M Plan must be submitted for review and approved by the Co-Permittee prior to building permit final and issuance of a certificate of occupancy. ***Local requirements vary as to schedule. Check with Co-Permittee staff.***

4. ***Maintain*** the BMPs from the time they are constructed until ownership and maintenance responsibility is formally transferred.

5. ***Formally transfer*** operation and maintenance ***responsibility*** to the site owner or occupant. A warranty, secured by a bond, or other financial instrument, may be required to secure against lack of performance due to flaws in design or construction. A typical warranty period will cover two rainy seasons. All Structural BMPs described in the Project-Specific WQMP shall be constructed and installed in conformance with approved plans and specifications. It shall be demonstrated that the applicant is prepared to implement all Non-Structural BMPs described in the approved project specific WQMP and that copies of the approved Project-Specific WQMP are available for the future owners/occupants. The District will not release occupancy permits for any portion of the project exceeding 80% of the total recorded residential lots within the map or phase within the map prior to the completion of these tasks.

6. Maintain the BMPs in perpetuity and comply with your Co-Permittee's self-inspection, reporting, and verification requirements.

See the schedule for these stages in Table 6-1. ***Again, local requirements will vary.***

TABLE 6-1. SCHEDULE FOR PLANNING Operation and Maintenance of Stormwater BMPs

Stage	*Description*	*Where documented*	*Schedule*
1	Determine facility ownership and maintenance responsibility	Preliminary Project-Specific WQMP	Discuss with planning staff at pre-application meeting
2	Identify typical maintenance requirements	Preliminary Project-Specific WQMP	Submit with planning & zoning application
3	Develop detailed operation and maintenance plan	Final Project-Specific WQMP	Submit draft with Building Permit application; final due before building permit final and applying for a Certificate of Occupancy
4	Interim operation and maintenance of BMPs	As required by Co-Permittee O&M verification program	During and following construction including warranty period
5	Formal transfer of operation & maintenance responsibility	As required by Co-Permittee O&M verification program	On sale and transfer of property or occupancy
6	Ongoing maintenance and compliance with inspection & reporting requirements	As required by Co-Permittee O&M verification program	In perpetuity

Stage 1: Ownership and Maintenance Responsibility

Your Project-Specific WQMP must specify a means to ***finance maintenance*** of Stormwater BMPs ***in perpetuity once the stormwater facility is implemented.***

Depending on the intended use of your site and the policies of the local Co-Permittee, this may require one or more of the following:

- Execution of a maintenance agreement that "runs with the land."
- Creation of a homeowners' association (HOA), Property Owners' Association (POA) and execution and recordation of a CC&R that clearly stipulates the maintenance responsibilities.
- Formation of a new community facilities district or other special district, or annexation of the properties to an existing special district.

Ownership & maintenance responsibility for Stormwater BMPs should be discussed as early as due diligence and definitely at the ***beginning of project planning***, typically at the pre-application meeting, if available, for planning and zoning review. Experience has shown provisions to implement a stormwater facility and financing maintenance of Stormwater BMPs can be a major stumbling block to project approval, particularly for ***small residential subdivisions***. (See "Applying WQMP Requirements to New Subdivisions" in Chapter 1.)

☐ *PRIVATE OWNERSHIP AND MAINTENANCE*

The Co-Permittee may require—as a condition of project approval—that a maintenance agreement be executed and recorded.

The model agreement "runs with the land," so the agreement executed by a developer is binding on the owners of the subdivided lots. The agreement must be recorded prior to conveyance of the subdivided property.

The model agreement provides that, if the property owner fails to maintain the stormwater facility, the Co-Permittee may enter the property, restore the stormwater facility to good working order and obtain reimbursement, including administrative costs, from the property owner.

☐ *TRANSFER TO PUBLIC OWNERSHIP*

Co-Permittees may sometimes choose to have a stormwater BMP deeded to the public in fee or as an easement and maintain the facility as part of the municipal storm drain system. The Co-Permittee may recoup the costs of maintenance through a special tax, assessment district, or similar mechanism.

Locating an LID BMP in a public right-of-way or easement creates an additional design constraint—along with hydraulic grade, aesthetics, landscaping, and circulation and additional maintenance burden. However, because sites typically drain to the street, it may be possible to locate a bioretention swale parallel to the street and within road right of way. The facility may complement, or substitute for, an underground storm drain system. However, this has to be negotiated with all affected public agencies prior to any design of such BMPs.

> ***Local Requirements***
> Co-Permittees may have requirements that differ from, or are in addition to, this WQMP. Check with local planning and community development staff.

Even if the facility is to be deeded or transferred to the Co-Permittee after construction is complete, it is still the responsibility of the applicant/developer, and to maintain the facility in accordance with the O&M Plan until that responsibility is formally transferred.

☐ CO-PERMITTEE PROJECTS

Public projects implemented by a Co-Permittee will be maintained by the Co-Permittee in accordance with a Facility Pollution Prevention Plan as described in the Co-Permittees LIP.

Stage 2: General Maintenance Requirements

Include in your Project-Specific WQMP a general description of anticipated facility maintenance requirements. This will help ensure that:

- Ongoing costs of maintenance have been considered in your facility selection and design.
- Site and landscaping plans provide for access for inspections and by maintenance equipment.
- Landscaping plans incorporate irrigation requirements for facility plantings as appropriate.
- Initial maintenance and replacement of facility plantings is incorporated into landscaping contracts and guarantees.

Fact sheets in the LID BMP Design Handbook describe general maintenance requirements for many of the Stormwater BMPs featured in the LID Design Guide (Chapter 4). You can use this information, or other requirements specified by the Co-Permittee to specify general maintenance requirements in your Project-Specific WQMP.

Stage 3: Stormwater BMP O&M Plan

Submit a ***draft*** O&M Plan with construction documents when you apply for permits to begin grading or construction on the site. ***Revise*** your draft O&M Plan in response to any comments from your Co-Permittee, and incorporate new information and changes developed during project construction. Submit a revised, ***final*** O&M Plan before construction is complete.

The final O&M Plan should incorporate solutions to any problems noted or changes that occurred during construction. For this reason, the final O&M Plan may be submitted at the end of the construction period, before the application for final building permit and Certificate of Occupancy.

Your Final Stormwater Control O&M Plan must be submitted to and approved by your Co-Permittee before your building permit can be made final and a certificate of occupancy issued.

Your O&M Plan must be kept on-site for use by maintenance personnel and during site inspections. It is also recommended that a copy of the Project-Specific WQMP be kept onsite as a reference.

NPDES Permit Provision XII.K requires each facility be inspected at least once during the permit term to verify operation and maintenance.

☐ YOUR O&M PLAN: STEP BY STEP

The following step-by-step guidance will help you prepare each required section of your Stormwater Control Operation and Maintenance Plan. Preparation of the plan will require familiarity with your Stormwater BMPs as they have been constructed and a fair amount of "thinking through" plans for their operation and maintenance. The text and forms provided here will assist you, but are no substitute for thoughtful planning.

☐ STEP 1: DESIGNATE RESPONSIBLE INDIVIDUALS

To begin creating your O&M Plan, your organization must designate and identify:

- The individual who will have direct responsibility for the maintenance of stormwater controls. This individual should be the designated contact with Co-Permittee inspectors and should sign self-inspection reports and any correspondence with the Co-Permittee regarding verification inspections. The Co-Permittee may accept self-certification or third-party certification by a California licensed Professional Engineer.

- Employees or contractors who will report to the designated contact and are responsible for carrying out BMP operation and maintenance.

- The corporate officer authorized to negotiate and execute any contracts that might be necessary for future changes to operation and maintenance or to implement remedial measures if problems occur.

- Your designated respondent to problems, such as clogged drains or broken irrigation mains, that would require immediate response should they occur during off-hours.

Updated contact information must be provided to the Co-Permittee immediately whenever a property is sold and whenever designated individuals or contractors change. Complete a new form—and mail or fax a copy to the Co-Permittee—whenever this occurs.

Draw or sketch an ***organization chart*** to show the relationships of authority and responsibility between the individuals responsible for O&M. This need not be elaborate, particularly for smaller organizations.

Describe how ***funding for BMP operation and maintenance*** will be assured, including sources of funds, budget category for expenditures, process for establishing the annual maintenance budget, and process for obtaining authority should unexpected expenditures for major corrective maintenance be required.

Describe how your organization will accommodate initial ***training*** of staff or contractors regarding the purpose, mode of operation, and maintenance requirements for the Stormwater BMPs on your site. Also, describe how your organization will ensure ongoing training as needed and in response to staff changes.

☐ STEP 2: SUMMARIZE DRAINAGE AND BMPS

Incorporate the following information from your Project-Specific WQMP into your O&M Plan:

- Figures delineating and designating pervious and impervious areas.

- Figures showing locations of Stormwater BMPs on the site.

- Tables of pervious and impervious areas served by each facility.

Review the Project-Specific WQMP narrative that describes each facility and its tributary drainage area and update the text to incorporate any changes that may have occurred during planning and zoning review, building permit review, or construction. Incorporate the updated text into your O&M Plan.

☐ STEP 3: DOCUMENT BMPS "AS BUILT"

Once the stormwater facility is implemented, plans shall be 'as-built' by a licensed civil/geotechnical engineer registered in the state of California and submitted to the Co-Permittee, and also included as part of the O&M Plan. The information contained on the 'as-built' plans must be consistent with standard engineering practice. Following is a list of types of information that should be documented on 'as-built' plans as applicable and appropriate:

- Plans, elevations, and details of all BMPs. Annotate if necessary with designations used in the Project-Specific WQMP.
- Design information or calculations submitted in the detailed design phase (i.e., not included in the Project-Specific WQMP).
- Specifications of construction for BMPs, including sand or soil, compaction, pipe materials, and bedding.

In the final O&M Plan, incorporate field changes to design drawings, including changes to any of the following:

- Location and layouts of inflow piping, flow splitter boxes, and piping to off-site discharge.
- Depths and layering of soil, sand, or gravel.
- Placement of filter fabric or geotextiles (not recommended between soil and gravel layers of bioretention BMPs).
- Changes or substitutions in soil or other materials.
- Natural soils encountered (e.g. sand or clay lenses).

☐ STEP 4: PREPARE CUSTOMIZED MAINTENANCE PLANS

Prepare a maintenance plan, schedule, and inspection checklists (routine, annual, and after major storms) for each facility. Plans and schedules for two or more similar BMPs on the same site may be combined.

Use the following resources to prepare your customized maintenance plan, schedule, and checklists.

- Specific information noted in Steps 2 and 3, above.
- Other input from the facility designer, Co-Permittee staff, or other sources.

- BMP Fact Sheets in the LID BMP Design Handbook, as applicable.

Note any particular characteristics or circumstances that could require attention in the future, and include any troubleshooting advice.

Also include manufacturer's data, operating manuals, and maintenance requirements for any:

- Pumps or other mechanical equipment.
- Proprietary devices used as or in conjunction with BMPs.

Manufacturers' publications should be referenced in the text (including models and serial numbers where available). Copies of the manufacturers' publications should be included as an attachment in the back of your O&M Plan or as a separate document.

☐ STEP 5: COMPILE O&M PLAN

Your O&M Plan should follow the general outline below. Note that for Public Projects implemented by a Co-Permittee, the O&M Plan must comply with the format and content of the model Facility Pollution Prevention Plan included in Appendix F of the DAMP, and result in the creation of a facility specific FPPP.

I. Inspection and Maintenance Log

II. Updates, Revisions and Errata

III. Introduction

A. Narrative overview describing the site; drainage areas, routing, and discharge points; and Stormwater BMPs

IV. Responsibility for Maintenance

A. General

(1) Name and contact information for responsible individual(s).

(2) Organization chart or charts showing organization of the maintenance function and location within the overall organization.

(3) Reference to Operation and Maintenance Agreement (if any). A copy of the agreement should be attached.

(4) Maintenance Funding

(a) Sources of funds for maintenance

(b) Budget category or line item

(c) Description of procedure and process for ensuring adequate funding for maintenance

B. Staff Training Program

C. Records

D. Safety

V. Summary of Drainage Areas and Stormwater BMPs

A. Drainage Areas

(1) Drawings showing pervious and impervious areas (copied or adapted from Project-Specific WQMP)

(2) Designation and description of each drainage area and how flow is routed to the corresponding facility

B. Structural Post-Construction BMPs

(1) Drawings showing location and type of each Structural Post-Construction BMP

(2) General description of each facility (Consider a table if more than two BMPs)

(a) Area drained and routing of discharge

(b) Facility type and size

VI. BMP Design Documentation

A. "As-built" drawings of each facility (design drawings in the draft Plan)

B. Manufacturer's data, manuals, and maintenance requirements for pumps, mechanical or electrical equipment, and proprietary facilities (include a "placeholder" in the draft plan for information not yet available).

C. Specific operation and maintenance concerns and troubleshooting

VII. Maintenance Schedule or Matrix

A. Maintenance Schedule for each facility with specific requirements for:

(1) Routine inspection and maintenance

(2) Annual inspection and maintenance

(3) Inspection and maintenance after major storms

B. Service Agreement Information

Assemble and make copies of your O&M Plan. One or more copies must be submitted to the Co-Permittee, including one electronic copy, and at least one copy kept on-site. Here are some suggestions for formatting the O&M Plan:

- Format plans to 8½" x 11" to facilitate duplication, filing, and handling
- Include the revision date in the footer on each page
- Scan graphics and incorporate with text into a single electronic file. Keep the electronic file backed-up so that copies of the O&M Plan can be made if the hard copy is lost or damaged.

☐ ***STEP 6: UPDATES***

Your Stormwater Control Operation and Maintenance Plan (or FPPP for Co-Permittee projects) will be ***a living document***.

Operation and maintenance personnel may change; mechanical equipment may be replaced, and additional maintenance procedures may be needed. Throughout these changes, the O&M Plan must be kept up-to-date.

Updates may be transmitted to your Co-Permittee at any time. However, at a minimum, updates to the O&M Plan must be maintained and implemented onsite and available to Co-Permittee inspectors. These updates should reference the sections of the Plan being changed and should be placed in reverse chronological order (most recent updates at the top) in Section II of the binder. If the entire O&M Plan is updated, as it should be from time to time, these updates should be removed from the first section, but may be filed (perhaps in the back of the binder) for possible future reference.

Stage 4: Interim Operation & Maintenance

Include the following statement in your Project-Specific WQMP:

> The property owner accepts responsibility for interim operation and maintenance of Stormwater BMPs until such time as this responsibility is formally transferred to a subsequent owner.

Applicants will typically be required to warranty Stormwater BMPs against lack of performance due to flaws in design or construction for a minimum of two rainy seasons following completion of construction. The warranty may need to be secured by a bond or other financial instrument.

Stage 5: Transfer Responsibility

As part of the final O&M Plan, note the expected date when responsibility for operation and maintenance will be transferred. Notify your Co-Permittee when this transfer of responsibility takes place.

Stage 6: Operation & Maintenance Verification

Each Co-Permittee implements a program to ensure that the Structural Post-Construction BMPs are operating and are maintained properly and all BMPs are working effectively to remove Pollutants in runoff from the site. This may include periodic site inspections, or requirements for self-certifications by a licensed professional engineer.

References and Resources

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- *Urban Runoff Quality Management* (WEF/ASCE, 1998). pp 186-189.
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- *California Stormwater Best Management Practice Handbooks* (CASQA, 2003).
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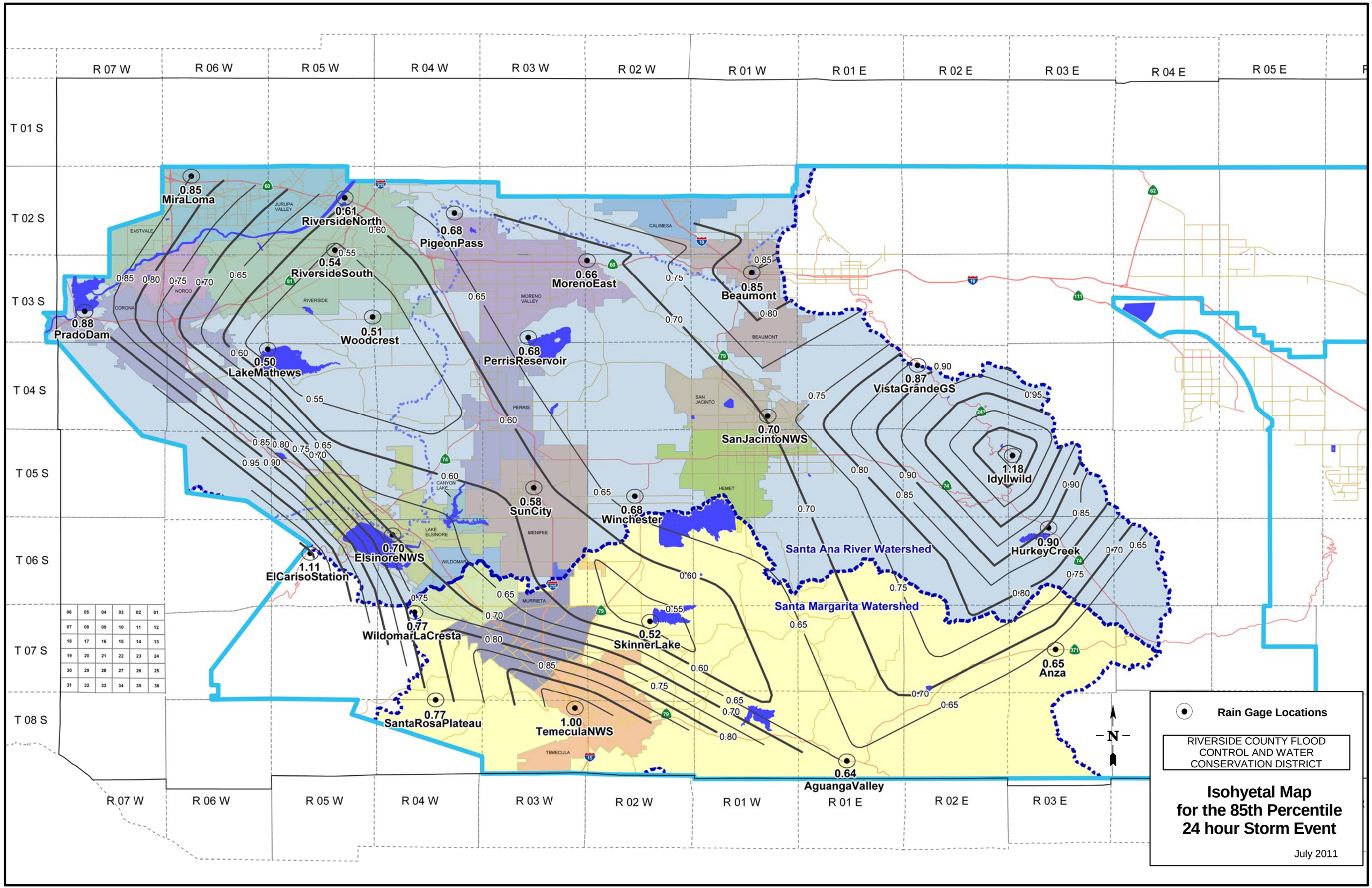
EXHIBIT A:

Isohyetal Map for the 85th Percentile 24-hour Storm Event


R 07 W
R 06 W
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R 03 W
R 02 W
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R 01 E
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R 03 E
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R 05 E
T 01 S
T 02 S
T 03 S
T 04 S
T 05 S
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T 08 S
0.85 MiraLoma
0.61 RiversideNorth
0.68 PigeonPass
0.54 RiversideSouth
0.66 MorenoEast
0.85 Beaumont
0.88 PradoDam
0.51 Woodcrest
0.50 LakeMathews
0.68 PerrisReservoir
0.87 VistaGrandeGS
0.70 SanJacintoNWS
1.18 Idyllwild
0.58 SunCity
0.68 Winchester
0.90 HurkeyCreek
0.70 ElsinoreNWS
1.11 ElCarisoStation
0.77 WildomarLaCresta
0.52 SkinnerLake
0.65 Anza
0.77 SantaRosaPlateau
1.00 TemeculaNWS
0.64 AguangaValley
Santa Ana River Watershed
Santa Margarita Watershed
EASTVALE
JURUPA VALLEY
CORONA
NORCO
RIVERSIDE
MORENO VALLEY
CALIMESA
BEAUMONT
SAN JACINTO
PERRIS
HEMET
CANYON LAKE
LAKE ELSINORE
WILDOMAR
MENIFEE
MURRIETA
TEMECULA
N
Rain Gage Locations
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
Isohyetal Map for the 85th Percentile 24 hour Storm Event
July 2011

EXHIBIT B:

Pollutant Sources/Source Control Checklist

EXHIBIT B—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

How to use this worksheet (also see instructions on page 38 of the WQMP):

1. Review Column 1 and identify which of these potential sources of stormwater pollutants apply to your site. Check each box that applies.
2. Review Column 2 and incorporate all of the corresponding applicable BMPs in your WQMP Exhibit.
3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in a table in your WQMP. Use the format shown in Table 3-1 on page 33 of the WQMP. Describe your specific BMPs in an accompanying narrative, and explain any special conditions or situations that required omitting BMPs or substituting alternative BMPs for those shown here.

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	***... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE***		
1 ***Potential Sources of Runoff Pollutants***	***2*** ***Permanent Controls—Show on WQMP Drawings***	***3*** ***Permanent Controls—List in WQMP Table and Narrative***	***4*** ***Operational BMPs—Include in WQMP Table and Narrative***
❑ ***A.*** **On-site storm drain inlets**	❑ **Locations of inlets.**	❑ **Mark all inlets with the words "Only Rain Down the Storm Drain" or similar. Catch Basin Markers may be available from the Riverside County Flood Control and Water Conservation District, call 951.955.1200 to verify.**	❑ **Maintain and periodically repaint or replace inlet markings.** ❑ **Provide stormwater pollution prevention information to new site owners, lessees, or operators.** ❑ **See applicable operational BMPs in Fact Sheet SC-44, "Drainage System Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com** ❑ **Include the following in lease agreements: "Tenant shall not allow anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains."**
❑ ***B.*** **Interior floor drains and elevator shaft sump pumps**		❑ **State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.**	❑ **Inspect and maintain drains to prevent blockages and overflow.**
❑ ***C.*** **Interior parking garages**		❑ **State that parking garage floor drains will be plumbed to the sanitary sewer.**	❑ **Inspect and maintain drains to prevent blockages and overflow.**

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ ***D1.*** Need for future indoor & structural pest control		❑ Note building design features that discourage entry of pests.	❑ Provide Integrated Pest Management information to owners, lessees, and operators.
❑ ***D2.*** Landscape/ Outdoor Pesticide Use	❑ Show locations of native trees or areas of shrubs and ground cover to be undisturbed and retained. ❑ Show self-retaining landscape areas, if any. ❑ Show stormwater treatment and hydrograph modification management BMPs. (See instructions in Chapter 3, Step 5 and guidance in Chapter 5.)	State that final landscape plans will accomplish all of the following. ❑ Preserve existing native trees, shrubs, and ground cover to the maximum extent possible. ❑ Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution. ❑ Where landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions. ❑ Consider using pest-resistant plants, especially adjacent to hardscape. To insure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.	❑ Maintain landscaping using minimum or no pesticides. ❑ See applicable operational BMPs in "What you should know for…..Landscape and Gardening" at http://rcflood.org/stormwater/ Error! Hyperlink reference not valid. ❑ Provide IPM information to new owners, lessees and operators.

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ ***E.*** **Pools, spas, ponds, decorative fountains, and other water features.**	❑ **Show location of water feature and a sanitary sewer cleanout in an accessible area within 10 feet. (Exception: Public pools must be plumbed according to County Department of Environmental Health Guidelines.)**	**If the Co-Permittee requires pools to be plumbed to the sanitary sewer, place a note on the plans and state in the narrative that this connection will be made according to local requirements.**	❑ **See applicable operational BMPs in** "Guidelines for Maintaining Your Swimming Pool, Jacuzzi and Garden Fountain" at http://rcflood.org/stormwater/
❑ ***F.*** **Food service**	❑ **For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment.** ❑ **On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.**	❑ **Describe the location and features of the designated cleaning area.** ❑ **Describe the items to be cleaned in this facility and how it has been sized to insure that the largest items can be accommodated.**	❑ **See the brochure, "**The Food Service Industry Best Management Practices for: Restaurants, Grocery Stores, Delicatessens and Bakeries" at http://rcflood.org/stormwater/ **Provide this brochure to new site owners, lessees, and operators.**
❑ ***G.*** **Refuse areas**	❑ **Show where site refuse and recycled materials will be handled and stored for pickup. See local municipal requirements for sizes and other details of refuse areas.** ❑ **If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run-on and show locations of berms to prevent runoff from the area.** ❑ **Any drains from dumpsters, compactors, and tallow bin areas shall be connected to a grease removal device before discharge to sanitary sewer.**	❑ **State how site refuse will be handled and provide supporting detail to what is shown on plans.** ❑ **State that signs will be posted on or near dumpsters with the words "Do not dump hazardous materials here" or similar.**	❑ **State how the following will be implemented:** **Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post "no hazardous materials" signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on-site. See Fact Sheet SC-34, "Waste Handling and Disposal" in the CASQA Stormwater Quality Handbooks at** www.cabmphandbooks.com

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ ***H.*** Industrial processes.	❑ Show process area.	❑ **If industrial processes are to be located on site, state: "All process activities to be performed indoors. No processes to drain to exterior or to storm drain system."**	❑ **See Fact Sheet SC-10, "Non-Stormwater Discharges" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com** See the brochure "Industrial & Commercial Facilities Best Management Practices for: Industrial, Commercial Facilities" at http://rcflood.org/stormwater/

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ ***I.*** Outdoor storage of equipment or materials. (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.)	❑ Show any outdoor storage areas, including how materials will be covered. Show how areas will be graded and bermed to prevent run-on or run-off from area. ❑ Storage of non-hazardous liquids shall be covered by a roof and/or drain to the sanitary sewer system, and be contained by berms, dikes, liners, or vaults. ❑ Storage of hazardous materials and wastes must be in compliance with the local hazardous materials ordinance and a Hazardous Materials Management Plan for the site.	Include a detailed description of materials to be stored, storage areas, and structural features to prevent pollutants from entering storm drains. Where appropriate, reference documentation of compliance with the requirements of Hazardous Materials Programs for: ▪ Hazardous Waste Generation ▪ Hazardous Materials Release Response and Inventory ▪ California Accidental Release (CalARP) ▪ Aboveground Storage Tank ▪ Uniform Fire Code Article 80 Section 103(b) & (c) 1991 ▪ Underground Storage Tank www.cchealth.org/groups/hazmat/	❑ See the Fact Sheets SC-31, "Outdoor Liquid Container Storage" and SC-33, "Outdoor Storage of Raw Materials " in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ ***J.*** Vehicle and Equipment Cleaning	❑ **Show on drawings as appropriate:** **(1) Commercial/industrial facilities having vehicle/equipment cleaning needs shall either provide a covered, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses.** **(2) Multi-dwelling complexes shall have a paved, bermed, and covered car wash area (unless car washing is prohibited on-site and hoses are provided with an automatic shut-off to discourage such use).** **(3) Washing areas for cars, vehicles, and equipment shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer.** **(4) Commercial car wash facilities shall be designed such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility shall discharge to the sanitary sewer, or a wastewater reclamation system shall be installed.**	❑ **If a car wash area is not provided, describe any measures taken to discourage on-site car washing and explain how these will be enforced.**	**Describe operational measures to implement the following (if applicable):** ❑ **Washwater from vehicle and equipment washing operations shall not be discharged to the storm drain system.** Refer to "Outdoor Cleaning Activities and Professional Mobile Service Providers" for many of the Potential Sources of Runoff Pollutants categories below. Brochure can be found at http://rcflood.org/stormwater/ ❑**Car dealerships and similar may rinse cars with water only.**

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ ***K.*** Vehicle/Equipment Repair and Maintenance	❑ **Accommodate all vehicle equipment repair and maintenance indoors. Or designate an outdoor work area and design the area to prevent run-on and runoff of stormwater.** ❑ **Show secondary containment for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas.** ❑ **Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer and an industrial waste discharge permit will be obtained.**	❑ **State that no vehicle repair or maintenance will be done outdoors, or else describe the required features of the outdoor work area.** ❑ **State that there are no floor drains or if there are floor drains, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.** ❑ **State that there are no tanks, containers or sinks to be used for parts cleaning or rinsing or, if there are, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.**	**In the Stormwater Control Plan, note that all of the following restrictions apply to use the site:** ❑ **No person shall dispose of, nor permit the disposal, directly or indirectly of vehicle fluids, hazardous materials, or rinsewater from parts cleaning into storm drains.** ❑ **No vehicle fluid removal shall be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids shall be contained or drained from the vehicle immediately.** ❑ **No person shall leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment.** Refer to "Automotive Maintenance & Car Care Best Management Practices for Auto Body Shops, Auto Repair Shops, Car Dealerships, Gas Stations and Fleet Service Operations". Brochure can be found at http://rcflood.org/stormwater/ Refer to Outdoor Cleaning Activities and Professional Mobile Service Providers for many of the Potential Sources of Runoff Pollutants categories below. Brochure can be found at http://rcflood.org/stormwater/

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ ***L.*** Fuel Dispensing Areas	❑ Fueling areas[6] shall have impermeable floors (i.e., portland cement concrete or equivalent smooth impervious surface) that are: a) graded at the minimum slope necessary to prevent ponding; and b) separated from the rest of the site by a grade break that prevents run-on of stormwater to the maximum extent practicable. ❑ Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area[1].] The canopy [or cover] shall not drain onto the fueling area.		❑ The property owner shall dry sweep the fueling area routinely. ❑ See the Fact Sheet SD-30 , "Fueling Areas" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

[6] The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ ***M.*** Loading Docks	❑ Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks shall be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts shall be positioned to direct stormwater away from the loading area. Water from loading dock areas shall be drained to the sanitary sewer, or diverted and collected for ultimate discharge to the sanitary sewer. ❑ Loading dock areas draining directly to the sanitary sewer shall be equipped with a spill control valve or equivalent device, which shall be kept closed during periods of operation. ❑ Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.		❑ Move loaded and unloaded items indoors as soon as possible. ❑ See Fact Sheet SC-30, "Outdoor Loading and Unloading," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ ***N.*** Fire Sprinkler Test Water		❑ Provide a means to drain fire sprinkler test water to the sanitary sewer.	❑ See the note in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com
O. Miscellaneous Drain or Wash Water or Other Sources ❑ Boiler drain lines ❑ Condensate drain lines ❑ Rooftop equipment ❑ Drainage sumps ❑ Roofing, gutters, and trim. ❑ Other sources		❑ Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system. ❑ Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system. ❑ Rooftop equipment with potential to produce pollutants shall be roofed and/or have secondary containment. ❑ Any drainage sumps on-site shall feature a sediment sump to reduce the quantity of sediment in pumped water. ❑ Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff. Include controls for other sources as specified by local reviewer.	

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ ***P.*** Plazas, sidewalks, and parking lots.			❑ Sweep plazas, sidewalks, and parking lots regularly to prevent accumulation of litter and debris. Collect debris from pressure washing to prevent entry into the storm drain system. Collect washwater containing any cleaning agent or degreaser and discharge to the sanitary sewer not to a storm drain.

EXHIBIT C:

LID BMP Design Handbook

Please Visit

www.rcflood.org/npdes/developers

to access the current Handbook.

EXHIBIT D:

Transportation Project Guidance

Low Impact Development:

Guidance and Standards for Transportation Projects

Riverside County
Flood Control and
Water Conservation
District

July 2011

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Section 1
Introduction

A. Purpose of the Guidance

The federal Clean Water Act (CWA) establishes requirements for the discharge of urban runoff from Municipal Separate Storm Sewer Systems (MS4) under the National Pollutant Discharge Elimination System (NPDES) program. On January 29, 2010, the Santa Ana Regional Water Quality Control Board (RWQCB) issued Permit Order No. R8-2010-0033 ("MS4 Permit") to authorize the discharge of urban runoff from MS4 facilities in Riverside County within the Santa Ana Region MS4 Permit area.

The MS4 Permit requires development of a standard design and post-development Best Management Practices (BMPs) guidance to guide application of Low Impact Development (LID) BMPs to the maximum extent practicable (MEP) on public street, road, highway, and freeway ("road") improvement projects to reduce the discharge of pollutants to Receiving Waters. This requirement is based on Finding II.G.18 in the MS4 Permit:

> *"...Permittee streets, roads and highways capital projects have special limitations. For example, the footprint of street, road and highway capital projects is often limited and may have hydraulic constraints due to lack of underground storm drain systems that would otherwise be necessary to hydraulically facilitate treatment of runoff. There are also limitations specified in state and federal design and code specifications that may limit or prohibit certain BMPs. Permittees may also be subject to flow diversion liability and limited road maintenance budgets and equipment. Street, road and highway projects that function as part of the MS4 also receive runoff and associated Pollutants from both existing urban areas and other external sources, including adjacent land use activities, aerial deposition, brake pad and tire wear and other sources that may be outside the Co-Permittee's authority to regulate and/or economic or technological ability to control. These offsite flows can overwhelm Treatment Control BMPs designed to address the footprint (consistent with the typical requirements for a WQMP [Water Quality Management Plan]) of street, road or highway capital projects incorporating curb and gutter as part of its storm water conveyance function. Despite these limitations, the Regional Board finds that Permittee construction of streets, roads and highway capital projects may provide an opportunity to address Pollutant loads from existing urban areas. However, due to the nature of the facilities and projects, it would be unduly burdensome for the Co-Permittees to maintain WQMP documents for transportation projects (in addition to Facility Pollution Prevention Plans and other overlapping requirements of this Order). The Permittees are therefore not required to prepare WQMP documents for street, road and highway capital projects, but instead are required to develop functionally equivalent documents that include site specific consideration utilizing BMP guidance to address street, roads and highway capital project runoff to the MEP."*

The Santa Ana Region MS4 Permittees prepared this *Low Impact Development: Guidance and Standards for Transportation Projects* ("Guidance") to provide direction to Transportation Project owners and operators (including city engineers, planners, and MS4 program staff) regarding how to address MS4 Permit requirements for public works Transportation Projects (including Class I Bikeway and sidewalk projects) within their jurisdictions.

For Transportation Projects, this Guidance is largely based upon BMP techniques contained within the Environmental Protection Agency's (EPA) Municipal Handbook, *Managing Wet Weather with Green Infrastructure: Green Streets*. Other documents, e.g., California Stormwater Quality Association (CASQA) guidelines, also provide information regarding the application of BMPs to Transportation Projects.

The remaining parts of this section provide information regarding the applicability and appropriate use of this Guidance. Subsequent sections of this document provide detailed information regarding how to apply this Guidance to applicable projects.

B. NPDES Permit Requirement

MS4 Permit Section XII.F.1 states:

> *"Within 24 months of adoption of this Order, the Co-Permittees shall develop standard design and post-development BMP guidance to be incorporated into projects for streets, roads, highways, and freeway improvements, under the jurisdiction of the Co-Permittees to reduce the discharge of Pollutants from the projects to the MEP. The draft guidance shall be submitted to the Executive Officer for review and approval and shall meet the performance standards for site design/LID BMPs, Source Control and Treatment Control BMPs as well as the HCOC [Hydrologic Conditions of Concern] criteria. The guidance and BMPs shall address streets, roads or highways under the jurisdiction of the Co-Permittees used for transportation of automobiles, trucks, motorcycles, and other vehicles, and excludes routine road maintenance activities where the surface footprint is not increased. The guidance shall incorporate principles contained in the USEPA guidance, "Managing Wet Weather with Green Infrastructure: Green Streets" to the MEP and at a minimum shall include the following:*
>
> *a. Guidance specific to new road projects;*
>
> *b. Guidance specific to projects for existing roads;*
>
> *c. Size or impervious area criteria that trigger project coverage;*
>
> *d. Preference for green infrastructure approaches wherever feasible;*
>
> *e. Criteria for design and BMP feasibility analyses on a project-specific basis."*

This Guidance fulfills this MS4 Permit requirement. Also, as noted above, this document also addresses Class I Bikeway and sidewalk projects. All jurisdictions subject to the requirements of the Santa Ana Region MS4 Permit shall implement this Guidance to the extent that it is applicable to their project.

C. Applicability

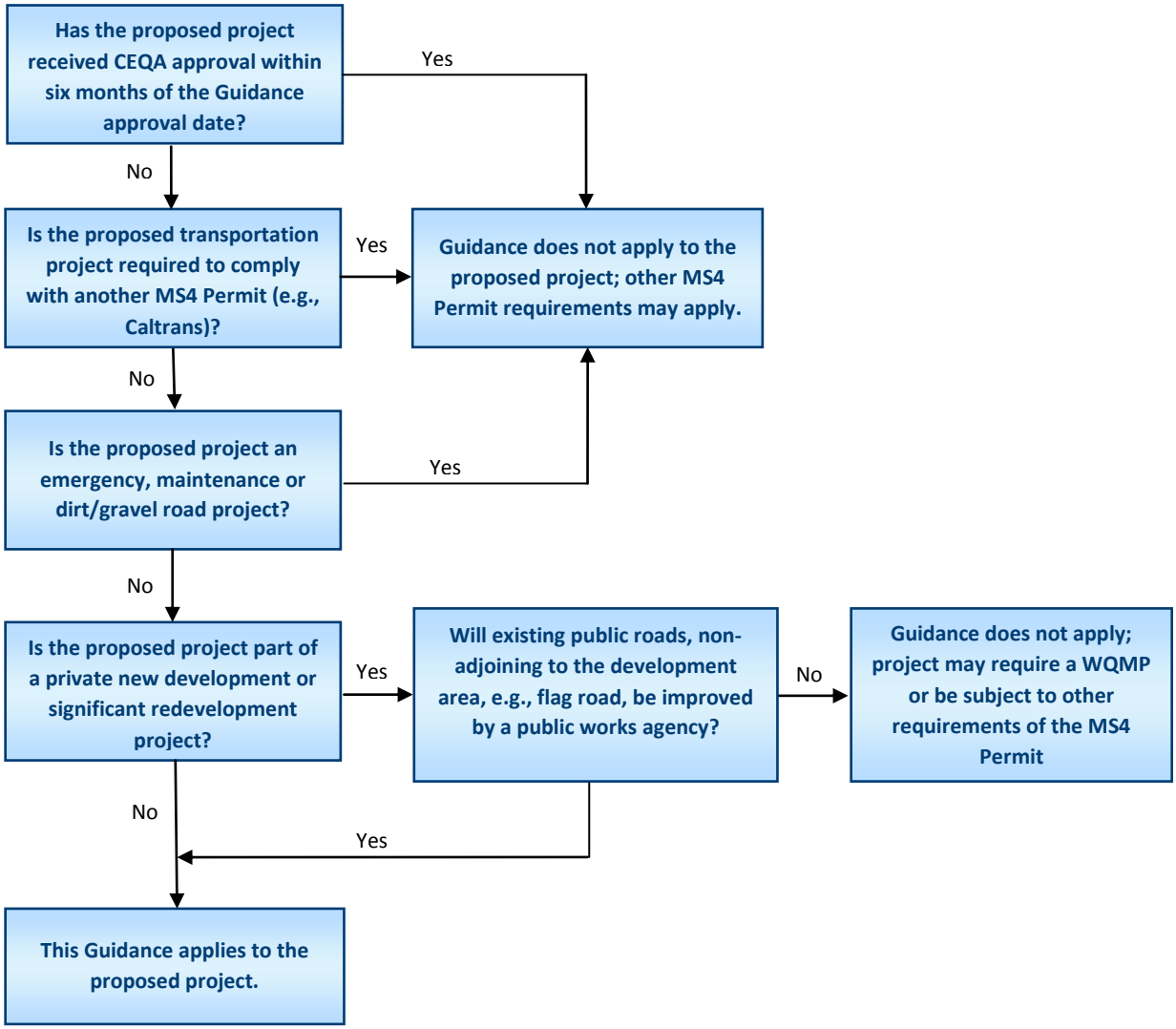
Transportation Projects are implemented to address many needs, ranging from improving the transportation network to support local and regional development, to meeting public safety and maintenance needs. Given the vast array of potential activities carried out to develop and manage transportation networks, project owners and operators should consult this Guidance, as needed, to evaluate its applicability to a proposed project. **Table 1-1** and **Figure 1-1** summarize Guidance applicability.

If a finding is made that this Guidance applies, then the project owner and operator should continue to use this Guidance to ensure compliance with MS4 Permit requirements applicable to Transportation Projects. If it is determined that this Guidance does not apply to the Transportation Project, this finding, along with the basis for the finding, should be documented in the project file.

Table 1-1. Transportation Project Guidance Applicability

This Guidance applies to the following projects: • Public Transportation Projects in the area covered by the Santa Ana Region MS4 Permit, which involve the construction of new transportation surfaces or the improvement of existing transportation surfaces (including Class I Bikeways and sidewalks) that have not obtained CEQA approval within six months after the Santa Ana RWQCB Executive Officer's approval this Guidance.
This Guidance does not apply to the following projects: • Emergency Projects, as defined by this Guidance (see Section 2) • Maintenance Projects, as defined by this Guidance (see Section 2) • Dirt or gravel roads • Transportation Projects that are part of a private new development or significant redevelopment project and required to prepare a Water Quality Management Plan (WQMP) • Transportation Projects subject to other MS4 Permit requirements, e.g., California Transportation Department (Caltrans) oversight projects, cooperative projects with an adjoining County or an agency outside the jurisdiction covered by the Santa Ana Region MS4 Permit • Transportation Projects that have received California Environmental Quality Act (CEQA) approval prior to the approval date of this Guidance

Figure 1-1. Applicability of the Transportation Project Guidance to a Proposed Project



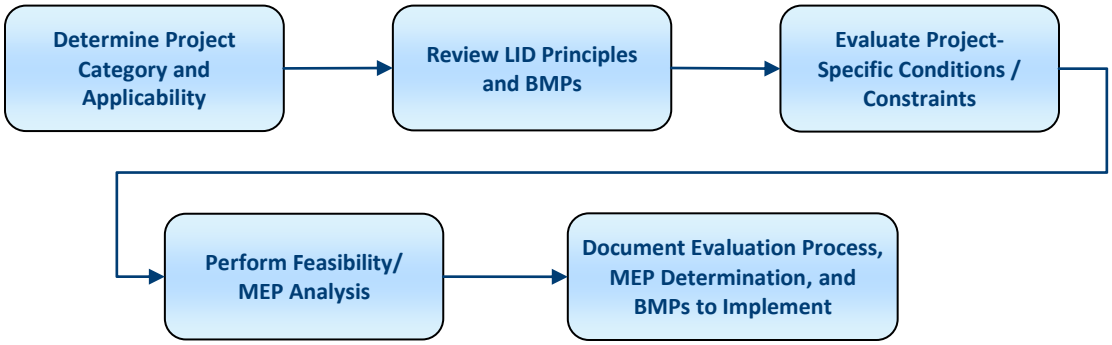
D. Functional Equivalence to WQMP

As stated in MS4 Permit Finding II.G.18, the Santa Ana Region MS4 Permit requires the establishment of guidance that facilitates the development of project documents that are functionally equivalent to WQMP documents prepared for new development and significant redevelopment projects. These functionally equivalent documents should "include site specific considerations utilizing BMP guidance to address road capital project runoff to the MEP." This Guidance establishes minimum LID Principles and BMPs that will treat runoff and address Hydrologic Conditions of Concern to the MEP; and which shall be evaluated for projects subject to the requirements of this Guidance. Depending on the nature of the project and BMPs selected, this Guidance also establishes source control requirements.

E. Organization and Use of the Guidance

The project category, project type, and project-specific feasibility analysis determines the extent to which LID Principles and BMPs are applicable to a project. **Figure 1-2** summarizes the key process steps for evaluating a proposed Transportation Project.

Figure 1-2. Project Evaluation Steps



The remaining sections of this Guidance describe each step in the process, specifically:

- **Section 2, Project Categories** – This section further refines Guidance applicability based on the type of project.
- **Section 3, Project Evaluation** – This section establishes Guidance specific to new and existing Transportation Projects. The Guidance does not establish specific minimum size or impervious area criteria that trigger project coverage. Instead, Section 3 establishes (a) minimum BMP design principles and techniques that shall be considered for all projects to which the Guidance applies; (b) summarizes site constraints that should be evaluated with each project; and (c) provides project-specific BMP feasibility criteria for consideration to evaluate the feasibility of incorporating green infrastructure elements (LID Principles and BMPs) into the proposed project.
- **Section 4, Source Control BMPs** – This section notes the Source Control BMPs that should be evaluated for applicability to Transportation Projects.
- **Section 5, Project Implementation Requirements** – This section describes the minimum documentation requirements applicable to projects and the nexus between the project evaluation and other permit requirements.

- **Section 6, Resources** – This section includes resources for implementation, including a Glossary and Project BMP Template that should be used as part of the evaluation process for proposed projects.

Section 2
Project Categories

This Guidance establishes four categories of projects (**Table 2-1**):

- Category 1 – Emergency Projects
- Category 2 – Maintenance Projects
- Category 3 – Existing Transportation Projects
- Category 4 – New Transportation Projects

Consistent with MS4 Permit Provisions XII.F.1 and XII.D.2, Category 1 or 2 projects are considered exempt from the LID and Source Control BMP implementation requirements contained within this Guidance and the WQMP. The project owner and operator should consult the Local Implementation Plan (LIP) for the jurisdiction within which the project will be built to identify applicable requirements, such as for Category 2 – Maintenance Projects.

If the project falls within Category 3 or 4, this Guidance applies to the project. Accordingly, the LID Principles and BMPs applicable to the project type shall be evaluated and incorporated into the project design to the MEP (see Section 3).

Category 3 projects may be subcategorized into capacity improvement, non-capacity improvement, or Class I Bikeway and sidewalk projects (not adjoining an existing road). This subcategorization may be important for the selection and evaluation of appropriate LID Principles and BMPs for incorporation into the project (see Section 3). If a road project includes adjoining bikeway or sidewalk features, the selection and evaluation of BMPs should consider both the road and the adjoining bikeway/sidewalk features as a single project.

Table 2-1. Project Categories and Example Projects[1]

Exempt from Guidance Requirements		Category 3 Existing Transportation Project	Category 4 New Transportation Project
Category 1 Emergency Project	**Category 2 Maintenance Project**		
▪ Emergency road work of any nature that occurs outside the normal planning process	▪ Routine, reactive, or preventive maintenance activities ▪ Pavement preservation, preventive maintenance, pavement reconstruction, or pavement rehabilitation activities within the existing surface footprint ▪ Traffic control device improvements to address safety concerns ▪ Bridge rehabilitation within existing surface footprint (no traffic capacity change or modification of existing drainage) ▪ Seismic enhancement / retrofit projects ▪ Safety enhancement projects that result in the addition of no new transportation surfaces ▪ Median improvement projects with no new road surface ▪ Curb and gutter improvements ▪ Utility cuts ▪ Alteration of the existing road profile within the existing surface footprint	▪ **Roadway Capacity Improvement Projects** — Lane additions — Bridge capacity improvements — Grade separation projects, where capacity is increased ▪ **Non-Capacity Roadway Improvement Projects** — Shoulder / parking lane improvements — Turn pocket additions — Signal project that adds a turn lane — Horizontal alignment correction to improve sight distance — Grade separation projects, where no change in capacity — Addition of passing lane — Addition of a turn out — Addition of a bike lane or sidewalk that adjoins an existing roadway ▪ **Class I Bikeway or Sidewalk Projects** — Improvements to existing Class I Bikeway or sidewalk, not adjoining a roadway	▪ New road or bridge project ▪ New Class I Bikeway or sidewalk project, not adjoining a roadway

[1]The described project types for each Category are considered as examples that a Co-Permittee can use in determining which category is applicable to the project.

Section 3
Project Evaluation

A. LID Principles and BMPs

Transportation Projects shall incorporate the following LID Principles and BMPs to the maximum extent practicable:

- Conservation of natural areas to the extent feasible
- Minimization of the impervious footprint
- Minimization of disturbances to natural drainage
- Design and construction of pervious areas to receive runoff from impervious areas
- Use of landscaping that minimizes irrigation and runoff, promotes surface infiltration, and minimizes the use of pesticides and fertilizers

The extent to which these design principles may be incorporated into a project through the use of LID Principles and BMPs techniques depends on the project type and the project-specific feasibility analysis (see below). For Transportation Projects, potential LID Principles and BMPs to be evaluated include:

- Minimizing Road Widths
- Drainage Swales
- Bioretention Curb Extensions and Sidewalk Planters
- Permeable Pavements
- Sidewalk Trees and Tree Boxes
- Infiltration Basins

With the exception of infiltration basins, these LID Principles and BMPs are generally described in EPA's Guidance *Managing Wet Weather with Green Infrastructure: Green Streets*. Infiltration basin techniques, based on CASQA guidelines, are already in use throughout Riverside County. Their use as a BMP for Transportation Projects shall be consistent with Santa Ana Region MS4 Permit requirements for pretreatment of runoff prior to infiltration. The following sections provide an overview of each of the above LID Principles and BMPs.

Where the bikeway or sidewalk features are part of or adjoining to a road project, the BMP evaluation is based on the entire project. For separate Class I Bikeway or sidewalk projects that do not adjoin the road surface, only a select group of BMP techniques are required for evaluation. These are discussed separately at the end of this section.

Minimizing Road Widths

a. Plan site layout and road network to respect the existing hydrologic functions of the land (preserve wetlands, buffers, high-permeability soils, etc.) and minimize the impervious area.

b. Minimize road widths while maintaining jurisdictional code requirements for emergency service vehicles and a free flow of traffic.

c. Look for opportunities to eliminate imperviousness within all areas of the proposed project site.

Drainage Swales

a. Plan site drainage using vegetated swales (preferably without irrigation) to accept sheet flow runoff and convey it in broad shallow flow to reduce stormwater volume through infiltration, improve water quality through vegetative and soil filtration, and reduce flow velocity by increasing channel roughness.

Green Streets: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure

b. Consider use of vegetated or pervious material swales for site drainage before considering use of hard-lined impervious channels.

c. Identify additional benefits that may be attained from swales through amended soils, bioretention soils, gravel storage areas, underdrains, weirs, and thick diverse vegetation, including, where possible, use of native vegetation.

Bioretention Curb Extensions and Sidewalk Planters

a. Plan site layout using bioretention features such as curb extensions, sidewalk planters, and tree boxes designed to take runoff from the road.

Green Streets: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure

b. Look for opportunities to incorporate site specific bioretention features into specifications and standards.

c. Evaluate road configurations, topography, soil conditions, and space availability for opportunities to incorporate bioretention features.

d. Evaluate existing site utilities for opportunities to incorporate bioretention features as a retrofit.

e. Evaluate and select plants with respect to maintenance requirements, salt tolerance, and plant height considering traffic safety and security. If an approved plant list is available, plants should be selected from this list.

Permeable Pavement

a. Plan low speed and parking areas within a site layout for incorporating permeable pavement.

b. Evaluate permeable gutters.

c. Evaluate permeable concrete, permeable asphalt, permeable interlocking concrete pavers, and grid pavers as alternatives to conventional, less pervious concrete and asphalt surfaces.

d. Incorporate an aggregate base to provide structural support, runoff storage, and pollutant removal through filtering and adsorption.

Green Streets: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure

Sidewalk Trees and Tree Boxes

a. Incorporate tree cover into the site layout.

b. Evaluate site opportunities for sidewalk tree features and tree boxes.

c. Provide sufficient uncompacted soil and space for proper tree health and growth via larger tree boxes, structural soils, root paths, or "silva cells" that allow sufficient tree root space.

d. Consider sufficient tree space in the right-of-way (ROW) while maintaining traffic and pedestrian safety. Consider sufficient tree space for root growth to prevent road structural impacts.

e. Evaluate space for trees vs. added construction costs.

Green Streets: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure

Infiltration Basins

a. Plan roadway drainage to be directed away from the road surface to infiltration basins. Typical detention or retention basins may be designed as infiltration facilities in some cases, with the ability to store runoff until it gradually exfiltrates through the soil. A 72-hour drawn down is usually recommended.

b. Incorporate infiltration basins, which can have high pollutant removal efficiency and can reduce flows to mimic pre-development hydrologic conditions. Use of infiltration BMPs shall be consistent with the pretreatment of runoff prior to infiltration requirements established by the MS4 Permit for areas subject to high vehicular traffic (25,000 or more average daily traffic).

www.casqa.org – Califonia BMP Handbooks

c. Locate infiltration basins at least 20 feet away from roadway pavement, and at least 100 feet from bridge structures.

d. Evaluate appropriate soil conditions for infiltration and site constraints. Groundwater separation should be at least 10 feet from the basin invert to the measured ground water elevation.

e. Evaluate traffic / pedestrian safety and site aesthetics while locating infiltration basins.

f. Reference the county's design criteria for infiltration basins for consistency with these and other design elements. Caltrans also has specific design requirements for infiltration basins in their ROW.

LID Principles and BMPs Applicable to Class I Bikeway and Sidewalk Projects

LID Principles and BMPs for Class I Bikeway and sidewalk projects not adjoining the road surface:

- Directing drainage to pervious surfaces
- Minimizing path width
- Use of tree wells
- Use of permeable pavement

B. Feasibility/MEP Analysis of LID Principles and BMP Design Techniques

The extent to which the BMP techniques described above are applied to a Transportation Project depends on the results of the BMP feasibility analysis completed for each project. All potential BMP techniques described above shall be considered for each project.

Each Transportation Project is unique and will have site-specific constraints that influence the feasibility of BMP implementation. Therefore, project site constraints must be considered as part of the effort to evaluate the feasibility of implementing the BMP techniques contained within this Guidance (**Figure 3-1**). For example, available ROW may constrain BMP options and feasibility from a space perspective. As space is typically a limiting factor for BMP implementation, Category 4 projects (new Transportation Projects) should acquire as much available space as feasible early in the process, where feasible. Site drainage features, characteristics and connectivity, site grades, and underground utilities may make some BMPs desirable over others, while making others infeasible. For example, inability to access irrigation water and power for components and controls will limit the functionality of certain vegetated BMPs. The type of traffic or intended road use may make some BMPs infeasible (i.e., heavy traffic on pervious pavement).

Figure 3-1. Potential Project Constraints

- **Regulatory Requirements**
  - TMDL requirements
  - Environmentally sensitive areas
  - CEQA conditions
- **Site-specific Characteristics**
  - Drainage characteristics
  - Soil characteristics, geologic conditions
  - Elevated groundwater conditions
  - Groundwater protection areas
  - Natural sediment loads
- **Infrastructure & Project-specific Characteristics**
  - Programmatic or funding restrictions
  - Right of way constraints
  - Existing features (drainage, curb and gutter, grades, etc.)
  - Utility constraints (e.g., pipelines, cables)
  - Availability of irrigation water
  - Availability of power
  - Types of traffic loads
  - Maintenance resources and expertise

The following sections identify common Transportation Project elements that should be evaluated as part of the analysis to determine the feasibility of implementing BMPs to the MEP. They should also be used to demonstrate where specific BMPs are infeasible. This list is not necessarily exhaustive given the unique nature of each Transportation Project; accordingly, other considerations may be evaluated and documented, as appropriate. These elements should also be evaluated for Class I Bikeway and sidewalk projects, not adjoining a roadway surface to determine the feasibility of incorporating BMPs potentially applicable to these projects.

Programmatic Requirements / Funding Restrictions

a. The BMPs techniques described within this Guidance may be implementable and approvable for a wide variety of Transportation Projects, capital improvement programs, and funding sources; however, some programs or funding sources may place constraints on the nature or type of project features that can be implemented. For example, funding sources for certain safety improvement projects may have strict project / program requirements that only allow funding for select project features. Such constraints may restrict the feasibility of some BMP techniques.

b. Other programs may require project features that affect BMP implementation, such as compliance with Americans with Disabilities Act (ADA) requirements.

c. Some BMP techniques may be too costly for the scope of the project.

Drainage Connectivity and Utilities

a. The project may alter previously established drainage patterns. New Transportation Projects and improvements to existing transportation facilities must tie into adjoining drainage features creating opportunities for and potential constraints on implementation of BMP techniques. The drainage characteristics of each project site must be evaluated to determine which BMP techniques will be feasible, and the extent to which such BMPs may be implemented.

b. Run-on conditions from adjoining properties or existing roadway surfaces will affect how certain BMP techniques can be implemented within a project. Run-on conditions should be determined and analyzed to determine the extent to which they influence BMP selection and implementation. Opportunities for re-directing run-on prior to entering the project site to reduce the hydraulic impact on water quality BMPs should be considered.

c. Location of existing utilities may reduce the feasibility of certain BMP techniques.

d. Design and placement of new utilities can provide opportunities for implementation of BMP techniques. New utilities should be considered along with BMP design and placement to maximize implementation opportunities and minimize feasibility constraints.

Environmentally Sensitive Areas and Impaired Waterbodies

a. A Transportation Project's proximity to an Environmentally Sensitive Area (ESA), drinking water well or other location requiring enhanced water quality protection, e.g., because of a downstream impaired waterbody, may necessitate specific BMP techniques. The LIP applicable to the project area provides information regarding any required BMPs to address local environmental concerns.

Road Widths and Parking Requirements

a. General Plan roadway classifications and local code requirements may place minimum width restrictions on roads, limiting the amount pervious surface that can be reduced and the remaining space available for BMP technique implementation.

b. Parking area requirements and restrictions may limit the amount of pervious surface that can be reduced and the remaining space available for BMP implementation.

Drainage Swales

a. Sufficient ROW must be present for proper swale installation. Proper grade and drainage connectivity must be available to provide for broader, shallower flows while tying into existing local drainage.

b. The size of the project's drainage area, amount of site run-on, and ability to redirect the run-on will affect the size and feasibility of drainage swales.

c. Vegetated drainage swales require healthy vegetation for proper functionality. Irrigation water and power must be available for maintaining proper vegetative growth during dry periods. Using non-native vegetation may increase maintenance costs and resource requirements, which may affect feasibility of implementation.

d. Soil characteristics should allow for infiltration.

e. Aesthetic goals and vector control requirements may necessitate specific swale features or affect the feasibility of their implementation.

Infiltration Basins

a. Appropriate soil conditions for infiltration must exist. Area slopes that are no steeper than 4:1 should be present and baseflow conditions should not exist.

b. Infiltration basins should be located at least 20 feet away from roadway pavement, and at least 100 feet from bridge structures.

c. Groundwater separation should be at least 10 feet from the basin invert to the measured groundwater elevation.

d. A 72-hour drawn down period is recommended for proper functionality.

e. Use of infiltration BMPs shall be consistent with the pretreatment of runoff prior to infiltration requirements established by the MS4 Permit for areas subject to high vehicular traffic (25,000 or more average daily traffic).

f. Traffic and pedestrian safety and site aesthetics may affect locating infiltration basins and their feasibility.

Bioretention Curb Extensions and Sidewalk Planters

a. Sufficient ROW must be present for including bioretention curb extension or sidewalk planters within a Transportation Project, including ADA requirements.

b. Curb extensions and sidewalk planters must tie into existing drainage conditions.

c. Traffic and pedestrian safety and site aesthetics may affect locating curb extensions and sidewalk planters and their feasibility.

d. Irrigation water and power must be available for proper plant maintenance. Using native vegetation vs. non-native may reduce the need for maintenance, improving feasibility.

Permeable Pavement

a. Permeable pavement can be an effective BMP technique in selected low speed areas, e.g., entrance/exits to parking lots, or parking areas (e.g., dedicated areas or along existing streets) applications, but is not considered suitable for most city and county Transportation Projects.

b. Permeable pavement is not suitable for transportation surfaces with high traffic or that may bear a heavy load.

c. Using permeable pavement for parking surfaces may be feasible unless soil characteristics will not support infiltration or drainage conditions affect functionality.

d. Specialized maintenance is necessary for permeable pavements to maintain the intended infiltration capacity. The ability for a public agency to provide resources (funding, labor, and equipment) for proper maintenance of permeable surfaces will affect feasibility.

Sidewalk Trees and Tree Boxes

a. Sufficient ROW within the Transportation Project site must be present for implementation of this BMP technique.

b. Irrigation water and power must be available for proper tree maintenance. Using native vs. non-native trees may reduce the need for maintenance, improving feasibility.

c. Traffic and pedestrian safety and site aesthetics may affect locating sidewalk trees or tree boxes and their feasibility.

Maintenance Requirements

a. Every BMP technique described in this Guidance requires maintenance to help ensure long term effectiveness. The feasibility of any BMP technique will depend upon the level of maintenance resources available in the long term.

b. The feasibility of BMP techniques will depend on the level of expertise necessary to maintain the BMPs. Project owners and operators must have the expertise and equipment necessary to maintain all aspects of the BMP techniques selected for a project, or have the resources to contract for the maintenance.

c. Several BMP techniques may require another public agency or department for proper maintenance. For example, maintenance of vegetated BMPs may fall within a local landscape maintenance program. As such, the resources, equipment, expertise available from other agencies may affect BMP feasibility.

d. Several BMP techniques may require consideration of existing source control programs, e.g., catch-basin cleaning or street sweeping. The local LIP should be consulted for applicable source control requirements.

Section 4
Source Control BMPs

Each Transportation Project must evaluate and incorporate applicable Source Control BMPs into project planning to control pollutants after project construction is complete and the project is put into its intended service.

Table 4-1 identifies recommended Source Control BMPs. The agency responsible for implementing and maintaining the applicable Source Control BMPs should be identified and documented. In addition, it is recommended that the project proponent review the Source Control BMP section of the WQMP of the jurisdiction within which the project is planned to determine if any additional Source Control BMPs may apply to the project.

Table 4-1. Potential Source Control BMPs for Transportation Projects

Recommended Source Control BMPs	
Category 3 or 4 Projects (other than Class I Bikeway or sidewalk projects)	**Class I Bikeway and Sidewalk Projects**
Non-Structural Source Control BMPs	**Non-Structural Source Control BMPs**
▪ Irrigation System and Landscape Maintenance ▪ Sweeping of Transportation Surfaces Adjoining Curb and Gutter ▪ Drainage Facility Inspection and Maintenance	▪ Public Education Program ▪ Use of Signage ▪ Installation and Maintenance of Trash Bins and Pet Waste Collection Bags
Structural Source Control BMPs	
▪ MS4 Stenciling and Signage ▪ Landscape and Irrigation System Design ▪ Protect Slopes and Channels	

Section 5
Project Implementation Requirements

A. Project Documentation

For Category 1 and 2 projects (Emergency and Maintenance Projects, respectively), the project development file should contain documentation showing that this Guidance and the implementation of LID-based BMP practices did not apply.

All Category 3 and 4 projects require supplemental documentation in the project development file that includes the following:

- Project category and type;
- Site constraints;
- Project feasibility analysis findings; and
- LID-based BMPs incorporated into the project.

Permittee MS4 staff responsible for assuring compliance with MS4 Permit requirements will evaluate the applicability and feasibility determination made by the project owner and operator for each project. Where appropriate, these staff may require additional information to demonstrate compliance with this Guidance in order for acceptance and permitting. Appendix A includes a template for documenting the project specific analysis for Category 3 and 4 projects.

If the funding source of a project has requirements that affect what project features and/or BMPs may be incorporated or implemented, such as block grant funding, the funding requirements may be used in determining the feasibility of BMPs. Funding requirements affecting BMP implementation must be documented to demonstrate how the requirements affect the feasibility determinations and must be included in the project file.

A project owner and operator may document the proposed BMP techniques via a supplementary document to the proposed project plans, such as contract documents or specifications, or directly within the project plans as plan notes. Project plans and file documentation will show or describe the types, sizes, and locations of BMP techniques proposed for each proposed project. The Permittee shall maintain the documentation along with all other information required for approval and permitting the proposed project within the project files.

B. Compliance with Other Permit Requirements

Other regulations and requirements are applicable to proposed projects, for example, 404 Permit/401 Certification requirements, and NPDES General Construction Permit requirements. Other permit conditions may require additional or more (or less) stringent BMP implementation. Compliance with this Guidance does not supplant all conditions associated with other permits and programs. In cases where other requirements are similar but not prescriptive nor specific, they do not automatically overrule a feasibility evaluation performed using this Guidance. In such cases, the feasibility evaluation performed using this Guidance shall be considered the most thorough evaluation also meeting the intent of the other similar requirements.

Projects that have completed design phases but have not been constructed (shelved projects) do not have to be redesigned to incorporate the requirements of this Guidance as long as they have satisfied CEQA approval at the time of the implementation date of this Guidance.

C. Other Considerations

This Guidance has been developed to assist project owners and operators and Permittee staff with implementing the Transportation Project requirements in the MS4 Permit. Project owners and operators or Permittees wishing to go beyond MEP requirements to develop "demonstration projects" for stormwater quality design may do so, as long as the minimum MEP requirements for each BMP technique are met. Such demonstration projects would be developed under a different, more expansive determination of feasibility not considered to be the standard applicable to conventional Transportation Projects.

Section 6
Resources

A. Glossary

B. Transportation Project BMP Template

C. Managing Wet Weather with Green Infrastructure: Green Streets (EPA 2008)

A. Glossary

Adjoining – Proposed project sites (or land parcels) that share a common border. For example, a parcel slated for new development or significant redevelopment that has a common border with an existing road ROW that will be modified as a result of the development project.

Average Daily Traffic (ADT) - The average 24-hour volume of traffic, being the total volume during a stated period divided by the number of days in that period. The period is a year, unless stated otherwise.

Baseflow - Sustained natural stream flow or channelized flow caused by groundwater and/or uncontrolled irrigation flows. Sometimes referred to as groundwater flow or dry-weather flow.

Best Management Practice (BMP) – Defined in 40 CFR 122.2 as schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of Waters of the U.S. BMPs also include treatment requirements, operating procedures and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. In the case of MS4 permits, BMPs are typically used in place of numeric effluent limits.

Bioretention - BMP that functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through the buffer strip and subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days. Bioretention BMPs are feasible on all soil types and distinguished from biotreatment BMPs (below) by the fact that their design will process the design volume entirely through a biologically active soil media, and that they inherently maximize both infiltration and evapotranspiration of runoff.

California Environmental Quality Act (CEQA) Approval – Formal approval of a proposed project under CEQA (California environmental legislation that establishes procedures for conducting an environmental analysis for all projects in California [California Public Resources Code, Section 21000, et. seq.]).

Capacity Improvement Project – Transportation Project that changes the maximum sustainable flow rate at which vehicles or persons reasonably can be expected to traverse a point or uniform segment of a lane or roadway during a specified time period under given roadway, geometric, traffic, environmental, and control conditions; usually expressed as vehicles per hour, passenger cars per hour, or persons per hour.

Class I Bikeway – Bike path that provides a completely separated right of way for the exclusive use of bicycles and pedestrians.

Curb Extension - Landscaped areas within the parking zone of a street that capture urban runoff. Curb extensions are enclosed by a curb on the street side, which has openings, called "curb cuts," that allow street runoff to enter and exit the facility. Extending into the street from the curb narrows the road width which also increases pedestrian safety and helps calm traffic. A curb extension allows water to flow into a landscaped area that may include vegetated swales, planters, or rain gardens.

Drainage Swale - Open channels designed to accept sheet flow runoff and convey it in broad shallow flow. The intent of swales is to reduce stormwater volume through infiltration, improve water quality through vegetative or soil filtration, and reduce flow velocity by increasing channel roughness.

Drawdown Time - The time required for a stormwater detention or infiltration facility to drain and return to the dry weather condition. For detention BMPs, drawdown time is a function of basin volume and outlet orifice size. For infiltration BMPs, drawdown time is a function of basin volume and infiltration rate.

Emergency - Any sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property, or essential public services. "Emergency" includes such occurrences as fire, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage.

Emergency Project – Work on a highway, street, road, Class I Bikeway or sidewalk in response to an emergency. Emergency Projects are Category 1 projects per this Guidance.

Environmentally Sensitive Area (ESA) - An area "in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which would be easily disturbed or degraded by human activities and developments" (California Public Resources Code § 30107.5). ESAs subject to stormwater mitigation requirements are:

- Areas adjacent to Receiving Waters designated as "Preservation of Biological Habitats of Special Significance (BIOL)", "Spawning, Reproduction, and Development (SPWN)" or "Rare, Threatened, or Endangered Species (RARE)" Beneficial Uses in the Basin Plan;
- Areas within the MSHCP [Multi-Species Habitat Conservation Plan] that contain rare or especially valuable plant or animal life or their habitat. These areas are considered mitigated as the MSHCP contains substantive alternatives analysis for any proposed development that has the potential to impact resources;
- Areas adjacent to CWA 303(d) Listed Water Bodies or adopted TMDLs with implementation plans that have yet to achieve the urban WLA [wasteload allocation] or LA [load allocation] goals; and
- Any other equivalent environmentally sensitive areas which the Permittees have defined.

Existing Transportation Project – Proposed project that will modify an existing transportation surface in a manner that increases the surface footprint or impervious area of the roadway; includes both capacity and non-capacity improvement projects.

Flag Road – A non-capacity improvement project that modifies an existing road that is non-adjoining to a new development or significant redevelopment to accommodate traffic access to the development project when completed.

Freeway – A divided arterial highway with full control of access and with grade separations at intersections.

General Plan - Blueprints for jurisdictions in the Santa Ana Region MS4 Permit area that describe the future growth and development planned within the area over the long term. The General Plan acts as a constitution for both public and private development, the foundation upon which local leaders make growth and use related decisions. The General Plan is meant to express goals with respect to both human-made and natural environments and sets forth the policies and implementation measures to achieve them for the welfare of those who live, work, and do business in the area (e.g., see http://www.tlma.co.riverside.ca.us/genplan/default.aspx, for Riverside County General Plan).

Grade Separation - A crossing of two highways or a highway and a railroad at different levels.

Horizontal Alignment Correction – A Transportation Project designed to increase the sight distance for drivers that does not change existing road capacity.

Hydrologic Conditions of Concern (HCOC) - An HCOC exists when the alteration of a site's hydrologic regime caused by development would cause significant impacts on downstream channels and aquatic habitats, alone or in conjunction with impacts of other projects.

Impervious - Any surface in the landscape that cannot effectively absorb or infiltrate urban runoff; for example conventional paved: sidewalks, rooftops, roads, and parking areas.

Lane Addition – Addition to an existing road of a strip of roadway to be used for a single line of vehicles.

Local Implementation Plan (LIP) - Document describing an individual Permittee's procedures, ordinances, databases, plans, and reporting materials for compliance with the Santa Ana Region MS4 Permit.

Low Impact Development (LID) – Comprises a set of technologically feasible and cost-effective approaches to stormwater management and land development that combines a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality. LID techniques mimic the site's predevelopment hydrology by using site design techniques that store, infiltrate, evapotranspire, bio-treat, bio-filter, bio-retain or detain runoff close to its source.

LID BMPs - A type of stormwater BMP that is based upon Low Impact Development concepts. LID BMPs not only provide highly effective treatment of stormwater runoff, but also yield potentially significant reductions in runoff volume – helping to mimic the pre-project hydrologic regime, and also require less ongoing maintenance than Treatment Control BMPs.

LID Principles - LID Principles are site design concepts that help prevent or minimize the causes (or drivers) of project impacts, and help mimic the pre-development hydrology. Implementing LID Principles will help minimize the need for specific stormwater BMPs on a project.

Maintenance Project- A project conducted to maintain original line and grade, hydraulic capacity, or original purpose of the facility. Maintenance Projects are Category 2 projects, as described in Table 2-1 of this Guidance.

Maximum Extent Practicable (MEP) – As defined in Appendix 4 (Glossary) of the Santa Ana Region MS4 Permit (Order No. R8-2010-0033).

Median Improvement – Improvements made to the portion of a divided street, road, or highway separating travel lanes for traffic moving in opposite directions.

MS4 Permit –NPDES Permit and Waste Discharge Requirements for the Riverside County Flood Control and Water Conservation District, the County of Riverside, and the incorporated Cities of Riverside County within the Santa Ana Region (Order No. R8-2010-0033, NPDES Permit No. CAS618033).

New Development – Categories of development identified in Section XI.D of the Santa Ana Region MS4 Permit. "New Development" does not include routine maintenance to maintain original line and grade,

hydraulic capacity, or original purpose of a facility, nor does it include Emergency Projects required to protect public health and safety.

New Transportation Project – Proposed project will establish a new street, road, or highway, rather than modify an existing road.

Non-Adjoining – Proposed project sites (or land parcels) that do not share a common border. For example, a parcel slated for new development or significant redevelopment that does not share a common border with an existing road that will be improved as a result of the development project.

Non-Capacity Improvement Project - Transportation Project that does not change the maximum sustainable flow rate at which vehicles or persons reasonably can be expected to traverse a point or uniform segment of a lane or roadway during a specified time period under given roadway, geometric, traffic, environmental, and control conditions; usually expressed as vehicles per hour, passenger cars per hour, or persons per hour.

Overlay – An overlay is a layer, usually hot mix asphalt, placed on existing flexible or rigid pavement to restore ride quality, to increase structural strength (load carrying capacity), and to extend the service life of a road.

Parking Lane - An auxiliary lane primarily for the parking of vehicles.

Pavement Preservation – The sum of all activities undertaken to provide, maintain and extend the life of a street, road, or highway. This includes corrective, routine and preventive maintenance to keep the roadway in a safe and usable condition and delay the need for rehabilitation.

Pavement Reconstruction - Replacement of an existing pavement structure by the placement of the equivalent of a new pavement structure. Reconstruction usually involves complete removal and replacement of the existing pavement structure and may include new and/or recycled materials.

Pavement Rehabilitation - Structural enhancements that extend the service life of an existing pavement and/or improve its load carrying capability. Rehabilitation techniques include restoration treatments and structural overlays.

Pervious – Surface or area that is not impervious, that is, at least some portion of urban runoff or run-on to the surface infiltrates to underlying soil (see also definition for "impervious").

Pollutant – Broadly defined as any agent that may cause or contribute to the degradation of water quality such that a condition of pollution or contamination is created or aggravated.

Preventive Maintenance - A planned treatment on a road in good condition that is intended to preserve the surface, retard future deterioration, prolong service life and delay the need for rehabilitation.

Project Owner and Operator – The agency or jurisdiction responsible for the management and maintenance of the Transportation Project following its completion.

Public Works Project – A Transportation Project implemented under the jurisdiction of the Santa Ana Region MS4 Permit by a Permittee with authority to finance, build, operate, or maintain the facility.

Reactive Maintenance - Maintenance applied to restore a pavement to an acceptable level of service due to unforeseen conditions. Activities such as pothole, crack, rutting, or spalling repairs, performed to correct random or isolated localized pavement distresses or failures, are considered reactive.

Receiving Water – Waters of the U.S. (as defined in Appendix 4 (Glossary) of the Santa Ana Region MS4 Permit) within the area under the jurisdiction of the MS4 Permit.

Right-of-Way (ROW) - A general term denoting land, property, or interest therein (usually in a strip) acquired for or devoted to transportation purposes.

Road – see "Street, Road, or Highway."

Routine Maintenance – Maintenance work that is planned and performed on a regular basis to maintain and preserve the condition of the street, road or highway, or to respond to specific conditions and events that restore the street, road or highway to an adequate level of service.

Run-On - Stormwater that flows from another property or properties onto a subject property via overland flow (uncontrolled run-on) or via a local storm drain (directed run-on).

Safety Enhancement - A project that corrects or improves high hazard locations, eliminates roadside obstacles, improves highway signing and pavement marking, installs priority control systems for emergency vehicles at signalized intersections, installs or replaces emergency motorist aid call boxes, or installs traffic control or warning devices at locations with high accident potential.

Seismic Enhancement/Retrofit – Maintenance activity to modify an existing transportation infrastructure to comply with structural requirements for seismic activity.

Shoulder - The paved or unpaved portion of the roadway adjoining the traveled way for accommodating stopped vehicles, for emergency use, and for lateral support of base and surface courses.

Sight Distance - The length of highway ahead that is visible to the driver.

Significant Redevelopment – As defined in Section XII.D.2.a of the Santa Ana Region MS4 Permit.

Site Design BMPs – Any project design feature that reduces the creation or severity of potential pollutant sources or reduces the alteration of the project site's natural flow regime. Redevelopment projects that are undertaken to remove pollutant sources (such as existing surface parking lots and other impervious surfaces) or to reduce the need for new roads and other impervious surfaces (as compared to conventional or low density new development) by incorporating higher densities and/or mixed land uses into the project design, are also considered site design BMPs.

Street – see "Street, Road, or Highway."

Street, Road, or Highway – A general term denoting a public way for the transportation of people, materials, goods, and services but primarily for vehicular travel.

Surface Footprint – The area of an existing road that is part of the active transportation surface.

Total Maximum Daily Load (TMDL) - Maximum amount of a pollutant that can be discharged into a water body from all sources (point and non-point) and still maintain water quality standards. Under CWA Section 303(d), TMDLs must be developed for all waterbodies that do not meet water quality standards after application of technology-based controls.

Traffic Control Device - A sign, signal, marking, or other device placed on or adjacent to a street or highway by authority of a public body or official having jurisdiction to regulate, warn, or guide traffic.

Transportation Projects – Streets, roads, highways, Class I Bikeways, or sidewalks within the area under the jurisdiction of the Santa Ana Region MS4 Permit used for transportation of automobiles, trucks, motorcycles, bicycles and other vehicles; excludes routine, reactive, or preventive maintenance activities where the surface footprint is not increased (Maintenance Projects) and Emergency Projects. Category 3 and Category 4 projects, described in Table 2-1 of this Guidance, are considered Transportation Projects.

Turn Pocket – Addition of impervious surface at an existing road intersection for the purpose of facilitating right or left turns.

Water Quality Management Plan (WQMP) – The WQMP is a plan for managing the quality and quantity of stormwater or urban runoff that flows from a developed site after construction is completed and the facilities or structures are occupied and/or operational. WQMPs are required for new development and significant redevelopment projects as described in Section XII.D of the Santa Ana Region MS4 Permit and Section 6 of the Riverside County Flood Control & Water Conservation District Drainage Area Management Plan (DAMP).

B. Transportation Project BMP Template

Santa Ana Region MS4 Permit Program

Template for
Low Impact Development:
Guidance and Standards for Transportation Projects

Insert Project Name

Prepared for/by:

Insert Owner/Developer Name

Insert Address

Insert City, State, ZIP

Insert Telephone

Prepared by (if prepared by Consultant):

Insert Consulting/Engineering Firm Name

Insert Address

Insert City, State, ZIP

Insert Telephone

Insert Address

Project Certification

This report has been completed in compliance with the *Low Impact Development: Guidance and Standards for Transportation Projects*, prepared to comply with the Santa Ana Region MS4 Permit requirements applicable to Transportation Projects. The signatory of this document attests to the technical information contained herein and the date upon which recommendations, conclusions, and decisions have been based. I find this report to be complete, current, and accurate:

Name: _____

Title: _____

Agency: _____

Date: _____

Section 1 Introduction

Overview

The federal Clean Water Act (CWA) establishes requirements for the discharge of urban runoff from Municipal Separate Storm Sewer Systems (MS4) under the National Pollutant Discharge Elimination System (NPDES) program. On January 29, 2010, the Santa Ana Regional Water Quality Control Board (RWQCB) issued Permit Order No. R8-2010-0033 ("MS4 Permit") to authorize the discharge of urban runoff from MS4 facilities in Riverside County within the Santa Ana Region MS4 Permit area.

The MS4 Permit requires development of a standard design and post-development Best Management Practices (BMP) guidance to guide application of Low Impact Development (LID) BMPs to the maximum extent practicable (MEP) on streets, roads or highways under the jurisdiction of the Permittees used for transportation of automobiles, trucks, motorcycles, and other vehicles. The Santa Ana Region MS4 Permit Program prepared the *Low Impact Development: Guidance and Standards for Transportation Projects* ("Guidance") to provide direction to Transportation Project owners and operators regarding how to address MS4 Permit requirements for public works Transportation Projects within their jurisdiction. This Guidance is largely based upon BMP techniques contained within the Environmental Protection Agency's (EPA) Municipal Handbook, *Managing Wet Weather with Green Infrastructure: Green Streets*.

This template was prepared to provide a tool for project proponents to (1) determine the applicability of the Guidance to a proposed Transportation Project; (2) provide a process for evaluating the feasibility of using LID-based techniques in the proposed project; and (3) establish a template for documenting the project evaluation process and the decisions made regarding the feasibility to incorporate LID-based BMPs into the design of the project. Users should review the Guidance before applying this template to a proposed project.

Guidance Applicability

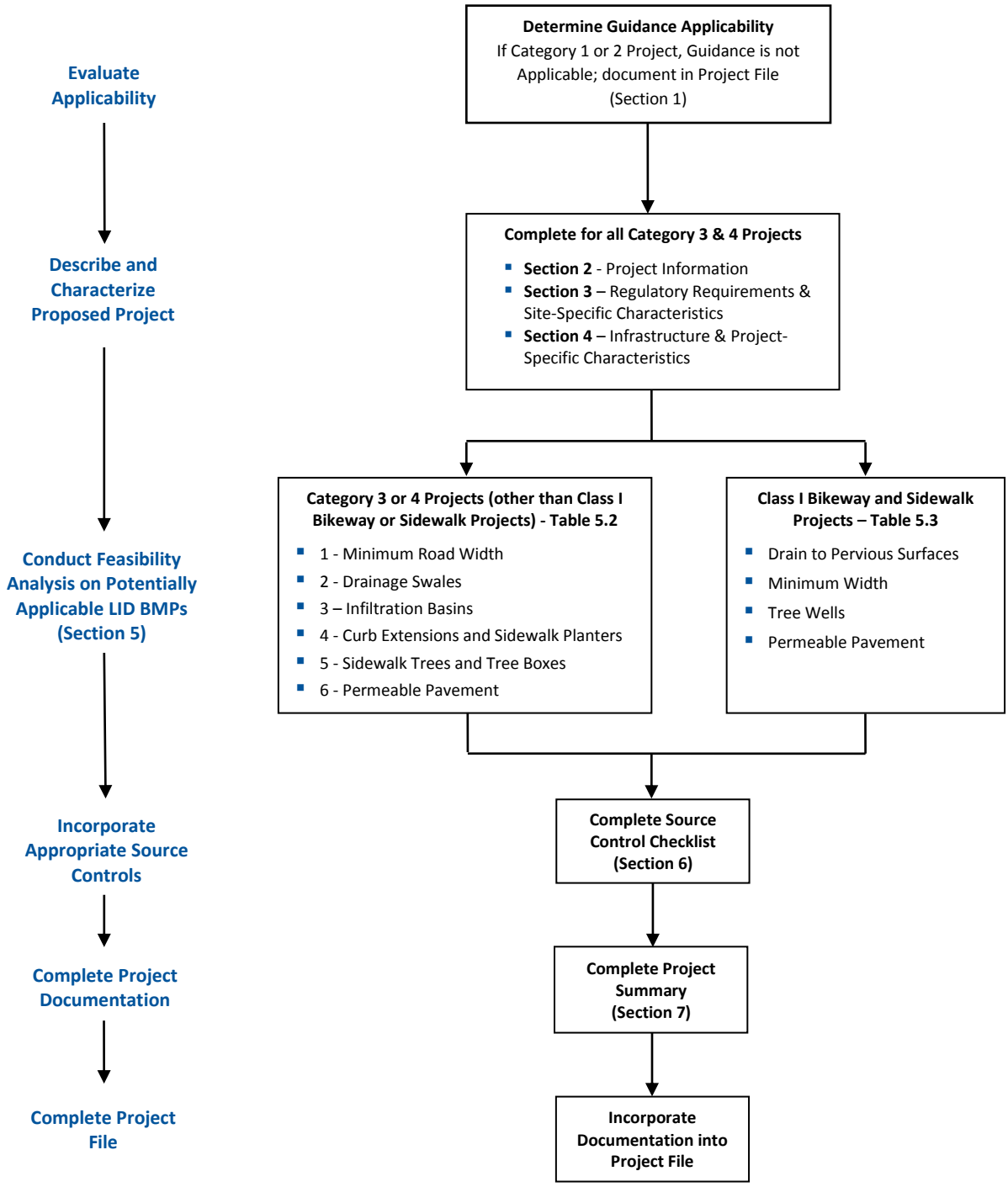
Table 1.1 summarizes the applicability of the Guidance to Transportation Projects.

Table 1.1. Transportation Project Guidance Applicability

The Transportation Project Guidance applies to the following projects: • Public Transportation Projects in the area covered by the Santa Ana Region MS4 Permit, which involve the construction of new transportation surfaces or the improvement of existing transportation surfaces (including Class I Bikeways and sidewalks) that have not obtained CEQA approval within six months after the Santa Ana RWQCB Executive Officer's approval this Guidance.
The Transportation Project Guidance does not apply to the following projects that are either exempt or covered by other MS4 Permit requirements: • Emergency Projects, as defined by this Guidance (see Section 2 of the Guidance) • Maintenance Projects, as defined by this Guidance (see Section 2 of the Guidance) • Dirt or gravel roads • Transportation Projects that are part of a private new development or significant redevelopment project and required to prepare a Water Quality Management Plan (WQMP) • Transportation Projects subject to other MS4 Permit requirements, e.g., California Transportation Department (Caltrans) oversight projects, cooperative projects with an adjoining County or an agency outside the jurisdiction covered by the Santa Ana Region MS4 Permit • Transportation Projects that have received CEQA approval prior to the approval date of this Guidance

If the Guidance applies to the proposed project, this template should be used to evaluate the feasibility of incorporating LID-based BMPs into the project design. Figure 1-1 illustrates the process for completing the template. Refer to this figure as needed to ensure that all steps are completed.

Figure 1-1. Process to Complete Transportation Project BMP Template



Section 2 Project Information

The purpose of this section is to provide general project information and a description of the proposed project. The description should have sufficient detail to identify the project location, project boundaries and size, and, if classified as a Category 3 Project, the basis for the subcategorization (Capacity vs. Non-Capacity Roadway Improvement Project or non-adjoining Class I Bikeway or Sidewalk Project).

Table 2.1 - Project Characteristics					
Project Name					
Project Owner/Operator (Agency)					
Project Contact Name:					
Mailing Address:		E-mail Address:		Telephone:	
Project Category	Check the box for the applicable Project Category *(See Table 2-1 in Guidance* ☐ Category 3 – Existing Transportation Project ☐ Category 4 – New Transportation Project				
Check the appropriate boxes below, based on the Project Category checked above					
Category 3	☐ Roadway Capacity Improvement Project	☐ Lane additions ☐ Bridge project ☐ Grade separation project ☐ Other project type			
	☐ Non-Capacity Roadway Improvement Project	☐ Shoulder improvements ☐ Parking lane improvements ☐ Turn pocket addition ☐ Signal project that adds a turn lane ☐ Horizontal alignment correction (improve sight distance) ☐ Grade separation project ☐ Passing lane addition ☐ Turn out addition ☐ Other project type			
	☐ Class I Bikeway or sidewalk	☐ Improvement to existing Class I Bikeway or sidewalk ☐ Other project type			
Category 4	☐ New road project ☐ New bridge project ☐ New Class I Bikeway or sidewalk project				
Project Schedule:					

Table 2.2 - Project Description					
General Project Description:					
Project Area (ft^2):		Project Length (ft):		Coordinates of the approximate center of the project:	Latitude: Longitude:
For Category 3 & 4 projects, complete the information below.					
Describe how the existing surface footprint will be modified, if applicable					
Describe how the capacity of the existing transportation surface (if any) will be improved					
For a Class I Bikeway or sidewalk project, describe how the existing surface will be improved					

Section 3 Regulatory Requirements & Site-Specific Chararacteristics

Describe the regulatory requirements and site-specific characteristics associated with the project site that can influence the selection of LID-based BMPs. Attach supporting information, as needed.

Table 3.1 – Regulatory Requirements & Site-Specific Characteristics	
Regulatory Requirements	
Document any TMDL requirements established in the Local Implementation Plan applicable to the project area	
Document any known CEQA conditions, Multi-Species Habitat Conservation Plan, California Fish & Game Code Section 1600, CWA Section 401, or CWA Section 404 requirements	
Site-Specific Characteristics	
Drainage Area (ft^2)	
Existing Site Impervious Area (ft^2)	
Expected Post-Project Impervious Area (ft^2)	
Hydrologic Soil Group* *Describe hydrologic soil group and associated infiltration characteristics, if known*	
Expected Infiltration Characteristics *Describe known infiltration characteristics based on soil group or soil test data (attach if such data are available)*	
Natural Sediment Load Characteristics *Describe local sediment characteristics that could impact selection or functionality of BMPs*	
Depth to Groundwater *Determine depth to groundwater, if known (provide source of information*)	

* See soils section of the Flood Control District's Hydrology Manual
http://floodcontrol.co.riverside.ca.us/downloads/planning/Hydrology%20Manual%20-%20Complete.pdf

Section 4 Infrastructure & Project-Specific Characteristics

Describe the existing infrastructure and project-specific characteristics associated with the project site that can influence the selection of LID-based BMPs. Attach supporting information, as needed; insert N/A for any element that is not applicable to the proposed project.

Table 4.1 - Infrastructure & Project-Specific Characteristics	
Programmatic & Funding Restrictions	
Project Funding *Provide information regarding project funding*	Project Budget:
	Funding Source:
	Are there any limitations or restrictions on the use of dedicated funds: ☐ Yes; if this box checked, explain limitations ☐ No
Programmatic Constraints *Identify any programmatic or regulatory constraints, e.g., Americans with Disabilities Act; need for emergency access, etc.*	Does the project require compliance with other programmatic, regulatory, or code requirements that may affect application of BMPs? ☐ Yes; if this box checked, explain limitations ☐ No
Right-of-Way (ROW)	
ROW Constraints *Describe potential ROW constraints to BMP implementation*	
Drainage Connectivity	
Connectivity Constraints *Based on drainage features of the project site, describe potential constraints to BMP implementation*	

Table 4.1 - Infrastructure & Project-Specific Characteristics	
Utilities	
Utility Constraints *Identify any utility-related constraints*	Does the project have any utility constraints that that may affect application of BMPs? ☐ Yes; if this box checked, explain constraints ☐ No
Resource Availability	
Irrigation Water *Describe availability of irrigation water to support BMPs that require establishment of landscaping*	
Power *Describe availability of power to support use of an irrigation system*	
Estimated Road Use	
Vehicle Load *Describe the expected vehicle loads, e.g., H-20 truck loads, that will use the transportation surface after project completion*	
Maximum Allowable Speed (MAS) *Describe expected speed of vehicles on completed transportation surface; if variable, provide the MAS for different project elements*	
Roadside Parking Requirements *Describe any minimum requirements associated with design of roadside parking areas*	
Capacity Design (Average Daily Traffic, ADT). Is the ADT ≥ 25,000?	☐ Yes ☐ No

Section 5 BMP Feasibility Analysis

Projects categorized as a Category 3 or Category 4 shall incorporate the following site design BMP principles to the maximum extent feasible:

- Conservation of natural areas to the extent feasible
- Minimization of the impervious footprint
- Minimization of disturbances to natural drainage
- Design and construction of pervious areas to receive runoff from impervious areas
- Use of landscaping that minimizes irrigation and runoff, promotes surface infiltration, and minimizes the use of pesticides and fertilizers

The extent to which these design principles may be incorporated into a project through the use of BMP techniques depends on the project type and the project-specific feasibility analysis. This section provides a stepwise approach for evaluating the feasibility to incorporate LID-based BMPs into a proposed project. Table 5.1 identifies the BMPs required for evaluation in relation to the project category or type. Based on the box checked the project reviewer is directed to the appropriate table for subsequent analyses.

Table 5.1 - LID BMP Evaluation Requirements	
Check the appropriate box. The LID BMPs listed within each category must be included in the feasibility analysis	
☐ **Category 3 or 4 (other than a Class I Bikeway or sidewalk project)** ▪ 1 - Minimum Road Width ▪ 2 - Drainage Swales ▪ 3 – Infiltration Basins ▪ 4 - Bioretention Curb Extensions and Sidewalk Planters ▪ 5 - Sidewalk Trees and Tree Boxes ▪ 6 - Permeable Pavement	☐ **Class I Bikeway or Sidewalk Project** ▪ Drain to Pervious Surfaces ▪ Minimum Width ▪ Use of Tree Wells ▪ Permeable Pavement
▪ If the Category 3 or 4 box was checked above, complete the feasibility analysis for <u>each</u> of the LID BMPs in Table 5.2 ▪ If the Class I Bikeway or Sidewalk project box was checked, complete Table 5.3	

Table 5.2 – LID BMP Feasibility Analysis 1 – Minimum Road Widths	
1.a - Does the project need to meet jurisdictional code or General Plan requirements for minimum road widths?	☐ Yes; if checked, describe requirements ☐ No
1.b – Based on the findings of 1.a., determine if this BMP can be applied to the project. If applicable, describe how it was incorporated into the project design.	☐ Applicable, describe design features incorporating this BMP; include in Table 7.1 ☐ Not Applicable, describe basis for decision (e.g., project requirements, traffic or pedestrian safety concerns)

Table 5.2 – LID BMP Feasibility Analysis 2 – Drainage Swales	
2.a – Are there any programmatic constraints that prevent the use of this BMP, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.? See Section 3.b of the Guidance.*	☐ Yes; if checked, provide basis for finding and STOP; this BMP is infeasible ☐ No; BMP is potentially feasible, continue to 2.b
2.b - Considering grade and need for drainage connectivity, is there sufficient ROW for proper swale installation?	☐ No; if checked, provide basis for finding ☐ Yes
2.c - Can drainage swales be sized large enough to capture site run-on and redirect it into the drainage system?	☐ No; if checked, provide basis for finding ☐ Yes
2.d - Are existing soil characteristics sufficient to support infiltration such that nuisance or vector conditions are not created by any ponded water that may occur?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 2.b, 2.c, <u>or</u> 2.d, then STOP - this BMP is infeasible; attach appropriate documentation support as needed • If "Yes" is checked for 2.b, 2.c, <u>and</u> 2.d, then this BMP is potentially feasible, continue on to 2.e and 2.f	
2.e - Are irrigation water and power available to support vegetation in swale during dry periods?	☐ No; if checked, provide basis for finding ☐ Yes
2.f - If irrigation water and power are not available, can the site support native vegetation that does not require irrigation?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 2.e <u>and</u> 2.f, this BMP is infeasible • If "Yes" is checked for 2.e <u>or</u> 2.f, then this BMP is potentially feasible; continue to 2.g	
2.g – Are there any special maintenance, equipment, or experience requirements associated with the implementation of this BMP?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
2.h – If this BMP is implemented, will there be any one-time capital costs incurred, e.g., for new equipment required to maintain the BMP, that impacts project funding?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
2.i – Is there long-term funding available to maintain this BMP?	☐ Yes ☐ No
• If any of the findings from 2.g, 2.h <u>or</u> 2.i prevent the use of this BMP, then this BMP is infeasible; attach appropriate documentation as needed • If the findings from 2.g., 2.h, <u>and</u> 2.i do not prevent implementation of this BMP, then the BMP is feasible; incorporate into Table 7.1	

Table 5.2 – LID BMP Feasibility Analysis 3 – Infiltration Basins	
3.a – Are there any programmatic constraints that prevent the use of this BMP, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.? See Section 3.b of the Guidance.*	☐ Yes; if checked, provide basis for finding and STOP; this BMP is infeasible ☐ No; BMP is potentially feasible, continue to 3.b
3.b - Do appropriate soil conditions exist at the project site to allow effective infiltration consistent with a drawdown period, not to exceed 72 hours?	☐ No; if checked, provide basis for finding ☐ Yes
3.c - Is there at least 10 feet separation between the planned basin invert and the measured groundwater elevation?	☐ No; if checked, provide basis for finding ☐ Yes
3.d- Is there at least 100 feet separation from the proposed basin(s) and any known water supply wells?	☐ No; if checked, provide basis for finding ☐ Yes
3.e - Is the underlying soil and/or groundwater free from any known contamination?	☐ No; if checked, provide basis for finding ☐ Yes
3.f - Is there sufficient space to size or place an infiltration basin that: • Has slopes that are no steeper than 4:1, and • Is located at least 20 feet from roadway pavement and 100 feet from bridge structures?	☐ No; if checked, provide basis for finding ☐ Yes
3.g - For a project area that has high vehicular traffic (25,000 or more average daily traffic), can the planned infiltration basin meet the MS4 Permit's pretreatment of runoff requirements?	☐ No; if checked, provide basis for finding ☐ Yes
3.h - Can an infiltration basin be incorporated into the site plan in a manner that does not create traffic or pedestrian safety concerns?	☐ No; if checked, provide basis for finding ☐ Yes
3.i - Does inclusion of an infiltration basin detract from the aesthetics of the roadway or project area that cannot be mitigated?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for any of the above questions (3.b – 3.i), this BMP is infeasible • If "Yes" is checked for all of the above (3.b - 3.i), then this BMP is potentially feasible; continue to 3.j	
3.j – Are there any special maintenance, equipment, or experience requirements associated with the implementation of this BMP?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
3.k – If this BMP is implemented, will there be any one-time capital costs incurred, e.g., for new equipment required to maintain the BMP, that impacts project funding?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
3.l – Is there long-term funding available to maintain this BMP?	☐ Yes ☐ No
• If any of the findings from 3.j, 3.k or 3.l prevent the use of this BMP, then this BMP is infeasible; attach appropriate documentation as needed • If the findings from 3.j., 3.k, and 3.l do not prevent implementation of this BMP, then the BMP is feasible; incorporate into Table 7.1	

Table 5.2 – LID BMP Feasibility Analysis 4 – Bioretention Curb Extensions and Sidewalk Planters	
4.a – Are there any programmatic constraints that prevent the use of this BMP, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.? See Section 3.b of the Guidance.*	☐ Yes; if checked, provide basis for finding and STOP; this BMP is infeasible ☐ No; BMP is potentially feasible, continue to 4.b
4.b - Is there sufficient ROW to consider curb extensions?	☐ No; if checked, provide basis for finding ☐ Yes
4.c - Is there sufficient ROW to consider sidewalk planters?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 4.b <u>and</u> 4.c, then STOP - this BMP is infeasible; attach appropriate documentation support as needed • If "Yes" is checked for 4.b <u>or</u> 4.c, then this BMP is potentially feasible, continue on to 4.d	
4.d – Can the site be designed so that curb extensions or sidewalk planters tie into the existing drainage at the project site?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 4.d, then STOP - this BMP is infeasible; attach appropriate documentation support as needed • If "Yes" is checked for 4.d, then this BMP is potentially feasible, continue on to 4.e and 4.f	
4.e - Are irrigation water and power available to support bioretention area or sidewalk planters?	☐ No; if checked, provide basis for finding ☐ Yes
4.f - If irrigation water and power are not available, can the site support native vegetation that does not require irrigation?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 4.e <u>and</u> 4.f, then STOP - this BMP is infeasible • If "Yes" is checked for 4.e <u>or</u> 4.f, then this BMP is potentially feasible; continue on to 4.g	
4.g – Based on anticipated traffic capacity and MAS applicable to the project site, are there any traffic or pedestrian safety concerns that prevent application of this BMP?	☐ Yes; if checked, provide basis for finding ☐ No
• If "Yes" is checked for 4.g this BMP is infeasible • If "No" is checked for 4.g, then this BMP is potentially feasible; continue to 4.h.	
4.h – Are there any special maintenance, equipment, or experience requirements associated with the implementation of this BMP?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
4.i – If this BMP is implemented, will there be any one-time capital costs incurred, e.g., for new equipment required to maintain the BMP, that impacts project funding?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
4.j – Is there long-term funding available to maintain this BMP?	☐ Yes ☐ No
• If any of the findings from 4.h, 4.i <u>or</u> 4.j prevent the use of this BMP, then this BMP is infeasible; attach appropriate documentation as needed • If the findings from 4.h., 4.i, <u>and</u> 4.j do not prevent implementation of this BMP, then the BMP is feasible; incorporate into Table 7.1	

Table 5.2 – LID BMP Feasibility Analysis 5 – Sidewalk Trees and Tree Boxes	
5.a – Are there any or programmatic constraints that prevent the use of this BMP, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.? See Section 3.b of the Guidance.*	☐ Yes; if checked, provide basis for finding and STOP; this BMP is infeasible ☐ No; BMP is potentially feasible, continue to 5.b
5.b - Is there sufficient ROW to incorporate sidewalk trees or tree boxes into the project site?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 5.b, then STOP - this BMP is infeasible; attach appropriate documentation support as needed • If "Yes" is checked for 5.b, then this BMP is potentially feasible, continue on to 5.c and 5.d	
5.c - Are irrigation water and power available to support vegetation in the bioretention area or sidewalk planters?	☐ No; if checked, provide basis for finding ☐ Yes
5.d - If irrigation water and power are not available, can the site support native vegetation that does not require irrigation?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 5.c <u>and</u> 5.d, then STOP - this BMP is infeasible • If "Yes" is checked for 5.c <u>or</u> 5.d, then this BMP is potentially feasible; continue on to 5.e	
5.e – Based on anticipated traffic capacity and MAS applicable to the project site, are there any traffic or pedestrian safety concerns that prevent application of this BMP?	☐ Yes; if checked, provide basis for finding ☐ No
• If "Yes" is checked for 5.e this BMP is infeasible • If "No" is checked for 5.e, then this BMP is potentially feasible; continue to 5.f	
5.f – Are there any special maintenance, equipment, or experience requirements associated with the implementation of this BMP?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
5.g – If this BMP is implemented, will there be any one-time capital costs incurred, e.g., for new equipment required to maintain the BMP, that impacts project funding?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
5.h – Is there long-term funding available to maintain this BMP?	☐ Yes ☐ No
• If any of the findings from 5.f, 5.g <u>or</u> 5.h prevent the use of this BMP, then this BMP is infeasible; attach appropriate documentation as needed • If the findings from 5.f, 5.g <u>and</u> 5.h do not prevent implementation of this BMP, then the BMP is feasible; incorporate into Table 7.1	

Table 5.2 – LID BMP Feasibility Analysis 6 – Permeable Pavement	
6.a – Are there any or programmatic constraints that prevent the use of this BMP, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.? See Section 3.b of the Guidance.*	☐ Yes; if checked, provide basis for finding; STOP, this BMP is infeasible ☐ No; BMP is potentially feasible, continue to 6.b
6.b - Does the planned road project include any of the listed types of impervious surfaces (check all that apply)?	☐ Roadside parking/parking lane ☐ Driveways ☐ Sidewalks, walkways ☐ None of the above
• If "none of the above" is checked in 6.b, then STOP – BMP is infeasible • If any box other than "none of the above" is checked, BMP is potentially feasible; continue to 6.c	
6.c – Will any of the transportation surfaces checked in 6.b be subject to high traffic volume or heavy traffic loads that prevent the use of permeable pavement?	☐ Yes; if checked, provide basis for finding ☐ No
6.d – Do the underlying soils at the project site provide adequate infiltration capacity for use of this BMP while not causing structural concerns?	☐ No; if checked, provide basis for finding ☐ Yes
• If "Yes" is checked for 6.c <u>or</u> "No" is checked for 6.d, then STOP - this BMP is infeasible; attach appropriate documentation support as needed • If "No" is checked for 6.c <u>and</u> "Yes" is checked for 6.d, then this BMP is potentially feasible for all impervious surface types checked in 6.b; continue to 6.e • If "Yes" is checked for 6.c <u>and</u> 6.d <u>and</u> "sidewalks, walkways" was checked in 6.b, then this BMP is potentially feasible for sidewalk or walkway elements of the project; continue to 6.e	
6.e – Are there any special maintenance, equipment, or experience requirements associated with the implementation of this BMP?	☐ No; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ Yes
6.f – Will the BMP maintain an adequate service life (at least 5 years) such that the BMP is economically feasible?	☐ No; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ Yes
6.g – If this BMP is implemented, will there be any one-time capital costs incurred, e.g., for new equipment required to maintain the BMP, that impacts project funding?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
6.h – Is there long-term funding available to maintain this BMP?	☐ Yes ☐ No
• If any of the findings from 6.e, 6.f, 6.g <u>or</u> 6.h prevent the use of this BMP, then this BMP is infeasible; attach appropriate documentation as needed • If the findings from 6.e, 6.f, 6.g <u>and</u> 6.h do not prevent implementation of this BMP, then the BMP is feasible; incorporate into Table 7.1	

Table 5.3 – LID BMP Feasibility Analysis – Class I Bikeway and Sidewalks	
1 - Has the Class I Bikeway or sidewalk been designed to sheet-flow runoff onto adjacent permeable areas in a manner that will maximize opportunities for infiltration and filtration, while not channelizing or causing erosion?	☐ Yes; if checked, provide basis for finding, incorporate BMP into Table 7.1 ☐ No; if checked, provide basis for finding; continue on to Question 2.
2 - Has the Class I Bikeway or sidewalk been designed using the minimum width possible, given expected usage and considering public safety?	☐ Yes; if checked, provide basis for finding; incorporate BMP into Table 7.1; continue on to Questions 3 and 4. ☐ No; if checked, provide basis for finding; continue on to Questions 3 and 4.
3 - If trees are incorporated into the design of the Bikeway or sidewalk, have tree boxes been used?	☐ Yes; if checked, provide basis for finding; incorporate BMP into Table 7.1 ☐ No; if checked, provide basis for finding
4 - Do the underlying soils at the project site provide adequate infiltration capacity for use of some type of permeable pavement?	☐ No; if checked, BMP is infeasible; provide basis for finding ☐ Yes; if checked, continue on to Question 5
5 – Are there any project funding or programmatic constraints that prevent the use of permeable pavement in the project design, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.*?	☐ Yes; if checked, BMP is infeasible; provide basis for finding ☐ No; if checked, continue on to Question 6
6 – Are there any maintenance requirements, including long-term funding, that prevent the use of permeable pavement in the project design?	☐ Yes; if checked, BMP is infeasible; provide basis for finding ☐ No; if checked, include permeable pavement in the project design and incorporate the BMP into Table 7.1

Section 6 Source Control BMPs

Section 6 identifies source control BMPs potentially applicable to the proposed project. If this is strictly a road project, then only Part 1 needs to be filled out. Part 2 needs to be filled out if the road project includes bike path or sidewalk features adjoining or non-adjoining the road surface, or if the proposed project is only a Class I Bikeway or sidewalk project. The project reviewer should evaluate the applicability of each source control BMP and identify the agency responsible for implementing the BMPs once the project is constructed.

Table 6.1 - Source Control BMPs

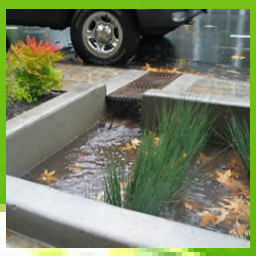
Source Control BMP	Check One		If not Included, Provide Basis	If Included, Agency Responsible for Implementation
	Included	Not Included		
Part 1: Category 3 or 4 Projects (other than Class I Bikeway or sidewalk projects)				
Irrigation System and Landscape Maintenance	☐	☐		
Sweeping of Transportation Surfaces adjoining curb and gutter	☐	☐		
Drainage Facility Inspection and Maintenance	☐	☐		
MS4 Stenciling and Signage	☐	☐		
Landscape and Irrigation System Design	☐	☐		
Protect Slopes and Channels	☐	☐		
Part 2: Class I Bikeway and Sidewalk Projects				
Public Education Program	☐	☐		
Use of Signage	☐	☐		
Installation and Maintenance of Trash Bins and Pet Waste Collection Bags	☐	☐		

Section 7 Project Summary

Table 7.1 summarizes and documents (a) applicability and use of LID-based BMPs in the project design; (b) applicable source control BMPs, and (c) known regulatory requirements that impacted the project design. Fill out the information relevant to the project type and provide supporting information where needed.

Table 7.1 – Project Summary (Category 3 & 4 Projects)		
☐ **Category 3 or Category 4 Project (other than Class I Bikeway or sidewalk projects)** Summarize the LID BMPs incorporated into the project design (based on the findings of the Table 5.2 - LID BMP Feasibility Analysis). For each LID BMP checked: ▪ Describe briefly how the LID BMP was incorporated; and ▪ Provide references to attachments or design plans (e.g., sheet numbers) where needed to support description	☐ Minimum Road Width	
	☐ Drainage Swales	Maintenance Responsibility:
	☐ Infiltration Basins	Maintenance Responsibility:
	☐ Bioretention Curb Extensions and Sidewalk Planters	Maintenance Responsibility:
	☐ Sidewalk Trees and Tree Boxes	Maintenance Responsibility:
	☐ Permeable Pavement	Maintenance Responsibility:
☐ **Class 1 Bikeway and Sidewalk Projects** Summarize the LID BMPs incorporated into the project design (based on the Table 5.3 - LID BMP Feasibility Analysis). For each BMP checked: ▪ Describe briefly how the LID BMP was incorporated; and ▪ Provide references to attachments or design plans (e.g., sheet numbers) as needed to support description	☐ Drain to Pervious Surfaces	
	☐ Minimum Width	
	☐ Use of Tree Wells	Maintenance Responsibility:
	☐ Permeable Pavement	Maintenance Responsibility:
Regulatory Requirements Document design elements that address any known regulatory requirements (see Table 3.1); if none, check the N/A box.	☐ Design elements affected by regulatory requirements Describe: ☐ N/A	
Source Control BMPs Summarize the applicable source controls and the agency responsible for implementation		
Documentation List all attachments that support this project summary		

C. Managing Wet Weather with Green Infrastructure: Green Streets (EPA 2008)



Managing Wet Weather with Green Infrastructure

Municipal Handbook

Green Streets

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Municipal Handbook

Green Streets

prepared by

Robb Lukes
Christopher Kloss
Low Impact Development Center

The Municipal Handbook is a series of documents
to help local officials implement green infrastructure in their communities.

December 2008

EPA-833-F-08-009

Front Cover Photos
Top: rain garden; permeable pavers; rain barrel;
planter; tree boxes.
Large photo: green alley in Chicago

Green Streets

Introduction

By design and function, urban areas are covered with impervious surfaces: roofs, roads, sidewalks, and parking lots. Although all contribute to stormwater runoff, the effects and necessary mitigation of the various types of surfaces can vary significantly. Of these, roads and travel surfaces present perhaps the largest urban pollution sources and also one of the greatest opportunities for green infrastructure use.

The Federal Highway Administration (FHA) estimates that more than 20% of U.S. roads are in urban areas.[1] Urban roads, along with sidewalks and parking lots, are estimated to constitute almost two-thirds of the total impervious cover and contribute a similar ratio of runoff.[2] While a significant source of runoff, roads are also a part of the infrastructure system, conveying stormwater along gutters to inlets and the buried pipe network. Effective road drainage, translated as moving stormwater into the conveyance system quickly, has been a design priority while opportunities for enhanced environmental management have been overlooked especially in the urban environment.

Table 1. Examples of Stormwater Pollutants Typical of Roads.[3, 4]

Pollutant	Source	Effects
Trash	---	Physical damage to aquatic animals and fish, release of poisonous substances
Sediment/solids	Construction, unpaved areas	Increased turbidity, increased transport of soil bound pollutants, negative effects on aquatic organisms reproduction and function
Metals • Copper • Zinc • Lead • Arsenic	 • Vehicle brake pads • Vehicle tires, motor oil • Vehicle emissions and engines • Vehicle emissions, brake linings, automotive fluids	Toxic to aquatic organisms and can accumulate in sediments and fish tissues
Organics associated with petroleum (e.g., PAHs)	Vehicle emissions, automotive fluids, gas stations	Toxic to aquatic organisms
Nutrients	Vehicle emissions, atmospheric deposition	Promotes eutrophication and depleted dissolved oxygen concentrations

The altered flow regime from traditional roadways, increased runoff volume, more frequent runoff events, and high runoff peak flows, are damaging to the environment and a risk to property downstream. These erosive flows in receiving streams will cause down cutting and channel shifting in some places and excessive sedimentation in others. The unnatural flow regime destroys stream habitat and disrupts aquatic systems.

Compounding the deliberate rapid conveyance of stormwater, roads also are prime collection sites for pollutants. Because roads are a component of the stormwater conveyance system, are impacted by atmospheric deposition, and exposed to vehicles, they collect a wide suite of pollutants and deliver them into the conveyance system and ultimately receiving streams (See Table 1). The metals, combustion by-products, and automotive fluids from vehicles can present a toxic mix that combines with the ubiquitous nutrients, trash, and suspended solids.

While other impervious surfaces can be replaced, for example using green roofs to decrease the amount of impervious roof surface, for the most part, impervious roads will, for some time to come, constitute a significant percentage of urban imperviousness because of their current widespread existence. Reducing road widths and other strategies to limit the amount of impervious surface are critical, but truly addressing road runoff requires mitigating its effects.

Green Streets achieve multiple benefits, such as improved water quality and more livable communities, through the integration of stormwater treatment techniques which use natural processes and landscaping.

Roads present many opportunities for green infrastructure application. One principle of green infrastructure involves reducing and treating stormwater close to its source. Urban transportation right-of-ways integrated with green techniques are often called "green streets". Green streets provide a source control for a main contributor of stormwater runoff and pollutant load. In addition, green infrastructure approaches complement street facility upgrades, street aesthetic improvements, and urban tree canopy efforts that also make use of the right-of-way and allow it to achieve multiple goals and benefits. Using the right-of-way for treatment also links green with gray infrastructure by making use of the engineered conveyance of roads and providing connections to conveyance systems when needed.

Green streets are beneficial for new road construction and retrofits. They can provide substantial economic benefits when used in transportation applications. Billions of dollars are spent annually on road construction and rehabilitation, with a large percentage focused on rehabilitation especially in urban areas. Coordinating green infrastructure installation with broader transportation improvements can significantly reduce the marginal cost of stormwater management by including it within larger infrastructure improvements. Also, and not unimportantly, right-of-way installations allow for easy public maintenance. A large municipal concern regarding green infrastructure use is maintenance; using roads and right-of-ways as locations for green infrastructure not only addresses a significant pollutant source, but also alleviates access and maintenance concerns by using public space.

In urban areas, roads present many opportunities for coordinated green infrastructure use. Some municipalities are capitalizing on the benefits gained by introducing green infrastructure in transportation applications. This paper will evaluate programs and policies that have been used to successfully integrate green infrastructure into roads and right-of-ways.

Green Street Designs

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

Alternative Street Designs (Street Widths)

A green street design begins before any BMPs are considered. When building a new street or streets, the layout and street network must be planned to respect the existing hydrologic functions of the land (preserve wetlands, buffers, high-permeability soils, etc.) and to minimize the impervious area. If retrofitting or redeveloping a street, opportunities to eliminate unnecessary impervious area should be explored.

Implementation Hurdles
Many urban and suburban streets, sized to meet code requirements for emergency service vehicles and provide a free flow of traffic, are oversized for their typical everyday functions. The Uniform Fire Code requires that streets have a *minimum 20 feet of unobstructed width;* a street with parking on both sides would require a width of at least 34 feet. In addition to stormwater concerns, wide streets have many detrimental implications on neighborhood livability, traffic conditions, and pedestrian safety.[5]

Oregon State Code Granting Authority for Street Standards to Local Government

ORS 92.044 - Local governments shall *supersede and prevail over any specifications and standards for roads and streets set forth in a uniform fire code adopted by the State Fire Marshal, a municipal fire department or a county firefighting agency....* Local governments shall consider the needs of the fire department or fire-fighting agency when adopting the final specifications and standards.

The Transportation Growth and Management Program of Oregon, through a Stakeholder Design Team, developed a guide for reducing street widths titled the *Neighborhood Street Design Guidelines.*[6] The document provides a helpful framework for cities to conduct an inclusive review of street design profiles with the goal of reducing widths. Solutions for accommodating emergency vehicles while minimizing street widths are described in the document. They include alternative street parking configurations, vehicle pullout space, connected street networks, prohibiting parking near intersections, and smaller block lengths.

Figure 1. The street-side swale and adjacent porous concrete sidewalk are located in the High Point neighborhood of Seattle, WA
(Source: Abby Hall, US EPA).

In 1997, Oregon, which has adopted the *Uniform Fire Code,* specifically granted local government the authority to establish alternative street design standards but requires them to consult with fire departments before standards are adopted. Table 2 provides examples of alternative street widths allowed in U.S. jurisdictions.[7]

Swales

Swales are vegetated open channels designed to accept sheet flow runoff and convey it in broad shallow flow. The intent of swales is to reduce stormwater volume through infiltration, improve water quality through vegetative and soil filtration, and reduce flow velocity by increasing channel roughness. In the simple roadside grassed form, they have been a common historical component of road design. Additional benefit can be attained through more complex forms of swales, such as those with amended soils, bioretention soils, gravel storage areas, underdrains, weirs, and thick diverse vegetation.

Implementation Hurdles
There is a common misconception of open channel drainage being at the bottom of a street development hierarchy in which curb and gutter are at the top. Seattle's Street Edge Alternative Project and other natural drainage swale pilot projects have demonstrated that urban swales not only mitigate stormwater impacts, but they can also enhance the urban environment.[8]

Table 2. Examples of Alternative Street Widths

Jurisdiction	Street Width	Parking Condition
Phoenix, AZ	28'	parking both sides
Santa Rosa, CA	30' 26'-28' 20' 20'	parking both sides, <1000ADT parking one side no parking neck downs @ intersection
Orlando, FL	28' 22'	parking both sides, res. Lots<55' wide parking both sides, res. Lots>55' wide
Birmingham, MI	26' 20'	parking both sides parking one side
Howard County, MD	24'	parking unregulated
Kirkland, WA	12' 20' 24' 28'	alley parking one side parking both sides – low density only parking both sides
Madison, WI	27' 28'	parking both sides, <3DU/AC parking both sides, 3-10 DU/AC

ADT: Average Daily Traffic DU/AC: dwelling units per acre

Bioretention Curb Extensions and Sidewalk Planters

Bioretention is a versatile green street strategy. Bioretention features can be tree boxes taking runoff from the street, indistinguishable from conventional tree boxes. Bioretention features can also be attractive attention grabbing planter boxes or curb extensions. Many natural processes occur within bioretention cells: infiltration and storage reduces runoff volumes and attenuates peak flows; biological and chemical reactions occur in the mulch, soil matrix, and root zone; and stormwater is filtered through vegetation and soil.

Figure 2. This bioretention area takes runoff from the street through a trench drain in the sidewalk as well as runoff from the sidewalk through curb cuts *(Source: Abby Hall, US EPA).*

Implementation Hurdles

A few municipal DOT programs have instituted green street requirements in roadway projects, but as of yet, specifications for street bioretention have not yet been incorporated into municipal DOT specifications. Many cities do have street bioretention pilot projects; two of the well documented programs are noted in the table. Several concerns and considerations have prevented standard implementation of bioretention by DOTs.

Table 3. Municipalities with Swale Specifications and Standard Details

Municipality	Document	Section Title	Section #
City of Austin[9]	Standard Specifications and Standard Details	Grass-Lined Swale and Grass-Lined Swale with Stone Center	627S
City of Seattle[10]	2008 Standard Specifications for Municipal Construction	Natural Drainage Systems	7-21

Table 4. Municipalities with Bioretention Pilot Projects in the Right-of-Way

Municipality	Bioretention Type	Document
Maplewood, MN	Rain gardens	*Implementing Rainwater in Urban Stormwater Management* [11]
Portland, OR	• Curb extensions • Planters • Rain gardens	*2006 Stormwater Management Facility Monitoring Report* [12]

The diversity of shapes, sizes, and layouts bioretention can take is a significant obstacle to their incorporation with DOT specifications and standards. Street configurations, topography, soil conditions, and space availability are some of the factors that will influence the design of the bioretention facility. These variables make documentation of each new bioretention project all the more important. By building a menu of templates from local bioretention projects, future projects with similar conditions will be easier to implement and cost less to design. The documentation should include copies of the details and specifications for the materials used. A section on construction and operation issues, costs, lessons learned, and recommendations for similar designs should also be included in project documentation. Portland's Bureau of Environmental Services has proven adept at documenting each of its Green Streets projects and making them accessible online.[13]

Utilities are a chief constraint to implementing bioretention as a retrofit in urban areas. The Prince George's County, MD Bioretention Design Specifications and Criteria manual recommends applying the same clearance criteria recommended for storm drainage pipes.[14] Municipal design standards should specify the appropriate clearance from bioretention or allowable traversing.

Prince George's County, MD - 2.12.1.16 Utility Clearance

Utility clearances that apply to storm drainage pipe and structure placement also apply to bioretention. Standard utility clearances for storm drainage pipes have been established at 1' vertical and 5' horizontal. However, bioretention systems are shallow, non-structural IMP's consisting of mostly plant and soil components, (often) with a flexible underdrain discharge pipe. For this reason, other utilities may traverse a bioretention facility without adverse impact. Conduits and other utility lines may cross through the facility but construction and maintenance operations must include safeguard provisions. In some instances, bioretention could be utilized where utility conflicts would make structural BMP applications impractical.

Plants are another common concern of municipal staff, whether it is maintenance, salt tolerance, or plant height with regard to safety and security. Cities actively implementing LID practices in public spaces maintain lists of plants which fit the vegetated stormwater management practice niche. These are plants that flourish in the regional climate conditions, are adapted to periodic flooding, are low maintenance, and, if in cold climates, salt tolerant. Most often these plants are natives, but sometimes an approved non-native will best fit necessary criteria. A municipal plant list should be periodically updated based on maintenance experience, and vegetation health surveys.

Permeable Pavement

Permeable pavement comes in four forms: permeable concrete, permeable asphalt, permeable interlocking concrete pavers, and grid pavers. Permeable concrete and asphalt are similar to their impervious counterparts but are open graded or have reduced fines and typically have a special binder added. Methods for pouring, setting, and curing these permeable pavements also differ from the impervious versions. The concrete and grid pavers are modular systems. Concrete pavers are installed with gaps between them that allow water to pass through to the base. Grid pavers are typically a durable plastic matrix that can be filled with gravel or vegetation. All of the permeable pavement systems have an aggregate base in common which provides structural support, runoff storage, and pollutant removal through filtering and adsorption. Aside from a rougher unfinished surface, permeable concrete and asphalt look very similar to their impervious versions. Permeable concrete and asphalt and certain permeable concrete pavers are ADA compliant.

Implementation Hurdles

Of all the green streets practices, municipal DOTs have been arguably most cautious about implementing permeable pavements, though it should be noted that some DOTs have, for decades, specified open-graded asphalt for low use roadways because of lower cost; to minimize vehicle hydroplaning; and to reduce road noise. The reticence to implement on a large-scale, however, is understandable given the lack of predictability and experience behind impervious pavements. However, improved technology, new and ongoing research, and a growing number of pilot projects are dispelling common myths about permeable pavements.

Figure 3. Pervious pavers used in the roadway of a neighborhood development in Wilsonville, OR *(Source: Abby Hall, US EPA).*

The greatest concern among DOT staff seems to be a perceived lack of long-term performance and maintenance data. Universities and DOTs began experimenting with permeable pavements in parking lots, maintenance yards, and pedestrian areas as early as twenty years ago in the U.S., even earlier in Europe. There is now a wealth of data on permeable pavements successfully used for these purposes in nearly every climate region of the country. In recent years, the cities of Portland, OR, Seattle, WA, and Waterford, CT and several private developments have constructed permeable pavement pilots within the roadway with positive results.

> Permeable pavement concerns in the roadway often raise concerns of safety, maintenance, and durability. Municipalities can replace impervious surfaces in other non-critical areas such as sidewalks, alleys, and municipal parking lots. These types of applications help municipalities build experience and a market for the technology.

The two typical maintenance activities are periodic sweeping and vacuuming. The City of Olympia, WA has experimented with several methods of clearing debris from permeable concrete sidewalks. Each of the methods was evaluated on the ease of use, debris removal, and the performance pace. The cost analysis by Olympia, WA found that the maintenance cost for pervious pavement was still lower than the traditional pavement when the cost of stormwater management was considered.

Table 5. Municipalities with Permeable Pavement Specifications and Standard Details

Municipality	Document	Section Title	Section #
Portland	2007 Standard Construction Specifications	Unit Pavers (includes permeable pavers)	00760
Olympia	WSDOT Specification	Pervious Concrete Sidewalks	8-30

Freeze/thaw and snow plows are the major concerns for permeable pavements in cold climate communities. However, these concerns have proven to be generally unwarranted when appropriate design and maintenance practices are employed. A well designed permeable pavement structure will always drain and never freeze solid. The air voids in the pavement allow plenty of space for moisture to freeze and ice crystals to expand. Also, rapid drainage through the pavement eliminates the occurrence of freezing puddles and black ice. Cold climate municipalities will need to make adjustments to snow plowing and deicing programs for permeable pavement areas. Snow plow blades must be raised enough to prevent scraping the surface of permeable pavements, particularly paver systems. Also, sand should not be applied.

Table 6. A Study in Olympia, WA Comparison of the cost of permeable concrete sidewalks to the cost of traditional impervious sidewalks[15]

Traditional Concrete Sidewalk		Permeable Concrete Sidewalk	
Construction Cost	Maintenance Cost	Construction Cost	Maintenance Cost
$5,003,000*	$156,000	$2,615,000*	$147,000
Total = $5,159,000 $101.16 per square yard		Total = $2,762,000 $54.16 per square yard	

*The cost of stormwater management (stormwater pond) for the added impervious surface is factored into the significantly higher cost of constructing the traditional concrete sidewalk. Maintenance of the stormwater pond is also factored into the traditional concrete sidewalk maintenance cost.

Sidewalk trees and tree boxes

From reducing the urban heat island effect and reducing stormwater runoff to improving the urban aesthetic and improving air quality, much is expected of street trees. Street trees are even good for the economy. Customers spend 12% more in shops on streets lined with trees than on those without trees.[16] However, most often street trees are given very little space to grow in often inhospitable environments. The soil around street trees often becomes compacted during the construction of paved surfaces and minimized as underground utilities encroach on root space. If tree roots are surrounded by compacted soils or are deprived of air and water by impervious streets and sidewalks, their growth will be stunted, their health will decline, and their expected life span will be cut short. By providing adequate soil volume and a good soil mixture, the benefits obtained from a street tree multiply. To obtain a healthy soil volume, trees can simply be provided larger tree boxes, or structural soils, root paths, or "silva cells" can be used under sidewalks or other paved areas to expand root zones. These allow tree roots the space they need to grow to full size. This increases the health of the tree and provides the benefits of a mature sized tree, such as shade and air quality benefits, sooner than a tree with confined root space.

Figure 4. Trees planted at the same time but with different soil volumes, Washington DC
(Source: Casey Trees)

Table 7. Healthy Tree Volume and Permeable Pavement Specifications and Standard Details

Jurisdictions	Minimum Soil Volume	Section Title	Section #
Prince William County, VA	Large tree 970 cf Medium tree 750 cf Small tree 500 cf	Design Construction Manual (Sec 800)	Table 8-8
Alexandria, VA	300 cf	Landscape Guidelines	II.B. (2)

Implementation Hurdles

Providing an adequate root volume for trees comes down to a trade off between space in the right-of-way and added construction costs. The least expensive way to obtain the volume needed for roots to grow to full size is providing adequate space unhindered by utilities or other encroachments. However, it is often hard to reserve space dedicated just to street trees in an urban right-of-way with so many other uses competing for the room they need. As a result, some creative solutions, though they cost more to install, have become useful alternatives in crowded subsurface space. Structural soils, root paths, and "silva cells" leave void space for roots and still allow sidewalks to be constructed near trees.

Root Paths can be used to increase tree root volume by connecting a small tree root volume with a larger subsurface volume nearby. A tunnel-like system extends from the tree underneath a sidewalk and connects to an open space on the other side.

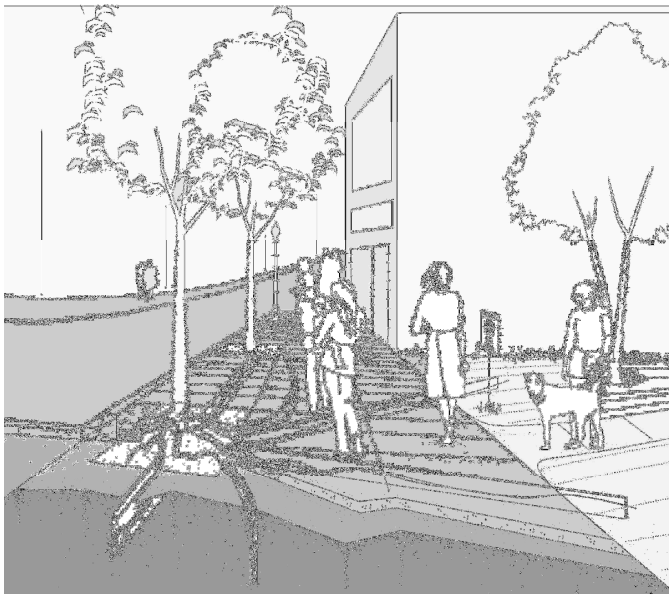

Figure 5. Root Paths direct tree roots under paving and into better soil areas for tree root growth
(Source: Arlington County, VA).

Silva Cells[17] are another option for supporting sidewalks near trees while still providing enough space for roots to grow. These plastic milk crate-like frames fit together and act as a supporting structure for a sidewalk while leaving room for uncompacted soil and roots inside the frame.

Permeable pavement sidewalks are another enhancement to the root space. They provide moisture and air to roots under sidewalks. Soils under permeable pavements can still become compacted. Structural soils[18] are a good companion tree planting practice to permeable pavement. When planting a tree in structural soils an adequate tree root volume is excavated and filled with a mix of stone and soil that still provides void space for healthy roots and allows for sidewalks, plazas or other paved surfaces to be constructed over them.

Case Studies

Portland, OR: Green Street Pilot Projects

Portland, Oregon is a national leader in developing green infrastructure. Portland's innovation in stormwater management was necessitated by the need to satisfy a Combined Sewer Overflow consent decree, Safe Drinking Water Act requirements, impending Total Maximum Daily Load limitations, Superfund cleanup measures and basement flooding. Through the 1990s, over 3 billion gallons of combined sewer overflow discharged to the Willamette River every year.[19] All of these factors plus leadership and local desires to create green solutions and industries compelled the city to implement green infrastructure as a complement to adding capacity to the sewer system with large pipe overflow interceptors. Despite gaps in long-term performance data, Portland took a proactive approach in implementing green infrastructure pilot projects.

Portland's green infrastructure pilot projects have their roots in the city's 2001 Sustainable Infrastructure Committee. The committee, consisting of representatives from Portland's three infrastructure management Bureaus, documented the city's ongoing efforts toward sustainable infrastructure, gathered research on green infrastructure projects from around the country, and identified opportunities for local pilots.[20, 21, 22]

Figure 6. Silva cell structures support the sidewalk while providing root space for street trees
(Source: Deep Root Partners, LP).

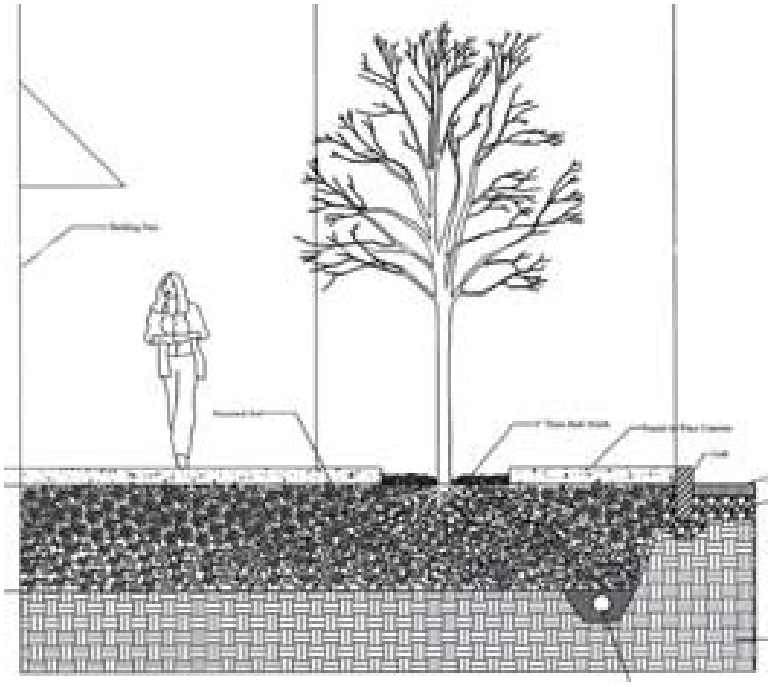

Figure 7. Structural soils provide void space for root growth and load-bearing for sidewalk
(Source: Urban Horticulture Institute, Cornell University).

One of the Bureau of Environmental Services' (BES) earliest green infrastructure retrofit projects within the right-of-way was a set of two stormwater curb extensions on NE Siskiyou Street. Portland had been retrofitting many streets with curb extensions for the purpose of pedestrian safety, but this was the first done for the purpose of treating street runoff. In a simulated 25-year storm event flow test, the curb extensions captured 85% of the runoff volume that would be discharged to the combined sewer system and reduced peak flow by 88%.[23]

Between 2003 and 2007, Portland designed and implemented a variety of Green Street pilots. Funding sources for these projects have come from BES, Portland Department of Transportation, U.S. EPA, and an Innovative Wet Weather Fund. BES combined funds with an EPA grant to create the Innovative Wet Weather Fund. In 2004, nearly $3 million from the Innovative Wet Weather Fund was budgeted for a long list of projects from city green roofs, public-private projects, and a number of pilot projects within the right-of-way.[24] Several pilots have been cost competitive with or less costly than conventional upgrades. The Bureau recognizes that costs will decrease once these projects become more routine. Many of the pilot project costs included one time costs such as the development of outreach materials and standard drawings.

Figure 8: NE Siskiyou Vegetated Curb Extensions
Source: City of Portland – Bureau of Environmental Services

Table 8. Portland, OR - Green Street Pilot Projects

Location	Design	Year Completed	Cost
NE Siskiyou b/w NE 35th Pl. and NE 36th Ave	Stormwater curb extension	2003	$20,000
3 blocks of the Westmoreland Neighborhood	Permeable Pavers in parking lanes and curb to curb	2004	$412,000
SE Ankeny b/w SE 56th and SE 57th Ave.	Stormwater curb extensions	2004	$11,946
NE Fremont b/w NE 131st and 132nd Av	Stormwater curb extension	2005	$20,400
SW 12th Ave b/w SW Montgomery and Mill	Stormwater planters	2005	$34,850
East Holladay Park	Pervious paver parking lot	2005	$165,000
4 blocks of North Gay Avenue b/w N Wygant and N Sumner	Porous concrete in curb lanes and curb to curb; porous asphalt in curb lanes and curb to curb	2005	--
SW Texas	Stormwater wetlands and swales	2007	$2.3 million
Division St. – New Seasons Market	Stormwater planters and swales	--	--
SE Tibbetts and SE 21st Ave.	Stormwater curb extension and planters	--	--

Source: Portland Bureau of Environmental Services, 2008
http://www.portlandonline.com/bes/index.cfm?c=44463&

Each of the pilot projects have been well documented by BES. A consistent format has been used to describe pilot background, features, engineering design, landscaping, project costs, maintenance, monitoring, and, most importantly, lessons learned. These case studies as well as other Green Street documentation can be found on BES's Sustainable Stormwater webpage, http://www.portlandonline.com/BES/index.cfm?c=34598. Due to physical factors (drainage, slope, soil, existing utilities, multiple uses) and development factors (retrofit, redevelopment, and new construction), there will be many variations on Green Streets. As part of the program, a continually updated Green Street Profile Notebook will catalog the successful green street projects. Users can use the Notebook for permitting guidance, to identify green streets facilities appropriate for various factors, but the document is not a technical document with standard details.

The Green Streets Team

The City of Portland, OR is widely acknowledged for long term, forward thinking, and comprehensive transportation and environmental planning. Portland recognized the fact that 66% of the City's total runoff is collected from streets and the right-of-way.[25] The city also saw the potential for transportation corridors to meet multiple objectives, including:

- Comprehensively address numerous City goals for neighborhood livability, sustainable development, increased green spaces, stormwater management, and groundwater protection;
- Integrate infrastructure functions by creating "linear parks" along streets that provide both pedestrian/bike areas and stormwater management;
- Avoid the key impacts of unmanaged stormwater whereby surface waterbodies are degraded, and water quality suffers;
- Manage stormwater with investments citizens can support, participate in, and see;
- Manage stormwater as a resource, rather than a waste;
- Protect pipe infrastructure investments (extend the life of pipe infrastructure, limit the additional demand on the combined sewer system as development occurs);
- Protect wellhead areas by managing stormwater on the surface; and
- Provide increased neighborhood amenities and value.

In a two phased process from 2005 to 2007, the Green Streets Team, a cross agency and interdisciplinary team, developed a comprehensive green streets policy and a way forward for the green streets agenda. Phase 1 identified challenges and issues and began a process for addressing them. Barriers to the public initiation of green street projects included a code and standards that would disallow or discourage green street strategies, long term performance unknowns, and maintenance responsibilities. To address these barriers, the Green Streets Team organized into subgroups focusing on outreach, technical guidance, infrastructure, maintenance, and resources.

Phase 2 of the Green Streets project synthesized the opportunities and solutions identified in Phase 1 into a citywide Green Streets Program. The first priority for this phase was the drafting of a binding citywide policy. The resolution was adopted by the Portland City Council in March 2007.

Prior to the start of the Portland effort, 90% of implemented green street projects were issued by private permits rather than city initiated projects.

Six Approaches to Implementing Green Streets	
Pathway	**Implementation**
City-initiated street improvement projects	City designs, manages, maintains
City-initiated stormwater retrofits	City designs, manages, maintains
Neighborhood-initiated LIDs	
Developer-initiated subdivisions with public streets	Developer designs and builds via City permit and review process, then turns over new right of way to the City after warranty period
Developer-initiated subdivisions with private streets	Developer designs and builds via City permit and review process, and turns over to home-owner association
Developer-related initiated frontage improvements on existing public streets	Developer designs and builds new sidewalks and curbs via City permit and review process, usually because the City required it via a building permit or via a land division

Source: Portland Green Streets, Phase 1

Portland City Council Approved Green Streets Policy

Goal: City of Portland will promote and incorporate the use of green street facilities in public and private development.

City elected officials and staff will:

1. Infrastructure Projects in the Right of Way:

   a. Incorporate green street facilities into all City of Portland funded development, redevelopment or enhancement projects as required by the City's September 2004 (or updated) Stormwater Management Manual. Maintain these facilities according to the May 2006 (or updated) Green Streets Maintenance Policy.

      If a green street facility (infiltrating or flow through) is not incorporated into the Infrastructure Project, or only partial management is achieved, then an off site project or off site management fee will be required.

   b. Any City of Portland funded development, redevelopment or enhancement project, that does not trigger the Stormwater Manual but requires a street opening permit or occurs in the right of way, shall pay into a "% for Green" Street fund. The amount shall be 1% of the construction costs for the project.
      Exceptions: Emergency maintenance and repair projects, repair and replacement of sidewalks and driveways, pedestrian and trail replacement, tree planting, utility pole installation, street light poles, traffic, signal poles, traffic control signs, fire hydrants, where this use of funds would violate contracted or legal restrictions.

2. Project Planning and Design:

   a. Foster communication and coordination among City Bureaus to encourage consideration of watershed health and improved water quality through use of green street facilities as part of planning and design of Bureau projects.
   b. Coordinate Bureau work programs and projects to implement Green Streets as an integrated aspect of City infrastructure.
   c. Plan for large-scale use of Green Streets as a means of better connecting neighborhoods, better use of the right of way, and enhancing neighborhood livability.
   d. Strive to develop new and innovative means to cost-effectively construct new green street facilities.
   e. Develop standards and incentives (such as financial and technical resources, or facilitated permit review) for Green Streets projects that can be permitted and implemented by the private sector. These standards and incentives should be designed to encourage incorporation of green street facilities into private development, redevelopment and enhancement projects.

3. Project and Program Funding:

   a. Seek opportunities to leverage the work and associated funding of projects in the same geographic areas across Bureaus to create Green Street opportunities.
   b. Develop a predictable and sustainable means of funding implementation and maintenance of Green Street projects.

4. Outreach:

   a. Educate citizens, businesses, and the development community/industry about Green Streets and how they can serve as urban greenways to enhance, improve, and connect neighborhoods to encourage their support, demand and funding for these projects.
   b. Establish standard maintenance techniques and monitoring protocols for green street facilities across bureaus, and across groups within bureaus.

5. Project Evaluation:

   a. Conduct ongoing monitoring of green street facilities to evaluate facility effectiveness as well as performance in meeting multiple City objectives for:
      - Gallons managed;
      - Projects distributed geographically by watershed and by neighborhood; and

The second priority for Phase 2 was developing communication and planning procedures for incorporating multi-bureaus plans into the scheduled Portland DOT Capital Improvement Program (CIP). Three timeframes for green street project planning were recommended. In the short term, the CIP Planning Group, backed by the citywide policy directive, will shift to a focus on "identifying and evaluating opportunities to partner." For example, coordinating Water Bureau and BES pipe replacement

projects with DOT maintenance, repair, and improvement projects. The mid-term approach is more proactive and involves forecasting potential green street projects using existing bureau data and GIS tools. As for the long term, green street objectives will be incorporated into the citywide systems plan which guides city bureaus for the next 20 years.

The Green Street Team methodology propelled Portland's early green street pilot projects into a comprehensive, citywide multi-bureau program. The program built on previous efforts by the Sustainable Infrastructure Committee as well as other efforts such as the 2005 Portland Watershed Management Plan, established a City Council mandated policy, and institutionalized green street development. The outcome of this approach is multi-agency buy-in and responsibility for the effort. For instance, because of their knowledge of plant maintenance, Portland Parks and Recreation is responsible for the maintenance of some DOT installations.

Chicago, IL: Green Alleys Program

The City of Chicago, Illinois has an alley system that is perhaps the largest in the world. These 13,000 publicly owned alleys result in 1,900 miles, or 3,500 acres, of impermeable surfaces in addition to the street network. Because the alley system was not originally paved, there are no sewer connections as part of the original design. Over time the alleys were paved and flooding in garages and basements began to occur as a result of unmanaged stormwater runoff. Since the city already spends $50 million each year to clean and upgrade 4,400 miles of sewer lines and 340,000 related structures, the preferred solution to the flooded alleys is one that doesn't put more stress on an already overburdened and expensive sewer system.[26]

In 2003, the Chicago Department of Transportation (CDOT) used permeable pavers and French drain pilot applications to remedy localized flooding problems in alleys in the 48th Ward.[27] These applications proved to be successful and by 2006, CDOT launched its Green Alley Program with the release of the Chicago Green Alley Handbook (Handbook).[28]

The Chicago Green Alley Program is unique because it marries green infrastructure practices in the public right-of-way with green infrastructure efforts on private property. The user-friendly Handbook, which describes both facets of the program including the design techniques and their benefits, is an award winning document. The American Society of Landscape Architects awarded the creators of the Handbook the 2007 Communications Honor Award for the clear graphics and simple, yet effective, message.[29] The Handbook explains to the residents why green infrastructure is important, how to be good stewards of the Green Alley in their neighborhood, and what sorts of "green" practices they can implement on their property to reduce waste, save water, and help manage stormwater wisely.

While the initial impetus behind the Green Alley Program was stormwater management, Chicago decided to use this opportunity to address other environmental concerns as well as reducing the urban heat island effect, recycling, energy conservation, and light pollution.

Green Infrastructure in the Right-of-Way

Chicago's Green Alley Program uses the following five techniques in the public right-of-way to "green" the alley:

1. Changing the grade of the alley to drain to the street rather than pond water in the alley or drain toward garages or private property.
2. Using permeable pavement that allows water to percolate into the ground rather than pond on the surface.
3. Using light colored paving material that reflects sunlight rather than adsorbing it, reducing urban heat island effect.

4. Incorporating recycled materials into the pavement mix to reduce the need for virgin materials and reduce the amount of waste going into the landfill.

5. Using energy efficient light fixtures that focus light downward, reducing light pollution.

Figure 9: Permeable Asphalt Installation Using Ground Tire Rubber.
Source: Chicago Department of Transportation, Sustainable Development Initiatives; Streetscape and Urban Design Program, CDOT Division of Project Development.

Four design approaches were created using these techniques. Based on the local conditions, the most appropriate approach is selected. In areas where soils are well-draining, permeable pavement is used. In areas where buildings come right up to the edge of pavement and infiltrated water could threaten foundations, impermeable pavement strips are used on the outside with a permeable pavement strip down the middle. In areas where soils do not provide much infiltration capacity, the alley is regraded to drain properly and impermeable pavement made with recycled materials is used. Another approach utilizes an infiltration trench down the middle of the alley. Light colored (high albedo) pavement, recycled materials, and energy efficient, glare reducing lights are a part of each design approach.

Green Infrastructure on Private Property
The Handbook also describes actions that property owners can take to "green" their own piece of Chicago. The Handbook describes the costs, benefits, and utility of the following practices:

- Recycling;
- Composting;
- Planting a tree;
- Using native landscape vegetation;
- Constructing a rain garden;
- Installing a rain barrel;
- Using permeable pavement for patios;
- Installing energy efficient lighting; and
- Utilizing natural detention.

By bringing this wide range of "green" practices to the attention of homeowners, the positive impacts of the Green Alley Program spread beyond the boundaries of the right-of-way, increasing awareness and providing practical resources to help community members be a part of the solution.

Chicago Green Alley Cost Considerations
When the program began in 2006, repaving the alleys with impermeable pavement ranged in cost from $120,000 to $150,000, whereas a total Green Alley reconstruction was more along the lines of $200,000 to $250,000.[30] While less expensive conventional rehabilitation options may seem more attractive, they don't provide a solution to the localized flooding issues or the combined sewer system overflow problems. Sewer system connections could be established to solve the localized flooding problem, but it would add to the already overburdened sewer system and increase the cost of the reconstruction to that of the impermeable alley option. Consequently, the higher priced Green Alley option proved to be the best investment as it has multiple benefits in addition to solving localized flooding and reducing flow into the combined sewer system. The additional benefits of the Green Alley Program include not only urban heat

island effect reduction, material recycling, energy conservation, and light pollution reduction, but also the creation of a new market.

In 2006, when the Green Alley Program began, the city paid about $145 per cubic yard of permeable concrete. Just one year later, the cost of permeable concrete had dropped to only $45 per cubic yard. Compared with the cost of ordinary concrete, $50 per cubic yard, permeable concrete may have seemed like an infeasible option in the past to customers wanting to purchase concrete.[31] After the city's initial investment in the local permeable concrete market, the product cost has come down making permeable concrete a more affordable option for other consumers besides the city. This has resulted in an increased application of permeable concrete throughout the region.

Figure 10: Permeable Pavers and Permeable Concrete Chicago Alleys
(Source: Abby Hall, US EPA)

The success of the Chicago Green Alley Program is evident. Not only are the alleys been "greened" as a result of the program, the surrounding properties and even the surrounding neighborhoods are experiencing the positive impacts of the program's implementation.

Conclusions and Recommendations

Incorporating green streets as a feature of urban stormwater management requires matching road function with environmental performance. Enhancing roads with green elements can improve their primary function as a transportation corridor while simultaneously mitigating their negative environmental impacts. In theory and practice many municipalities are not far removed from dedicated green streets programs. Street tree and other greenscaping programs are often identified and promoted along urban transportation corridors. Adapting them to become fully functional green streets requires minor design modifications and an evaluation of how to maximize the benefits of environmental systems.

Portland's green streets program demonstrates how common road and right-of-way elements (e.g., traffic calming curb extensions, tree boxes) can be modified and optimized to provide stormwater management in addition to other benefits. The curb cuts and design variations to allow runoff to enter the vegetated areas are subtle changes with a significant impact and demonstrate how stormwater can be managed successfully at the source. One of the biggest successes of the program was reassessing common design features and realizing that environmental performance can be improved by integrating stormwater management.

Where Portland used vegetation, Chicago's Green Alley Program similarly demonstrates that hardscape elements can be an integral part of a greening program. By incorporating permeable pavements that simulate natural infiltration, Chicago enhances the necessary transportation function of alleys while enhancing infrastructure and environmental management. Portland also contrasts the "soft" and "hard"

elements of green streets by using both permeable pavements and vegetated elements. The green options available demonstrate the flexibility of green infrastructure to satisfy road function and environmental objectives and highlight why transportation corridors are well suited for green infrastructure.

Elements necessary for a successful green streets program:

- **Pilot projects are critical.** The most successful municipal green street programs to date all began with well documented and monitored pilot projects. These projects have often been at least partially grant funded and receive the participation of locally active watershed groups working with the city infrastructure programs. The pilot projects are necessary to demonstrate that green streets can work in the local environment, can be relied upon, and fit with existing infrastructure. Pilot projects will help to dispel myths and resolve concerns.
- **Leadership in sustainability from the top.** The cities with the strongest green streets programs are those with mayors and city councils that have fully bought into sustainable infrastructure. Council passed green policies and mayoral sustainability mandates or mission statements are needed to institutionalize green street approaches and bring it beyond the token green project.
- **Buy-in from all municipal infrastructure departments.** By their nature, green streets cross many municipal programs. Green street practices impact stormwater management, street design, underground utilities, public lighting, green space planning, public work maintenance, and budgeting. When developing green streets, all of the relevant agencies must be represented. Also, coordination between the agencies on project planning is important for keeping green infrastructure construction costs low. Superior green street design at less cost occurs when sewer and water line replacement projects can be done in tandem with street redevelopment. These types of coordination efforts must happen at the long-term planning stage.
- **Documentation.** Green street projects need to be documented on two levels, the design and construction level and on a citywide tracking level. Due to the different street types and siting conditions, green street designs will take on many variations. By documenting the costs, construction, and design, the costs of similar future projects can be minimized and construction or design problems can be avoided or addressed. Tracking green street practices across the city is crucial for managing maintenance and quantifying aggregate benefits.
- **Public outreach.** Traditional pollution prevention outreach goes hand in hand with green street programs. Properly disposing of litter, yard waste, and hazardous chemicals and appropriately applying yard chemicals will help prolong the life of green street practices. An information campaign should also give the public an understanding of how green infrastructure works and the benefits and trade offs. In many cases, remedial maintenance of green street practices will be performed by neighboring property owners; they need to know how to maintain the practices to keep them performing optimally.

As public spaces, roads are prime candidates for green infrastructure improvements. In addition to enabling legislation, and technical guidance, developing a green streets program requires an institutional re-evaluation of how right-of-ways are most effectively managed. This process typically includes:

- Assessing the necessary function of the road and selecting the minimum required street width to reduce impervious cover;
- Enhancing streetscaping elements to manage stormwater and exploring opportunities to integrate stormwater management into roadway design; and
- Integrating transportation and environmental planning to capitalize on economic benefits.

The use of green streets offers the capability of transforming a significant stormwater and pollutant source into an innovative treatment system. Green streets optimize the performance of public space easing maintenance concerns and allowing municipalities to coordinate the progression and implementation of stormwater control efforts. In addition, green streets optimize the performance of both the transportation and water infrastructure. Effectively incorporating green techniques into the transportation network provides significant opportunity to decrease infrastructure demands and pollutant transport.

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EXHIBIT E:

WQMP Applicability Checklist

EXHIBIT F:

WQMP Review Checklist

Checklist for Identifying Projects Requiring a Project-Specific WQMP within the Santa Ana Region

Project File No.:	
Project Name:	
Project Location:	
Project Description:	

Proposed Project Consists of or Includes:	Yes	No
Significant Redevelopment: The addition or replacement of 5,000 square feet or more of impervious surface on an already developed site. Does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of the constructed facility or emergency redevelopment activity required to protect public health and safety.		
Residential developments that create 10,000 square feet or more of impervious surface (collectively over the entire project site), including residential housing subdivisions requiring a Final Map (i.e., detached single family home subdivisions, multi-family attached subdivisions, condominiums, or apartments, etc.).		
New industrial and commercial development where the land area[1] represented by the proposed map or permit is 10,000 square feet or more.		
Mixed use developments that create 10,000 square feet or more of impervious surface (collectively over the entire project site).		
Automotive repair shops [Standard Industrial Classification (SIC) codes[2] 5013, 5014, 5541, 7532, 7533, 7534, 7536, 7537, 7538, and 7539].		
Restaurants (SIC code 5812) where the land area of development is 5,000 square feet or more.		
Hillside developments disturbing 5,000 square feet or more which are located on areas with known erosive soil conditions or where the natural slope is 25 percent or more.		
Developments of 2,500 square feet or more impervious surface. "Directly" means situated within 200 feet of the ESA; "discharging directly" means outflow from a drainage conveyance system that is composed entirely of flows from the subject development or redevelopment site, and not commingled with flows from adjacent lands.		
Parking lots of 5,000 square feet or more exposed to stormwater, where "parking lot" is defined as a land area or facility for the temporary parking or storage of motor vehicles.		
Retail Gasoline Outlets that are either 5,000 square feet or more of impervious surface with a projected average daily traffic of 100 or more vehicles per day.		
Public Projects, other than Transportation Projects, that are implemented by a Permittee and similar in nature to the priority projects described above and meets the thresholds described herein.		

1 Land area is based on acreage disturbed.

2 Descriptions of SIC codes can be found at http://www.osha.gov/pls/imis/sicsearch.html.

DETERMINATION: Circle appropriate determination

Any questions answered "YES" → Project requires a project-specific WQMP.

All questions are answered "NO" → Project requires incorporation of Site Design BMPs and Source Control BMPs imposed through Conditions of Approval or permit conditions.

EXHIBIT G:

Glossary

Glossary

Best Management Practice (BMP)	Any procedure or device designed to minimize the quantity of pollutants that enter the storm drain system or to control stormwater flow. See Chapter Two.
California Stormwater Quality Association (CASQA)	Publisher of the California Stormwater Best Management Practices Handbooks, available at www.cabmphandbooks.com.
Condition(s) of Approval (COA)	Requirements a Co-Permittee may adopt for a project in connection with a discretionary action (e.g., adoption of an EIR or negative declaration or issuance of a use permit). COAs may specify features required to be incorporated into the final plans for the project and may also specify uses, activities, and operational measures that must be observed over the life of the project.
Design Capture Volume (DCV)	The volume of runoff resulting from the Design Storm. This volume must be captured within Stormwater BMPs to achieve pollutant removal to the MEP. The DCV will depend Design Storm rainfall depth (using Exhibit A) and the types of post-development surfaces on the site. Reducing impervious surfaces on the site will reduce the DCV.
Design Flow Rate	The flow rate resulting from an hourly rainfall intensity of 0.2 inches per hour. The design flow rate will depend on the types of post-development surfaces on the site. Flow-based BMP designs can only be used when implementing conventional Treatment Control BMPs
Design Storm	The 85th percentile 24-hour storm depth, based on local historical rainfall records. See Exhibit A
Detention	The practice of holding stormwater runoff in ponds, vaults, within berms, or in depressed areas and letting it discharge slowly to the storm drain system.
Directly Connected Impervious Area	Any impervious surface which drains into a catch basin, area drain, or other conveyance structure without first allowing flow across pervious areas (e.g. lawns).
Discretionary Approval	Means a project which requires the exercise of judgment or deliberation when the public agency or body decides to approve or disapprove a particular activity, as distinguished from situations where the public agency or body merely has to determine whether there has been conformity with applicable statutes, ordinances, or regulations. Check with the Co-Permittee to determine if a particular action is considered Discretionary.
Drainage Management Area (DMA)	Individual, discrete drainage areas that typically follow grade breaks and roof ridge lines.
Drawdown Time	The time required for a stormwater detention or infiltration facility to drain and return to the dry-weather condition. For detention BMPs, drawdown time is a function of basin volume and outlet orifice size. For infiltration BMPs, drawdown time is a function of basin volume and infiltration rate. For harvest and use BMPs, drawdown time is a function of the cistern volume and the demand for use of captured stormwater.
EIATIA	Effective Impervious Area To Irrigated Area that would be required to achieve the minimum 40% long-term retention of runoff when harvesting stormwater runoff for outdoor irrigation. See Chapter 2.

Evapotranspiration	The process of transferring moisture from the earth to the atmosphere by evaporation of water and transpiration from plants..
Final WQMP	Prior to recordation of the final map parcel map or issuance of building permit and for any subsequent applications for discretionary approvals. See also ***Preliminary WQMP***
Head	In hydraulics, energy represented as a difference in elevation. In slow-flowing open systems, such as storm drains and Treatment BMPs, the difference in water surface elevation, e.g., between an inlet and outlet.
Historic High Groundwater Mark	The groundwater elevation expected due to a normal wet season and shall be obtained by boring logs or test pits.
Hydrograph	Runoff flow rate plotted as a function of time.
Hydromodification Management Plan (HMP)	A Plan implemented so that projects will not cause increased runoff that would result in increased potential for erosion or other adverse impacts to beneficial uses.
Hydrologic Condition of Concern (HCOC)	An HCOC exists when the alteration of a site's hydrologic regime caused by development would cause significant impacts on downstream channels and aquatic habitats, alone or in conjunction with impacts of other projects. Whether a project creates an HCOC or not can be assessed using the criteria identified in Chapter 2.
Hydrologic Soil Group (HSG)	Classification of soils by the Natural Resources Conservation Service (NRCS) into A, B, C, and D groups according to infiltration characteristics.
Impervious surface	Any surface in the landscape that cannot effectively absorb or infiltrate urban runoff; for example conventional paved: sidewalks, rooftops, roads, and parking areas.
Infiltration	Seepage of runoff through soil to mix with groundwater.
Infiltration Rate	Rate at which water can be added to a soil without creating runoff (in/hr). Verify with the Co-Permittee regarding acceptable methods for testing infiltration rates.
Integrated Pest Management (IPM)	A decision-making process for managing pests that combines biological, cultural, mechanical, physical, and chemical tools and other management practices to control pests in a safe, cost effective, and environmentally sound manner that contributes to the protection of public health
K_{SAT}	See ***Saturated Hydraulic Conductivity***.
Lead Agency	The public agency that has the principal responsibility for carrying out or approving a project. (California Environmental Quality Act Guidelines §15367).
Low Impact Development (LID)	A set of technologically feasible and cost-effective approaches to stormwater management and land development that combine a hydrologically functional site design with Pollution Prevention measures to compensate for land development impacts on hydrology and water quality. LID techniques mimic the site's predevelopment hydrology by using site design techniques that store, infiltrate, evapotranspire, bio-treat, bio-filter, bio-retain or detain runoff close to its source.
LID Principles	LID Principles are site design concepts that help prevent or minimize the causes (or drivers) of project impacts, and help mimic the pre-development hydrology. Implementing LID Principles will help minimize the need for specific ***Stormwater BMPs*** on a project.

LID BMPs	A type of ***stormwater BMP*** that is based upon ***Low Impact Development*** concepts. LID BMPs not only provide highly effective ***treatment*** of stormwater runoff, but also yield potentially significant reductions in runoff volume – helping to mimic the pre-project hydrologic regime, and also require less ongoing maintenance than ***Treatment Control BMPs***. See discussion in Chapter 2.
Maximum Extent Practicable (MEP)	Standard, established by the 1987 amendments to the Clean Water Act, for the reduction of pollutant discharges from municipal storm drains. Also see Chapter Two.
Municipal Separate Storm Sewer System (MS4)	A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) as defined in 40 CFR 122.26(b)(8).
National Pollutant Discharge Elimination System (NPDES)	As part of the 1972 Clean Water Act, Congress established the NPDES Permitting system to regulate the discharge of pollutants from municipal sanitary sewers and industries. The NPDES was expanded in 1987 to incorporate permits for stormwater discharges as well. (aka MS4 Permits)
Numeric Criteria	Sizing requirements for ***Stormwater BMPs*** established in Provision XII.D.4 of the Santa Ana Region MS4 Permit. ***LID BMPs*** and Volume-based Treatment Control BMPs are to be sized to the ***Design Capture Volume***, and Flow-based Treatment Control BMPs are to be sized to the ***Design Flow Rate***
Operation and Maintenance (O&M)	Refers to requirements in Provision XII.K of the Santa Ana Region MS4 Permit to inspect Treatment BMPs and implement preventative and corrective maintenance in perpetuity. See Chapter Six.
Percolation Rate	The rate at which water flows through a soil.
Permeable or Pervious or Porous Pavements	Pavements for roadways, sidewalks, or plazas that are designed to infiltrate runoff, including pervious concrete, pervious asphalt, porous pavers, and granular materials.
Permeability	The rate at which water flows through a saturated soil under steady state conditions.
Pre-Approved Project	Projects that have been submitted to the Co-Permittees and have an approved preliminary Project-Specific WQMP by the date of Regional Board approval of the WQMP for the 2010 Santa Ana Region MS4 Permit. For additional information see Chapter 1.
Preliminary WQMP	A preliminary WQMP is commonly required to be submitted with an application for entitlements and development approvals and must be approved by the Co-Permittee before any approvals or entitlements will be granted.
Pre-Project	Conditions that exist on a project site immediately before the project to which Co-Permittee approvals apply.
Priority Development Project	New development and significant re-development projects that meet the categories and criteria identified in Table 1-1.
Project-Specific Water Quality Management Plan	A plan specifying and documenting permanent LID Principles and Stormwater BMPs to control post-construction pollutants and stormwater runoff for the life of the project, and to maintain Stormwater BMPs for the life of the project. Co-Permittees may require a preliminary Project-Specific WQMP submittal, to be followed by a final Project-Specific WQMP.

Proprietary Stormwater Treatment BMPs	Products designed and marketed by private businesses for treatment of stormwater. Many of these products require complicated or proprietary maintenance and many do not meet requirements of the Santa Ana Region Permit for typical applications. Check with the Co-Permittee before proposing to use Proprietary Stormwater Treatment BMPs
Rational Method	A method of calculating runoff flows based on rainfall intensity, tributary area, and a coefficient representing the proportion of rainfall that runs off.
Regional Water Quality Control Board (Regional Water Board or RWQCB)	California RWQCBs are responsible for implementing pollution control provisions of the Clean Water Act and California Water Code within their jurisdiction. There are nine California RWQCBs. Portions of Riverside County are within the jurisdiction of three RWQCBs: the Santa Ana Region, the San Diego Region, and the Colorado River Basin Region. The Regional Water Board issues MS4 Permits to the Cities and County of Riverside. Those MS4 Permits require the creation and implementation of the requirements of this WQMP.
Santa Ana Region	The portion of Riverside County covered by Order R8-2010-0033, an NPDES MS4 Permit issued by the Santa Ana Regional Water Quality Control Board.
Saturated Hydraulic Conductivity	The velocity at which water moves through a soil when subjected to a hydraulic gradient.
Self-retaining area	An area designed to retain runoff. Self-retaining areas may include graded depressions with landscaping or pervious pavements.
Self-treating area	Natural, or landscaped area that drains overland off-site or directly to the storm drain system.
Source Control	A facility or procedure to prevent pollutants from entering runoff.
Stormwater BMPs	Stormwater BMPs are Structural Post-Construction BMPs that are designed to meet minimum ***numeric criteria*** for the addressing stormwater runoff identified in WQMP. Stormwater BMPs are either ***LID BMPs*** or ***Treatment Control BMPs***.
Stormwater Pollution Prevention Plan (SWPPP)	A plan providing for temporary measures to control sediment and other pollutants *during* construction.
Treatment	Removal of pollutants from runoff
Treatment Control BMPs	A type of ***stormwater BMP*** that provides ***treatment*** of stormwater runoff. Treatment Control BMPs, while designed to treat particular pollutants, typically do not provide the same level of volume reduction as ***LID BMPs***, and commonly require more specialized maintenance than LID BMPs. As such, the MS4 Permit and this WQMP require the use of LID BMPs wherever feasible, before Treatment Control BMPs can be considered or implemented.
Total Maximum Daily Load (TMDL)	A TMDL is the maximum amount of a Pollutant that can be discharged into a waterbody from all sources (point and non-point) and still maintain Water Quality Standards. Under CWA Section 303(d), TMDLs must be developed for all waterbodies that do not meet Water Quality Standards after application of technology-based controls.
TUTIA	Toilet Users To Impervious Area ratio, that would be required to achieve the minimum 40% long-term retention of runoff when harvesting stormwater runoff for toilet use. See Chapter 2.

WEF Method A method for determining the minimum design volume of Stormwater Treatment BMPs, recommended by the Water Environment Federation and American Society of Civil Engineers. Described in *Urban Runoff Quality Management*. This method is not used by this WQMP and is defined for reference only.

Water Board See ***Regional Water Quality Control Board.***