



# STORMWATER C.3 GUIDEBOOK

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*Stormwater Quality Requirements for Development Applications*

8<sup>th</sup> Edition

December 23, 2022

Visit [www.cccleanwater.org](http://www.cccleanwater.org) for updates.

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# Stormwater C.3 Guidebook

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## Contra Costa Clean Water Program

925-313-2360

*This Guidebook is referenced in stormwater ordinances adopted by*

Antioch  
Brentwood  
Clayton  
Concord  
Danville  
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Richmond  
San Pablo  
San Ramon  
Walnut Creek  
Contra Costa County  
Contra Costa County Flood Control and Water Conservation District

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**8<sup>TH</sup> EDITION —**

**DEC 23, 2022**

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## Stormwater Glossary

Bay Area Hydrology Model (BAHM)	A software tool for design of flow control structures to meet hydromodification management requirements for new development or redevelopment projects.
Bay Area Municipal Stormwater Collaborative (BAMSC) --successor to the Bay Area Stormwater Management Agencies Association (BASMAA)	Informal collaborative of Bay Area municipal stormwater programs, including the Contra Costa Clean Water Program. BAMSC implements various regional activities mandated by the Municipal Regional Permit, provides a forum for promoting regional consistency among stormwater programs, and coordinates negotiations with the Regional Water Board on behalf of the permittees.
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.
Bioretention	The practice of capturing runoff within a matrix of soil and plant roots. Following capture, the runoff is evapotranspired or infiltrated to surrounding and underlying soils. During frequent or intense runoff events, the soil-and-plant-root matrix may become saturated, in which case excess runoff may be discharged to an underdrain (biotreatment).
Biotreatment	The practice of filtering runoff through a matrix of soil and plant roots prior to discharge to a receiving water or municipal storm drain.
C.3	Provision in the Municipal Regional Permit. Requires the Permittees to use their planning authorities to include appropriate source control, site design, and stormwater treatment measures in new development and redevelopment projects to address pollutant discharges and prevent increases in runoff flows.
C.3 Web Page	<a href="https://www.cccleanwater.org/development-infrastructure/development">https://www.cccleanwater.org/development-infrastructure/development</a>
California Environmental Quality Act (CEQA)	California law that requires public agencies to evaluate the environmental impacts of development projects.
California Stormwater Quality Association (CASQA)	Publisher of the California Stormwater Best Management Practices Handbooks. <a href="http://www.casqa.org">www.casqa.org</a>

Condition of Approval (COA)	Requirements a municipality may adopt for a project in connection with a discretionary action (e.g., adoption of a 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.
Contra Costa Clean Water Program (CCCWP)	<a href="#">CCCWP</a> was established by an agreement among 19 Contra Costa cities and towns, Contra Costa County, and the Contra Costa County Flood and Water Conservation District. CCCWP implements common tasks and assists the member agencies to implement their local stormwater pollution prevention programs.
Design Storm	A hypothetical rainstorm defined by rainfall intensities and durations.
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. See definitions of Infiltration and Retention.
Directly Connected Impervious Area	Any impervious surface which drains into a catch basin, area drain, or other conveyance structure without first flowing across pervious areas.
Direct Infiltration	Infiltration via methods or devices, such as dry wells or infiltration trenches, designed to bypass unsaturated surface soils and transmit runoff directly to groundwater.
Drainage Management Area (DMA)	Site areas subdivided by surface types for the purposes of a Stormwater Control Plan with each DMA identified as self-treating, self-retaining (zero-discharge), draining to a self-retaining area, or draining to an integrated management practice (IMP).
Drawdown time	The time required for a stormwater detention or infiltration facility to drain and return to the dry-weather condition. For detention facilities, drawdown time is a function of basin volume and outlet orifice size. For infiltration facilities, drawdown time is a function of basin volume and infiltration rate.
Harvesting and Reuse	The practice of capturing runoff and storing it for later use. Typical non-potable uses include toilet flushing, landscape irrigation, and industrial uses such as concrete production or washing.
Head	In hydraulics, energy represented as a difference in elevation. In slow-flowing open systems, the difference in water surface elevation, e.g., between an inlet and outlet.
Hydrograph	Runoff flow rate plotted as a function of time.

Hydromodification Management (HM)	Control of runoff intensities and durations to reduce the potential for downstream erosion.
Hydrologic Soil Group	Classification of soils by the Natural Resources Conservation Service (NRCS) into A, B, C, and D groups according to infiltration capacity.
IMP Sizing Calculator	A stand-alone application created by the CCCWP to facilitate the iterative calculations needed to size integrated management practices (IMPs) for Municipal Regional Stormwater Permit compliance. The calculator is available, along with instructions for its use, on the CCCWP's <a href="#">C.3 web page</a> .
Impervious surface	Any material that prevents or substantially reduces infiltration of water into the underlying soil. See discussion of imperviousness in Chapter 2.
Indirect Infiltration	Infiltration via facilities, such as bioretention areas, expressly designed to treat runoff and then allow infiltration to surface soils.
Infiltration	Seepage of runoff through soil to underlying groundwater. See Retention.
Infiltration Device	Any structure that is designed to infiltrate stormwater into the subsurface and, as designed, bypasses the natural groundwater protection afforded by surface or near-surface soil. See Direct Infiltration.
Infiltration Rate	Rate at which water can be added to a soil without creating runoff. See Percolation Rate.
Integrated Management Practice (IMP)	A facility Best Management Practice (BMP) that provides small-scale treatment, retention, and/or detention and is integrated into site layout, landscaping, and drainage design. See Low Impact Development.
Lead Agency	The public agency that has the principal responsibility for carrying out or approving a project. (California Environmental Quality Act Guidelines [CEQA §15367]).
Low Impact Development (LID)	A stormwater management strategy aimed at maintaining or restoring the natural hydrologic functions of a site. LID design detains, treats, and infiltrates runoff by minimizing impervious area, using pervious pavements and green roofs, dispersing runoff to landscaped areas, and routing runoff to rain gardens, cisterns, swales, and other small-scale facilities distributed throughout a site.

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.
Municipal Regional Stormwater Permit (MRP)	A stormwater National Pollutant Discharge Elimination System (NPDES) permit and Waste Discharge Requirements issued by the San Francisco Bay Regional Water Quality Control Board in 2009 (MRP 1.0) to cities, towns, and Flood Control Districts in five Bay Area counties. Reissued in 2015 (MRP 2.0) and in May 2022 (MRP 3.0).
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. NPDES was expanded in 1987 to incorporate permits for stormwater discharges.
National Resources Conservation Services (NRCS)	Federal government organization that classifies soils into hydrologic soil groups A, B, C, and D groups according to infiltration capacity.
Numeric Criteria	Sizing requirements for stormwater treatment facilities established in Provision C.3.d. of the Municipal Regional Permit.
Operation and Maintenance (O&M)	Refers to requirements in the Municipal Regional Permit to inspect treatment BMPs and implement preventative and corrective maintenance in perpetuity. See Chapter 5.
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. See the Design Sheet for Pervious Pavements.
Permeability	The rate at which water flows through a saturated soil under steady state conditions.
Pervious surface	Any material that allows infiltration of runoff into underlying soil.
Pre-Project	Conditions that exist on a development site immediately before the project, to which municipal approvals apply.
Project	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. This definition is consistent with the CEQA definition of a project.

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Proprietary Stormwater Treatment Facilities	Products designed and marketed by private businesses for treatment of stormwater. Many of these products do not meet requirements of the Municipal Regional Permit.
Rational Method	A method of calculating runoff flows based on rainfall intensity, tributary area, and a runoff coefficient representing the proportion of rainfall that runs off based on the type of ground cover.
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. Contra Costa County municipalities are under the jurisdiction of the <a href="#">RWQCB for the San Francisco Bay Region</a> for stormwater discharges.
Regulated Project	A land development project that meets the definition of Regulated Project in Municipal Regional Permit Provision C.3.b. See Table 1-1 on p. 7.
Replaced Impervious Area	In redeveloped projects, replaced impervious area refers to the square footage of existing impervious area that will be replaced with new impervious surfaces after redevelopment. See Illustration 2-1 on p. 18.
Retention	Practices such as infiltration, harvest and use, and evapotranspiration that reduce the amount of runoff discharged from a site.
Runs with the land	A legal expression with particular meaning that whoever owns the land has the obligation
Self-retaining area	An area designed to retain runoff. Self-retaining areas may include graded depressions with landscaping or pervious pavements. See Figure 3-2 on page 38.
Self-treating area	Natural, landscaped, or turf areas that do not drain to IMPs, but rather drain overland off site or to the storm drain system. See Figure 3-1 on page 37.
Source Control	A facility or procedure to prevent pollutants from entering runoff.
Stormwater Control Plan	A plan specifying and documenting permanent features and facilities to control pollutants and stormwater flows for the life of the project.
Stormwater Control Operation & Maintenance Plan	A plan detailing operation and maintenance requirements for stormwater treatment and flow-control facilities incorporated into a project.

Storm Water Pollution Prevention Plan (SWPPP)	A plan documenting temporary measures to control sediment and other pollutants during construction.
Surface Loading Rate	The flow applied to a filter divided by the filter surface area.
Treatment	Removal of pollutants from runoff, typically by filtration or settling.
WEF Method	A method developed by the Water Environment Federation (WEF) for determining the minimum design volume of stormwater treatment facilities, described in <i>Urban Runoff Quality Management</i> (WEF/ASCE, 1998).
Water Board	See Regional Water Quality Control Board.
Water Quality Volume (WQV)	For stormwater treatment facilities that depend on detention to work, the volume of water that must be detained for a minimum specified drawdown time to achieve pollutant removal.







## Do These Things First

Start out on the right track.

**T**HIS Stormwater C.3 Guidebook (*Guidebook*) will help you design your project to meet local requirements for Low Impact Development (LID) drainage design—and ensure that your project complies with the C.3 requirements in the third reissuance of the San Francisco Bay Regional Water Quality Control Board (Water Board)’s Municipal Regional Stormwater Permit (MRP 3.0). MRP 3.0 can be accessed online at [the Water Board’s website](#).

First, **confirm which requirements apply to your project**. See Table 1-1, page 7.

Then, **engage your whole project team**. LID drainage design disperses, infiltrates, detains, and treats runoff using landscape features and engineered bioretention facilities (“rain gardens”) dispersed throughout the site. LID features and facilities are integrated into the project’s landscaping and, when properly designed, can be used for active or passive retention. Your site designer, architect, landscape architect, and drainage engineer need to work together on the LID drainage design from concept to completion.

Your team should prepare and refine the LID drainage design concurrently with sketching building footprints, internal roadways and circulation, parking, and landscape features. For subdivisions, LID drainage design should be initiated before sketching parcel lines and before the first stages of producing a tentative map. Use the guidance and tools in Chapter 3.

Consider, at the outset, who will own the LID features and facilities, who will be responsible for their maintenance, and how they will be maintained. See Chapter 5.

In a **pre-application** meeting with municipal planning staff, discuss the basic elements of, or ideas for, your LID design along with other project objectives and features.

**Integrate the materials you prepare for discretionary review** so that the visual and aesthetic characteristics of your LID features and facilities—including valley gutters, conveyance swales, dispersal areas, and bioretention facilities—are accurately represented in the preliminary site plan, landscaping plan, and renderings.

Use the design criteria in Chapters 3 and 4, and the IMP Sizing Calculator available on the Contra Costa Clean Water Program (CCCWP) website (<https://www.cccleanwater.org/development-infrastructure/development/stormwater-c-3-guidebook>), to evaluate your LID drainage design for compliance with the runoff-treatment and flow-control requirements that apply to your project.

Then, adjust your design and iterate your entries into the IMP Sizing Calculator until you have an aesthetic and functional LID design that meets the numeric criteria outlined in Provision C.3.d of the MRP 3.0.

Follow the step-by-step guidance in Chapter 2, and use the template provided, to prepare a **Stormwater Control Plan** submittal that will accompany your application for entitlements and development approvals.

Plan ahead to ensure the required **elevations, details, cross-sections, and notes** appear in your construction plan set. See “What to Show on Construction Plans” on page 55, “Items to Be Inspected During Construction” on page 91, and the model construction inspection checklist on pages 92 through 94

Draft a separate, required **Stormwater Facilities Operation and Maintenance Plan** (O&M Plan) using the instructions in Chapter 5 and the template provided. The O&M Plan is to be referenced in a typically required Operation and Maintenance Agreement that “runs with the land.”

The most recent version of this *Guidebook*, updates and errata, templates, and example submittals are on the [CCCWP website](#). The *Guidebook* is formatted for 2-sided printing or, when viewed as a .pdf, allows the use of hyperlinks for internal navigation and to access external references and resources.

#### **Construction-Phase Controls**

Your Stormwater Control Plan is a separate document from the Storm Water Pollution Prevention Plan (SWPPP). A SWPPP provides for temporary measures to control sediment and other pollutants during construction. See the CCCWP website for information on requirements for construction-phase controls.

#### **Flood Controls:**

Implementation of the LID and Hydromodification (HM) requirements in this *Guidebook* is separate from, and in addition to, flood control requirements that may apply to your project.

The CCCWP 8<sup>th</sup> edition was updated from the 7<sup>th</sup> edition to incorporate changes to compliance requirements stemming from MRP 3.0. Additionally, reduced bioretention sizing language was updated to reflect the latest direction from the Water Board to reflect that reduced sizing can only be used for road reconstruction projects that follow requirements outlined in MRP 3.0, Provision C.3.b.ii (5)(c) or that are non-regulated projects under C.3.b. Design Sheets were updated with applicable language. Appendix D - Operational Best Management Practices (BMPs) was updated. Appendix E was updated regarding bioretention soils, LID, and

hydromodification (HM), including the 2020 addendum on facility sizing for treatment.

In MRP 3.0, Provision C.3.g.v.(2) directs CCCWP Permittees to require development projects subject to HM to use the methods and criteria in the *Guidebook*, as it may be updated. CCCWP will propose updated methods and criteria for HM in the 2023 Annual Report. Upon finalization of the CCCWP C.3 Guidebook 9<sup>th</sup> Edition (anticipated in mid- to late-2023), applicants for development projects subject to HM requirements will be directed to use the Bay Area Hydrology Model (BAHM) to demonstrate HM compliance.

The *Guidebook* is the collective work product of the Contra Costa Clean Water Program's Development Committee. The *Guidebook's* purpose is to facilitate the review and approval process for Provision C.3, while also obtaining excellence in the quality and community benefit of built projects. Development Committee members pool the expertise they have gained from working with applicants for development approvals, and the Committee directs updates and refinements to the *Guidebook* with each new edition. Some background for various policy and technical decisions, including submittal requirements and technical criteria for facility design, is in **Appendix E**.



## Policies and Procedures

*Determine if your development project must comply with the Municipal Regional Permit Provision C.3 requirements. Review the steps to compliance.*

### Thresholds, Effective Dates, and Requirements

Table 1-1 (on page 7) summarizes requirements for parcel-based development projects. Thresholds are based on the sum of **impervious area created or replaced** in connection with a project.

The following are included in that sum:

- Removing and replacing pavement to the top of the base course or lower—or repairing pavement base.
- Laying gravel over dirt or installing pavement over existing gravel.

The following may be excluded:

- Interior remodels and routine maintenance or repair such as replacement of a roof or exterior wall surface.
- Pavement overlay of pavement, or adding gravel to a gravel road, within the existing footprint.
- Pervious pavements constructed to the criteria in this *Guidebook*.
- Swimming pools and other features that overflow and drain to the sanitary sewer.

#### ► THE “50% RULE” FOR PROJECTS ON PREVIOUSLY DEVELOPED SITES

Projects on previously developed sites may also need to retrofit drainage to provide **treatment** of runoff from all impervious areas of the entire site. For sites creating

or replacing a total area of impervious surface greater than the applicable threshold (Table 1-1):

- If the new project results in an alteration of **more than 50%** of the impervious surface of a previously existing development, and the existing development was not subject to stormwater treatment measures, then the entire project must be included in the treatment measure design.
- If the new project results in an alteration of **less than 50%** of the impervious surface of a previously existing development, and the existing development was not subject to stormwater treatment measures, then only the new and replaced impervious surface must be included in the treatment system design.

Municipal staff will determine case-by-case when and how the “50% rule” applies. Staff may use the original entitlement (discretionary approval) or approved building plans as a guide when calculating the impervious area of the previously existing development.

TABLE 1-1. THRESHOLDS AND REQUIREMENTS FOR PARCEL-BASED PROJECTS

	Impervious Area Threshold	Requirement
Non-Regulated Projects	All projects requiring municipal approvals or permits (including single-family residences)	As encouraged or directed by local staff, preserve or restore open space, riparian areas, and wetlands as project amenities; minimize land disturbance and impervious surfaces (especially parking lots); cluster structures and pavements; include micro-detention in landscaped and other areas; and direct runoff to vegetated areas. Use Bay-friendly landscaping features and techniques. Include Source Controls specified in Appendix D.
	Projects creating or replacing more than 2,500 to 5,000 square feet of impervious surface that are not Regulated Projects	Using the template in Appendix C, prepare and submit a Stormwater Control Plan for a Small Land Development Project. Implement one of four options: (1) Disperse runoff from some amount of roof or paved area to a vegetated area; (2) incorporate some amount of permeable pavement into your project; (3) include a cistern or rain barrel if allowed by your municipality; or (4) incorporate a bioretention facility or planter box.
Regulated Projects	<b>One single-family home, not part of a larger plan of development, creating or replacing 10,000 square feet of impervious surface</b>	Prepare and submit a Stormwater Control Plan as described in Chapter 2, including features and facilities to ensure runoff is treated before leaving the site. Use the Low Impact Development (LID) Design Guide in Chapter 3 and the design criteria in Chapter 4, including sizing factors and criteria for “treatment only.”
	All other projects creating or replacing between <b>5,000</b> square feet and one acre of impervious surface (10,000 square feet for projects approved before 7/1/2023)	
	Projects creating or replacing an acre or more of impervious surface, unless exempted. See text.	Design LID features and facilities for hydromodification management (HM) as well as stormwater treatment. Prepare and submit a Stormwater Control Plan as described in Chapter 2 and use the LID Design Guide in Chapter 3, including the sizing factors and criteria for “treatment and HM.” See Appendix E for additional information.

<sup>1</sup> Summary only. Requirements for your project are determined by your municipality.

<sup>2</sup> Thresholds in **bold** apply to projects approved beginning 7/1/2023.

### C.3 Applicability and Entitlements

Provision C.3 compliance must be demonstrated at the time of application for a development project, including rezoning, tentative map, parcel map, conditional use permit, variance, site development review, design review, development agreement, or building permit.

All Regulated Projects require a Stormwater Control Plan showing the location and footprint of proposed impervious surfaces and of proposed stormwater facilities,

and a description of how runoff will flow from impervious surfaces to the facilities. Instructions for preparing a Stormwater Control Plan are in Chapter 2.

#### ► DEFINITION OF A “PROJECT”

When determining which Provision C.3 requirements apply, a “project” should be defined consistent with California Environmental Quality Act (CEQA) definitions of “project.” Specifically, the “project” is the **whole of an action** that has the potential for adding or replacing, or resulting in the addition or replacement, of roofs, pavement, or other impervious surfaces and thereby resulting in increased flows and runoff pollutants. “Whole of an action” means the project may not be segmented or piecemealed into smaller parts if the effect is to reduce the quantity of impervious area for any part to below the C.3 threshold.

The C.3 project scope includes any impervious surfaces **added or replaced within the adjacent public right-of-way** in connection with the project.

#### ► GRANDFATHERING

Regulated Projects approved prior to July 1, 2023 which have approved Stormwater Control Plans may be issued building permits and allowed to proceed. Regulated Projects with vesting tentative maps, regardless of the date of map approval, may be issued building permits to proceed with development in substantial compliance with the ordinance, policies, and standards in effect at the time the vesting tentative map was approved or conditionally approved, in accordance with California law.

This “grandfathering” applies only to the specific discretionary approval that was the subject of the original application. Subsequent applications for further approvals constitute a project for the purposes of C.3. If those subsequent approvals or entitlements cover specific locations, modes, or designs for addition or replacement of roofs, pavement, or other impervious surfaces, and if the impervious area created or replaced is in excess of the applicable thresholds, then the C.3 requirements will apply to those areas of the project covered by the subsequent approval or entitlement.

For example, an application for a subdivision tentative map which receives final discretionary approval prior to the C.3 start dates may be exempt from Provision C.3. However, if the project proponent later applies for discretionary approval, then C.3 requirements would apply to those improvements.

#### ► PROVISION C.3 COMPLIANCE REQUIREMENTS FOR SUBDIVISION MAPS

Your drainage design will determine where stormwater treatment facilities will be constructed. Note that **stormwater treatment facilities should not be located on individual single-family residential lots**. This is especially important when the facilities will manage runoff from other lots, from streets, or from common areas. Facility landowners will be responsible for facility maintenance. **See Chapter 5.**



For typical subdivisions, it works best to drain individual lots to the common street, and then drain the street to treatment facilities located within the private street right-of-way or on one or more separate, jointly owned parcels.

Your team should complete a preliminary drainage design before making final the right-of-way of internal streets and before sketching parcel lines. **Each stormwater treatment facility footprint must have a corresponding easement** to restrict future building of structures at the facility location.

Applications for tentative maps may be required to include the following:

- Delineation of separate parcels upon which stormwater facilities will be located.
- Dedication of easements and inclusion of provisions related to provision C.3 compliance.
- Execution of, or commitment to execute later, a covenant running with the land and agreement for residents of the subdivision to operate and maintain stormwater facilities.
- Conditions, Covenants, and Restrictions (CC&Rs) recorded against the subdivision to establish reciprocal obligations of the lot owners to maintain stormwater facilities.

If a tentative map approval would potentially entitle future owners of individual parcels to construct new or replaced impervious area which, in aggregate, could exceed the thresholds in Table 1-1, then the applicant must take steps to ensure C.3 requirements can and will be implemented as the subdivision is built out.

If the tentative map application does not include plans for site improvements, the applicant should nevertheless identify the type, size, location, and final ownership of stormwater treatment and flow-control facilities 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 municipality may condition approval of the map on implementation of stormwater treatment measures in compliance with Provision C.3 when construction occurs on the individual lots. This condition may be enforced by a grant deed of development rights or by a development agreement.

If a municipality deems it impervious area of one or by a deed restriction. This project is exempt from one because the total threshold, or to ensure

**Local Requirements:**  
Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide *Guidebook*. See Appendix A for local requirements.

necessary, the future more lots may be limited might be necessary when a or all C.3 provisions impervious area is below a runoff from impervious

areas added after the project is approved does not overload a stormwater treatment and flow-control facility.

See the *Policy for C.3 Compliance for Subdivisions* on the CCCWP's [C.3 web page](#). After consulting with local planning staff, applicants for subdivision approvals will propose one of the following four options, depending on project characteristics and local policies:

1. Show that the sum of future impervious areas to be created or replaced on all parcels could not exceed the applicable C.3 thresholds shown in Table 1-1.
2. Show that, for every lot, the intended use can be achieved with a design which disperses runoff from roofs, driveways, streets, and other impervious areas to self-retaining pervious areas, using the criteria in Chapter 3 of this *Guidebook*.
3. Prepare improvement plans showing drainage to treatment and/or flow-control facilities designed in accordance with this *Guidebook* and commit to constructing the facilities prior to transferring the lots.
4. Prepare improvement plans showing drainage to treatment and/or flow-control facilities designed in accordance with this *Guidebook* and provide appropriate legal instruments to ensure the proposed facilities will be constructed and maintained by subsequent owners.

For the option selected, municipal staff will determine the appropriate conditions of approval, easements, deed restrictions, or other legal instruments necessary to ensure future compliance. When new streets and common areas are constructed, facilities to treat runoff from those new impervious areas must be constructed concurrently, and agreements for the operation and maintenance of those facilities must be executed timely.

#### ► PHASED PROJECTS

As part of an application for approval of a phased development project, a conceptual or master Stormwater Control Plan which describes and illustrates, in broad outline, how the drainage for the project will comply with the Provision C.3 requirements should be provided. The level of detail in the conceptual or master Stormwater Control Plan shall be consistent with the scope and level of detail of the development approval being considered. The conceptual or master Stormwater Control Plan should specify that a more detailed Stormwater Control Plan for each later phase or portion of the project will be submitted with subsequent applications for discretionary approvals.

## Projects in Public Roads or Right-of-Way

Work within the public right-of-way that is part of a parcel-based project is included in the sum of impervious area created or replaced. For example, the following frontage improvements are included in the sum of impervious area:

- Removal or replacement of curb or sidewalk,
- Removal or replacement of roadway pavement to the top of the base course or lower,
- Construction of a new public street, or
- Paving of an existing dirt or gravel roadway.

For projects entirely within the public right-of-way, Regulated Project thresholds are shown in Table 1-2.

TABLE 1-2. THRESHOLDS FOR PUBLIC ROAD AND TRAIL PROJECTS

Impervious Area Threshold	Project Types
<b>5,000 square feet contiguous<sup>1</sup></b>	<ul style="list-style-type: none"> <li>▪ New roads, including sidewalks and bike lanes</li> <li>▪ Adding traffic lanes to an existing road</li> <li>▪ New stand-alone trail projects 10 feet wide or wider</li> <li>▪ Sidewalk gap closures, sidewalk replacement, Americans with Disabilities Act (ADA) curb ramps</li> </ul>
<b>One acre contiguous<sup>2</sup></b>	<ul style="list-style-type: none"> <li>▪ Removing/replacing asphalt or concrete to top of base course or lower</li> <li>▪ Repair of pavement base</li> <li>▪ Extending pavement edge (e.g., safety improvement, paving gravel shoulder)</li> <li>▪ Utility trenching projects 8 feet wide or wider</li> </ul>

<sup>1</sup> For projects approved prior to 7/1/2023, the threshold is 10,000 square feet contiguous.

<sup>2</sup> Projects approved prior to 7/1/2023 are exempt.

## Hydromodification Management Requirements

As shown in Table 1-1 on page 7, in addition to incorporating treatment controls, projects creating or replacing 1 acre or more of impervious area—unless exempted—must ensure post-project runoff does not exceed estimated pre-project rates and durations in a way that could potentially accelerate stream erosion. Additional information on hydromodification management (HM) is in Appendix E.

### ► EXEMPTIONS

Per MRP 3.0 Provision C.3.g.i, projects may be exempted from HM requirements if any of the following apply:

- The post-project impervious area is less than, or the same as, the pre-project impervious area. (At the discretion of municipal staff, on HM projects applicants may provide treatment-only controls for an impervious square footage that is less than or equal to the pre-project impervious square footage. See Appendix E).
- The project is in a catchment that drains to pipes or hardened channels. Hardened channels are defined as channel segments that are continuously concrete-lined on three sides, i.e., the bed and banks are concrete-lined.
- The project is in a catchment that drains to tidally influenced channels that extend continuously to the Bay, Delta, or to a flow-controlled reservoir.
- The project is in a catchment or subwatershed that is highly developed (70% or more impervious).

► **SITES THAT ARE ALREADY PARTIALLY DEVELOPED**

At the discretion of municipal staff, applicants with HM projects may provide treatment-only controls for an impervious square footage that is less than or equal to the pre-project impervious square footage. Treatment and HM controls must be provided for the remaining impervious square footage.

► **COMPLIANCE WITH HM REQUIREMENTS**

Projects subject to the HM requirements must use the LID Design Guide in Chapter 3 and the criteria in Chapter 4 **to develop a design that meets both treatment and HM requirements.**

For a compliant and efficient LID design for HM:

- Drain only impervious areas to bioretention or other treatment/HM facilities.
- Use self-treating areas and self-retaining areas to manage runoff from landscaped areas.
- Wherever possible, disperse runoff from impervious areas to landscaped areas.
- If the required footprint for a bioretention facility seems too large, consider using the cistern and bioretention or bioretention and vault options.

See the Design Guide in Chapter 3.

► **HM REQUIREMENTS - FUTURE UPDATES**

CCCWP recently went through the process of identifying, analyzing, and comparing options for HM implementation in compliance with Provision C.3.g. Upon finalization of the CCCWP C.3 Guidebook 9<sup>th</sup> Edition (anticipated in mid-to-late 2023), applicants for development projects subject to HM requirements will be required to use BAHM to demonstrate HM compliance. The 9<sup>th</sup> Edition Guidebook will provide detailed direction on this new HM compliance methodology and pathway. Until that time, the guidance and methodology in the 8<sup>th</sup> Edition Guidebook should be used for HM-related planning and design.

### Offsite Compliance Options for Runoff Treatment

Experience has shown that LID features and facilities, distributed throughout the site and designed using the guidance in Chapter 3, are feasible on nearly all development sites. However, in lieu of incorporating facilities to treat runoff from impervious areas at the development project site, an applicant may propose a secondary project that will **treat runoff from an equivalent amount of existing impervious area** with LID (i.e., retrofit with LID) at another location within the same watershed.

To be considered, the secondary project must include construction, operation, and maintenance of facilities that meet the criteria in Chapter 3. Those facilities must treat runoff from an amount of impervious surface equivalent to, or greater than, the impervious surface that would be subject to requirements at the project location.

An applicant may propose to combine onsite and offsite facilities to add up to the equivalent amount of impervious area as would be required for only onsite treatment. **Drainage from equivalent existing impervious square footage not subject to C.3 requirements, including existing impervious square footage on the same parcel\*** or on an adjacent parcel or public or private street, **may be retrofitted with LID and the retrofit drainage square footage used to offset new or replaced impervious square footage that would be difficult or expensive to route to treatment.**

An applicant may also propose to share in a larger project and be credited for a proportional amount of the impervious area for which runoff is treated by that project.

Consideration or acceptance of such proposals is at the discretion of the local municipality.

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\* Excluding existing impervious square footage subject to the 50% rule.



## Preparing A Stormwater Control Plan

*Step-by-step documentation of compliance for Regulated Projects*

**Y**our Stormwater Control Plan for a Regulated Project will demonstrate your project complies with all applicable requirements in MRP 3.0 to:

- minimize imperviousness and reduce runoff,
- slow runoff rates and retain or detain stormwater,
- incorporate required source controls,
- treat stormwater prior to discharge from the site,
- control runoff rates and durations if required, and
- provide for operation and maintenance of stormwater facilities,

The Stormwater Control Plan must be submitted with your application for discretionary approval and must have sufficient detail to ensure the stormwater design, site plan, and landscaping plan are congruent.

A complete and thorough Stormwater Control Plan will facilitate quicker review and fewer cycles of review. Every Contra Costa municipality requires a Stormwater Control Plan for every applicable project.

Your Stormwater Control Plan will consist of a report and an exhibit.

**Municipal staff may use the checklist on the following page** to evaluate your Stormwater Control Plan.

**STORMWATER CONTROL PLAN CHECKLIST****CONTENTS OF EXHIBIT**

Show the following on drawings:

- ☐ Existing natural hydrologic features (depressions, watercourses, relatively undisturbed areas) and significant natural resources.
- ☐ Existing and proposed site drainage network and connections to drainage off site.
- ☐ Layout of buildings, pavement, and landscaped areas.
- ☐ Impervious areas proposed (including roofs, plazas, sidewalks, and streets/parking) and area of each.
- ☐ Entire site divided into separate Drainage Management Areas (DMA), with each DMA identified as self-treating, self-retaining (zero-discharge), draining to a self-retaining area, or draining to an Integrated Management Practice (IMP). Each DMA has one surface type (roof, paving, or landscape), is labeled, and square footage noted.
- ☐ Locations, footprints, square footage, and top of soil elevation of proposed treatment and flow-control facilities.
- ☐ Potential pollutant source areas, including refuse areas, outdoor work and storage areas, etc. and corresponding required source controls listed in Appendix D.

**CONTENTS OF REPORT**

Include the following in a report:

- ☐ Narrative analysis or description of site features and conditions that constrain or provide opportunities for stormwater control. Include soil types (including Hydrologic Soil Group as defined by the Natural Resources Conservation Service (NRCS), slopes, and depth to groundwater.
- ☐ Narrative description of site design characteristics that protect natural resources.
- ☐ Narrative description and/or tabulation of site design characteristics, building features, and pavement selections that minimize imperviousness of the site.
- ☐ Tabulation of DMAs, including self-treating areas, self-retaining areas, areas draining to self-retaining areas, and areas draining to IMPs, in the format shown in Chapter 4. Output from the IMP Sizing Calculator may be used.
- ☐ Sketches and/or descriptions showing there is sufficient hydraulic head to route runoff into, through, and from each IMP to an approved discharge point.
- ☐ A table of identified pollutant sources and for each source, the source control measure(s) used to reduce pollutants to the maximum extent practicable. See Appendix D.
- ☐ General maintenance requirements for infiltration, treatment, and flow-control facilities.
- ☐ Means by which facility maintenance will be financed and implemented in perpetuity.
- ☐ Statement accepting responsibility for interim operation and maintenance of facilities.
- ☐ Identification of any conflicts with codes or requirements or other anticipated obstacles to implementing the Stormwater Control Plan.
- ☐ Construction Plan C.3 Checklist.
- ☐ Certification by a civil engineer, architect, and landscape architect.
- ☐ Appendix: Compliance with flow-control requirements



A template for a Stormwater Control Plan in Microsoft Word format can be found on at the Contra Costa Clean Water Program’s [C.3 web page](#). Follow the instructions in this *Guidebook* while using the template.

## Project Data

The table in the Stormwater Control Plan template is shown below for reference. The table is formatted to facilitate compilation of the municipalities’ annual reports.

TABLE 2-1. FORMAT FOR REPORTING PROJECT DATA

Project Name/Number	
Application Submittal Date	[to be verified by municipal staff]
Project Location	[Street Address if available, or intersection and/or Assessor’s Parcel Number]
Name of Developer	
Project Phase No.	[If project is being constructed in phases, indicate the phase number. If not, enter “NA”]
Project Type and Description	[Example entries: “5-story office building,” “Residential with 160 single-family homes with five 4-story buildings to contain 200 condominiums,” “100-unit, 2-story shopping mall,” “mixed use retail and residential development (apartments),” “Industrial warehouse.”]
Project Watershed	[Request from municipal staff]
Total Project Site Area (acres)	
Total Area of Land Disturbed (acres)	
Total New Impervious Surface Area (square feet [ft <sup>2</sup> ])	
Total Replaced Impervious Surface Area (ft <sup>2</sup> )	
Total Pre-Project Impervious Surface Area (ft <sup>2</sup> )	
Total Post-Project Impervious Surface Area (ft <sup>2</sup> )	
50% Rule[*]	[Applies or Doesn’t Apply]
Project Density	[State dwelling units per acre and/or Floor Area Ratio]
Applicable Special Project Categories [Complete even if all treatment is Low Impact Development (LID)]	[State A, B, C, or none. If “C”, state basis for affordable housing, location, density, and parking credits.]
Percent LID and non-LID treatment	[State totals for project and provide details under “Documentation of Drainage Design.”]
Hydromodification Management (HM) Compliance [†]	State “applies” or explain reason for exemption.

\* 50% rule applies if: Total Replaced Impervious Surface Area > 0.5 × Pre-Project Impervious Surface Area

† HM applies if: (Total New Impervious Surface Area + Total Replaced Impervious Surface Area) ≥ 1 acre unless exempt. See page 11.

To determine replaced impervious surface area, it is necessary to overlay a drawing of the existing, pre-project impervious areas with the proposed site plan and evaluate the square footage of existing impervious areas that will be covered with new impervious surfaces. See the example in Figure 2-1.

### Setting

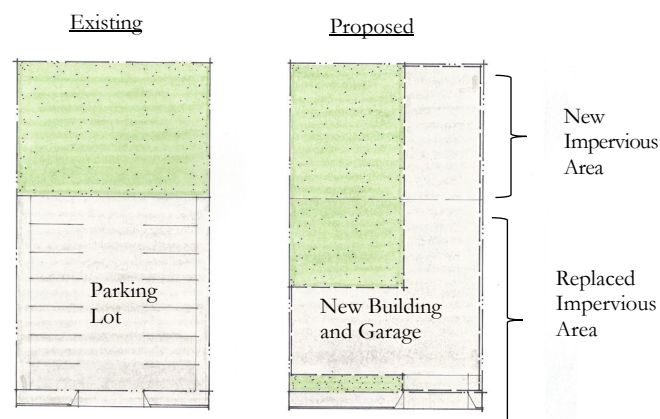
Prepare a brief narrative placing the project in context. Discuss, as appropriate, the site location, division of parcels, planned land uses, zoning, setback and open space requirements, project phasing, number of residential units or square footage of office or retail, parking requirements, neighborhood character, project design objectives (for example, Leadership in Energy and Environmental Design [LEED] certification), and other notable project characteristics.

Include a vicinity map.

### Existing Features and Site Conditions

In a well-organized narrative, describe:

- Project site size, shape, and existing topography, including the general direction of surface drainage, local high or low points or depressions, any outcrops or other significant geologic features, and any contiguous natural areas, wetlands, watercourses, seeps, or springs.
- Existing land use and current or proposed zoning, including requirements for setbacks and open space.
- Soil types (including hydrologic soil groups as defined by NRCS) and depth to groundwater.
- Existing and proposed site drainage, including connections to the municipal storm drain system. Describe any drainage from adjacent areas that runs on to the project area.
- Existing vegetative cover and impervious areas, if any.



**FIGURE 2-1. ILLUSTRATION OF REPLACED Impervious Area.** The proposed building replaces impervious area on the existing parking lot. It also creates new impervious area. To complete the Project Data Table, measure, calculate, and enter the total new impervious area, total replaced impervious area, the pre-project impervious area, and the post-project impervious area.

## Identify Constraints & Opportunities

Review the information compiled in Step 1. Identify the principal constraints on site design and selection of treatment and flow-control facilities as well as opportunities to reduce imperviousness and incorporate facilities 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 facilities), and differences in elevation (which can provide hydraulic head).

In your narrative, describe site opportunities and constraints. This narrative will help you as you proceed with LID design and explain your design decisions to others.

## Low Impact Development Design Strategies

Use the Low Impact Development Design Guide (Chapter 3) to analyze your project for LID, design and document drainage, and specify preliminary design details for integrated management practices.

After analyzing your project for LID (see page 28), prepare a narrative overview of your design and how your design decisions:

- Optimize the site layout,
- Use pervious surfaces where appropriate,
- Disperse runoff to pervious (self-retaining) areas, and
- Drain impervious surfaces to bioretention facilities or other IMPs.

## Documentation of Drainage Design

Chapter 3 includes calculation procedures and instructions for using the IMP Sizing Calculator to organize and present your calculations.

As shown in the checklist (page 16), your **Exhibit** must show the entire site divided into separate Drainage Management Areas (DMAs), with each area identified as one of the following:

1. SELF-TREATING AREA
2. SELF-RETAINING AREA
3. AREA DRAINING TO A SELF-RETAINING AREA, OR
4. AREA DRAINING TO AN IMP.

Each Drainage Management Area must be clearly marked with a unique identifier along with the types and square footage of any impervious surfaces.

Proposed location, size, and approximate top of soil elevation (TSL) of each treatment and flow-control facility must also be indicated on the exhibit. Each facility should be clearly marked with a unique identifier.

It is best to use the grading plan (screened) as background for the Exhibit. It may also be appropriate to show portions of the roofing plan (also screened) wherever roof ridges define DMAs.

Your Stormwater Control Plan **report** must include:

- Tabulation of proposed self-treating areas, self-retaining areas, areas draining to self-retaining areas, and areas draining to IMPs, with the corresponding IMPs identified on the Exhibit.
- Complete output from the IMP Sizing Calculator, showing the minimum square footage required and proposed square footage for each IMP. If flow-control requirements apply, the required storage volume or volumes, and the diameters of each underdrain orifice, must also be shown.

Your Stormwater Control Plan must also include preliminary design information for each bioretention facility or other IMP. Depending on the complexity of the project and the stage of the design, reviewers may expect to see renderings or details, in plan and/or cross-section, showing how the IMPs will be integrated into the site. This may include transitions between the flat, planted surface of bioretention facilities and the adjacent buildings, roadways, sidewalks, or landscapes, and planting plans consistent with the active or inactive uses of the planted bioretention area.

For submittals that include preliminary or final construction drawings, plan views, cross-sections, and other details must be consistent with the design criteria in this *Guidebook*. See Chapter 4 for “What to Show on Construction Plans” and for design guidance and design criteria.

Also include in your Stormwater Control Plan report:

- A narrative briefly describing each DMA, its drainage, and where drainage will be directed.

- A narrative briefly describing each IMP. Include any special characteristics or features distinct from the design sheets in Chapter 3.

Group and consolidate descriptions, or provide additional detail, as necessary to help the reviewer understand your drainage design.

### Source Control Measures

Some everyday activities – such as trash recycling/disposal and washing vehicles and equipment – 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.

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

1. **Identify Pollutant Sources:** Review the first column in the Pollutant Sources/Source Control Checklist (Appendix D). Check off the potential sources of pollutants that apply to your site.
2. **Note Locations on Stormwater Control Plan Exhibit:** Note the corresponding requirements listed in Column 2 of the Pollutant Sources/Source Control Checklist (Appendix D). Show the location of each pollutant source and each permanent source control BMP in your Stormwater Control Plan Exhibit.
3. **Prepare a Table and Narrative:** Check off the corresponding requirements listed in Column 3 in the Pollutant Sources/Source Control Checklist (Appendix D). Create a table using the format in Table 2-2 on the following page. In the left column, list each potential source on your site (from Appendix D, Column 1). In the middle column, list the corresponding permanent, structural BMPs (from Columns 2 and 3, Appendix D) 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.
4. **Identify Operational Source Control BMPs.** To complete your table, refer once again to the Pollutant Sources/Source Control Checklist (Appendix D, 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. The local stormwater ordinance requires that these 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.

TABLE 2-2. FORMAT FOR TABLE OF PERMANENT AND OPERATIONAL SOURCE CONTROL MEASURES

<i>Potential source of runoff pollutants</i>	<i>Permanent source control BMPs</i>	<i>Operational source control BMPs</i>

References and Resources:

- [Appendix D](#), Stormwater Pollutant Sources/Source Control Checklist
- Municipal Regional Permit Provision C.3.c.
- [Bay-Friendly Landscape Guidelines](#) (Stopwaste.org, 2008)
- [https://basmaa.org/wp-content/uploads/2021/04/basmaa\\_start-at-the-source-site-design-guidance-manual\\_1999.pdf](https://basmaa.org/wp-content/uploads/2021/04/basmaa_start-at-the-source-site-design-guidance-manual_1999.pdf) Section 6.7: Details, Outdoor Work Areas

## Stormwater Facility Maintenance

As required by MRP 3.0 Provision C.3.h, your local municipality will periodically verify that treatment and flow-control facilities on your site are maintained and continue to operate as designed.

To make this possible, your municipality will require that you include in your Stormwater Control Plan:

1. A means to finance and implement facility maintenance in perpetuity.
2. Acceptance of responsibility for maintenance from the time the facilities are constructed until responsibility for operation and maintenance is legally transferred. A warranty covering a period following construction may also be required. Check with your local municipality for warranty requirements.
3. An outline of general maintenance requirements for the treatment and flow-control facilities you have selected.

Your local municipality will also require that you prepare and submit a detailed Stormwater Facilities Operation and Maintenance Plan that sets forth a maintenance schedule for each of the treatment and flow-control facilities 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 Facilities Operation and Maintenance Plan, are in Chapter 5.

References and Resources:

- *Chapter 5*
- [\*Model Stormwater Ordinance\* \(CCCWP, 2013\)](#)
- [\*Model Operation and Maintenance Agreements\*](#)

### Construction Plan C.3 Checklist

When you submit construction plans for City review and approval, the plan checker will compare that submittal with your Stormwater Control Plan. By creating a Construction Plan C.3 Checklist for your project, you will facilitate the plan checker's comparison and speed review of your project by completing the following steps:

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

Note that the updated table—or Construction Plan C.3 Checklist—is **only a reference tool** to facilitate comparison of the construction plans to your Stormwater Control Plan. Local municipal staff can advise you regarding the process required to propose changes to the approved Stormwater Control Plan.

TABLE 2-3. FORMAT FOR CONSTRUCTION PLAN C.3 CHECKLIST

*Stormwater  
Control  
Plan  
Page #*

*BMP Description*

*See Plan Sheet #s*


See Chapter 3 for details of IMP construction to be included in construction plans.

## Certification

Your local municipality may require that your Stormwater Control Plan be certified by an architect, landscape architect, or civil engineer. See Appendix A.

Your certification should state: “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 R2-2022-0018.”



## Stormwater Control Plan Report Sample Outline

- I. Project Data (table)
- II. Setting
  - A. Project Name, Location, Description
  - B. Existing Site Features and Conditions
  - C. Opportunities and Constraints for Stormwater Control
- III. Low Impact Development Design Strategies
  - A. Optimization of site layout
    - (1) Limitation of development envelope
    - (2) Preservation of natural drainage features
    - (3) Setbacks from creeks, wetlands, and riparian habitats
    - (4) Minimization of imperviousness
    - (5) Use of drainage as a design element
  - B. Use of Permeable Pavements
  - C. Dispersal of Runoff to Pervious (Self-Retaining) Areas
  - D. Integrated Management Practices
- IV. Documentation of Drainage Design
  - A. Description of each Drainage Management Area
  - B. Tabulation and Sizing Calculations
- V. Source Control Measures
  - A. Description of site activities and potential sources of pollutants
  - B. Table showing sources, permanent source controls, and operational source controls
  - C. Features, Materials, and Construction of Source Control BMPs
- VI. Stormwater Facility Maintenance

A. Ownership and responsibility for maintenance in perpetuity

- (1) Commitment to execute any necessary agreements and/or annex into a fee mechanism, per local requirements
- (2) Statement accepting responsibility for operation and maintenance of facilities until that responsibility is formally transferred

B. Summary of maintenance requirements for each stormwater facility

VII. Construction Plan C.3 Checklist

VIII. Certifications

Attachment: Stormwater Control Plan Exhibit

Appendix: Compliance with Flow-Control (Hydrograph Modification) requirements (if IMPs are not used to achieve flow control).

### Stormwater Control Plan Template

A template with the above format and headings is available on the CCCWP website.

### Example Stormwater Control Plans

Example Stormwater Control Plans are available on the CCCWP website.

## Low Impact Development Site Design Guide

*Guidance for designing your site to include LID site drainage, stormwater treatment facilities, and HM facilities, and for documenting your site's compliance*

**L**ow Impact Development aims to mimic pre-development hydrology by directing runoff to natural landscape features throughout the development site that detain, disperse, infiltrate, and filter runoff.

Contra Costa municipalities require—as a condition of development approval for Regulated Projects—installation of LID measures to treat the amount of runoff specified in MRP 3.0.

Your Stormwater Control Plan must include an exhibit and calculations showing site drainage and proposed LID features and facilities to meet the criteria in this *Guidebook*. This will require that you delineate the entire site into DMAs, and for each DMA, characterize the square footage, surface type, and routing of the drainage. You will also need to show the locations, sizes, and types of proposed stormwater treatment and HM facilities.

This may be accomplished in two steps:

1. **Analyze your project** and identify and select options for meeting LID requirements and runoff treatment requirements as well as HM requirements, if they apply.
2. **Design and document drainage** for the whole site and document how that design meets this *Guidebook's* stormwater treatment and HM criteria.

For most projects, you will need to iterate these two steps to converge on a workable design that complements site conditions and project objectives.

Before beginning your LID design, first determine which requirements apply to your site. See Chapter 1. Determine whether the 50% rule applies, and whether you will need to incorporate HM. The guidance in this chapter will enable you to size stormwater facilities (IMPs) for treatment-only or for treatment plus HM.

## Analyze Your Project for LID

Conceptually, there are four LID strategies for managing runoff from roofs and paving:

1. **Optimize the site layout** by preserving natural drainage features and designing buildings and circulation to minimize the amount of impervious surface.
2. **Use pervious surfaces** such as turf, gravel, or pervious pavement, or use surfaces that retain rainfall, such as green roofs.
3. **Disperse runoff** from impervious surfaces onto adjacent pervious surfaces (e.g., direct a roof downspout to disperse runoff onto a lawn).
4. Drain impervious surfaces to engineered IMPs, which are typically bioretention facilities, sometimes augmented with additional storage. Other IMPs include flow-through planters and dry wells, which may be used in specific situations. IMPs evapotranspire runoff, infiltrate runoff to groundwater, and/or percolate runoff through engineered soil and allow it to drain away slowly.

With forethought in design, the four LID strategies can provide multiple, complementary benefits to your development. Pervious surfaces reduce heat island effects and temperature extremes. Landscaping improves air quality, creates a better place to live or work, and upgrades value for rental or sale. Retaining natural hydrology helps preserve and enhance the natural character of the area. LID drainage design can also conserve water and reduce the need for drainage infrastructure.

A combination of two or more strategies may work best for your project. Table 3-1 on the following page includes ideas for applying LID strategies to site conditions and types of development. It may be useful as a starting point for thinking through application of the four strategies.

TABLE 3-1. IDEAS FOR RUNOFF MANAGEMENT

<i>Site Features/Issues</i>	<i>Optimize Site Layout</i>	<i>Pervious Pavement</i>	<i>Green Roof</i>	<i>Disperse Runoff to Landscape</i>	<i>Bioretention Facility</i>	<i>Flow-through Planter</i>	<i>Cistern + bioretention</i>	<i>Bioretention + Vault</i>	<i>Dry Well</i>
Clayey native soils	✓		✓	✓	✓	✓	✓	✓	
Permeable native soils	✓	✓	✓	✓	✓	✓			✓
Very steep slopes	✓		✓			✓			
Shallow depth to groundwater	✓		✓			✓			
Roof drainage	✓			✓	✓	✓	✓		✓
Parking lots	✓	✓		✓	✓			✓	✓
Extensive landscaping	✓			✓	✓				
Densely developed sites with limited space/landscape		✓	✓		✓	✓	✓	✓	✓

## References and Resources

- [\*Green Roofs for Stormwater Runoff Control\*](#) (USEPA, 2009a)
- [\*Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act\*](#) (USEPA, 2009b)
- *Porous Pavements* (Ferguson, 2005)
- [\*Green Roof Minimum Specifications\*](#) (BASMAA, 2011b)

The four strategies for LID design are described in more detail below.

► **OPTIMIZE THE SITE LAYOUT**

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

- Define the development envelope and protected areas, identifying areas that are most suitable for development and areas that should be left undisturbed.
- Set back development from creeks, wetlands, and riparian habitats.
- Preserve significant trees.
- Where possible, conform the site layout along natural landforms, avoid excessive grading and disturbance of vegetation and soils, and replicate the site's natural drainage patterns.
- Concentrate development on portions of the site with less permeable soils and preserve areas that can promote infiltration.
- For all types of development, limit overall coverage of paving and roofs. This can be accomplished by designing compact, taller structures, narrower and shorter streets and sidewalks, smaller parking lots (fewer stalls, 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.
- Use drainage as a design element. Use depressed landscape areas, vegetated buffers, and bioretention facilities as amenities and focal points within the site and landscape design. Bioretention facilities can be almost any shape.
- Detain and retain runoff throughout the site. On flatter sites, it typically works best to intersperse landscaped areas and IMPs 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 IMPs in lower areas. Or use low retaining walls to create terraces that can accommodate IMPs. Wherever possible, direct drainage from landscaped areas offsite and not to IMPs.

► **USE PERVIOUS SURFACES**

Green roofs are one potential strategy for using pervious surfaces in LID design. Green roofs are growing in popularity and many have been built in the Bay Area in the last few years. Benefits include longer roof life, lower heating and cooling costs,

and better sound insulation, in addition to air-quality and water-quality benefits. However, initial costs are higher than for conventional roofs, and green roofs may add to the complexity of permitting, financing, and insuring new buildings. For C.3 compliance purposes, green roofs are considered not to produce increased runoff or runoff pollutants (that is, any runoff from a green roof requires no further treatment or detention) if the media is sufficiently deep to store an inch of rainfall (typically, a 3-inch media depth is sufficient) and also supports long-term health of vegetation.

Other options for using pervious surfaces in LID design are permeable, or pervious, pavements and surface treatments. Inventory paved areas on your preliminary site plan and 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. Pervious pavements generally cost more than impervious pavements. In clay soils, pervious pavements require a deep base course for structural stability and may not be cost-effective when compared to conventional pavement with drainage to bioretention facilities. Installation of pervious pavement on slopes requires special design features. Depending on the site, the additional costs may be partially offset by reduced needs for drainage structures and for stormwater treatment and HM. For C.3 compliance purposes, pervious pavements, when designed and constructed according to the criteria in Chapter 4, are not considered to produce increased runoff or runoff pollutants.

#### ► DISPERSE RUNOFF TO ADJACENT PERVIOUS AREAS

Look for opportunities to direct runoff from impervious areas to adjacent landscaping (“self-retaining” or “zero-runoff” areas). The design, including slopes and soils, must reflect a reasonable expectation that an inch of rainfall will soak into the soil and produce no runoff. For example, a lawn or garden depressed 3 to 4 inches below surrounding walkways or driveways provides a simple but functional landscape design element.

For sites subject to stormwater treatment requirements only a 2:1 maximum ratio of impervious to pervious area is acceptable. Dispersal is a particularly cost-effective strategy where HM requirements apply, but the impervious-to-pervious ratio must be limited to 1:1. Be sure soils will drain adequately. See the criteria for runoff reduction measures in Chapter 4.

Under some circumstances, it may be allowable to direct runoff from impervious areas to pervious pavement (for example, from roof downspouts to a parking lot paved with crushed aggregate or turf block). The pore volume of pavement and base course must be enough to retain 1 inch of rainfall, including runoff from the tributary impervious area. The slopes and soils must be compatible with infiltrating that volume without producing runoff. This solution is most practical on flat sites with permeable soils.

► **DIRECT RUNOFF TO BIORETENTION OR OTHER IMPS**

The CCCWP has developed design criteria (see Chapter 4) for the following IMPs:

- **Bioretention facilities**, which can be configured to integrate with your landscape design.
- **Flow-through planters**, which can be used on elevated plazas or other circumstances where infiltration to native soils is not possible.
- **Cistern + bioretention** facilities, which use an upstream storage volume and metered flow to reduce the required square footage of a bioretention facility or flow-through planter.
- **Bioretention + vault** facilities, which capture a volume downstream of bioretention and meter outflows.
- **Dry wells** and other infiltration facilities, which can be used only where soils are permeable. See other restrictions in Appendix E.

Table 3-4 on page 42 shows the conditions under which each IMP may be used.

Finding the right location for bioretention or other facilities on your site involves a careful and creative integration of several factors:

- Put bioretention facilities in **high-visibility, well-trafficked areas** and make them a focal point in the landscape.
- If the property is being subdivided now or in the future, the facility should be in a **common, accessible area**. In subdivisions, it often works best to drain roofs and driveways to the street gutter and direct the gutter to one or more IMPs located within the common right-of-way. Although the size and spacing of IMPs and their tributary areas will vary, an optimal design for subdivisions may have bioretention facilities of about 900 square feet (about 30 feet on a side) each receiving drainage from six to ten lots plus the associated fronting street (total of around 1/2 acre of impervious surface). **Avoid locating facilities 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 municipality and the Contra Costa Mosquito and Vector Control District.
- To make the most efficient use of the site and to maximize aesthetic value, **integrate IMPs with site landscaping**. Many local zoning codes 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 treatment and HM facilities within this same area, or within utility easements or other non-buildable areas.

- The facility must be accessible to equipment needed for its maintenance. Bioretention facilities will typically need access for the same types of equipment used for landscape maintenance.
- Where possible, **design site drainage so only impervious roofs and pavement drain to IMPs.** This yields a simpler, more efficient drainage design with smaller IMPs, which is especially important on projects where HM is required, and also helps protect IMPs from becoming clogged by sediment.
- Place bioretention inlet elevations and the top of the engineered soil layer as high as possible (typically 6 to 12 inches below the surrounding ground surface elevation). Avoid walls and steep slopes adjacent to the bioretention soil surface. On flatter sites, **keep drainage runs short and use surface drainage** (sheet flow, valley gutters, or trench drains) to convey runoff from paved areas to the bioretention facility. It may be necessary, or helpful, to pipe runoff from roof gutters all the way to the facility instead of using downspouts.
- For effective, low-maintenance operation, **locate facilities so drainage into and out of the device is by gravity flow.** Because pumped systems are expensive, require more maintenance, are prone to untimely failure, and can cause mosquito control problems, municipal reviewers may decline to approve them. Most IMPs require 2 feet or more of **head**.
- **Bioretention facilities must be level** all the way around, so that the entire soil surface is wetted. Linear bioretention facilities (swales) must be designed with their transverse sides at the same elevation. In the linear direction, slopes must be terraced or provided with check dams.
- Bioretention facilities and other IMPs require excavations 3 or more feet deep, which can **conflict with underground utilities.**
- Bioretention facilities may not be combined with, located within, or integrated with facilities for detention of flood flows. **Keep bioretention facilities and detention basins separate.** See below for methods for evaluating the peak-flow-mitigation benefit of LID features and facilities.

To complete your analysis, include in your Stormwater Control Plan 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 criteria.

#### References and Resources

- [Central Coast Low Impact Development Center](#)
- [Start at the Source](#) (BASMAA, 1999)
- [Urban Street Stormwater Guide](#) (National Association of City Transportation Officials, 2017)
- [San Mateo Green Streets Guide](#) (2009)

## Develop and Document Your LID Drainage Design

The CCCWP's **design documentation procedure** begins with careful delineation of pervious areas and impervious areas (including roofs) throughout the site. The procedure accounts for how runoff from each delineated DMA is managed. For areas draining to IMPs, the procedure ensures each IMP is appropriately sized.

The procedure results in a space-efficient, cost-efficient LID design for meeting C.3 requirements on residential and commercial/industrial developments. The procedure arranges documentation of drainage design and IMP sizing in a consistent format for presentation and review.

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.

You should be able to complete the needed calculations using only the project's site development plan. If your project requires HM, you will also need to know the hydrologic soil group (A, B, C, or D) of site soils and the mean annual precipitation at the project location. Mean annual precipitation at locations in Contra Costa County can be determined using isohyetal maps, contours of equal precipitation amounts recorded during a specific period of time, accessible from the CCCWP's [C.3 web page](#).

The CCCWP has created an **IMP Sizing Calculator** to facilitate the iterative calculations needed to create an optimal site design. The calculator is a stand-alone application and is available, along with instructions for its use, on the CCCWP's [C.3 web page](#). In addition to performing calculations, the IMP Sizing Calculator formats calculation results into a summary report. The summary report should be attached to your Stormwater Control Plan submittal. You may also be required to submit the calculator electronic output file.

The calculator can be used to demonstrate compliance with requirements for:

- Stormwater treatment, using
  - Standard sizing (applies to most development projects),
  - Reduced sizing (may be used, with justification, for road reconstruction projects that follow requirements outlined in MRP 3.0 Provision C.3.b.ii (5)(c), or that are non-regulated projects under C.3.b),
  - Non-LID treatment (may be used only for qualifying projects, with demonstration of infeasibility of LID treatment).
- HM (control of flow intensity and duration)
- Mitigation of peak flows (up to an estimated 10-year recurrence interval event)

When using the calculator, **be sure to read through the following instructions**, as they include key information you will need for design. These procedures and formulas can be used to **investigate, check, and verify** calculations made with the IMP Sizing Calculator.

#### ► STEP 1: DELINEATE DMAS

This is the key first step. You must divide the **entire project area** into individual, discrete DMAs. Typically, lines delineating DMAs follow grade breaks and roof ridge lines. The Exhibit, tables, text, and calculations in your Stormwater Control Plan will illustrate, describe, and account for runoff from each of these areas.

Use separate DMAs for each surface type (e.g., landscaping, pervious paving, or roofs). Each DMA must consist of a single hydrologic soil group. Assign each DMA an identification number and determine its area in square feet. Note this information on your Stormwater Control Plan exhibit.

#### ► STEP 2: CLASSIFY DMAS AND DETERMINE RUNOFF FACTORS

Next, determine how drainage from each DMA will be handled. Each DMA will be one of the following four types—based on the DMA’s drainage characteristics.

1. Self-treating areas.
2. Self-retaining areas (also called “zero-discharge” areas).
3. Areas that drain to self-retaining areas.
4. Areas that drain to IMPs.

Runoff from self-treating areas, self-retaining areas, and areas draining to self-retaining areas does not require any further treatment or HM. Except for pervious pavement installations greater than 3,000 ft<sup>2</sup> in area, there is no requirement for operation and maintenance inspections. Additional information about each type of DMA drainage characteristic is included on the following pages.

**#1. Self-treating areas** are landscaped or turf areas that do not drain to IMPs, but rather drain directly off site or to the storm drain system. Examples include upslope undeveloped areas that are ditched and drained around a development and grassed slopes that drain off site to an existing public street or storm drain. See Figure 3-1. Self-treating areas include no impervious areas, unless the impervious area is very small (5% or less) in relationship to the receiving pervious area, and slopes are gentle enough to ensure runoff from impervious areas will be absorbed into the vegetation and soil.

Rationale

Pollutants in rainfall and windblown dust will tend to become entrained in the vegetation and soils of landscaped areas, so no additional treatment is needed. It is assumed the self-treating landscaped areas will produce runoff volumes and durations less than or equal to the pre-project site condition.

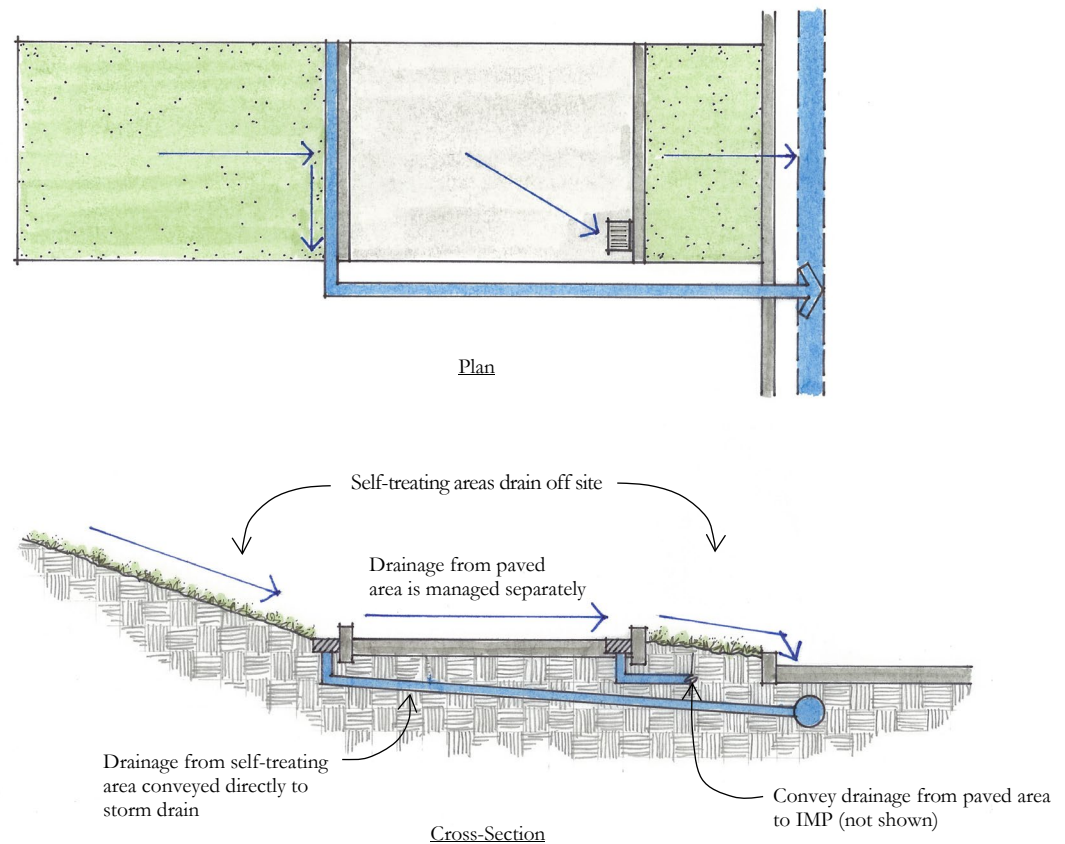


FIGURE 3-1. SELF-TREATING AREAS are landscaped or turf areas that drain directly off site or to the storm drain system.

**#2. Self-retaining areas** are designed to retain the first one inch of 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 a one-inch rainfall event would produce no runoff. See Figure 3-2.

To create self-retaining turf and landscape areas in flat areas or on terraced slopes, berm the area or depress the grade into a concave cross-section so that these areas will retain the first inch of rainfall. Grade slopes, if any, toward the center of the pervious area. Inlets of area drains, if any, should be set 3 inches above the low point to allow ponding.

Green roofs are considered self-retaining areas.

Pervious pavement (e.g., crushed stone, pervious asphalt, or pervious concrete) is self-retaining if designed and constructed according to the criteria in Chapter 4.

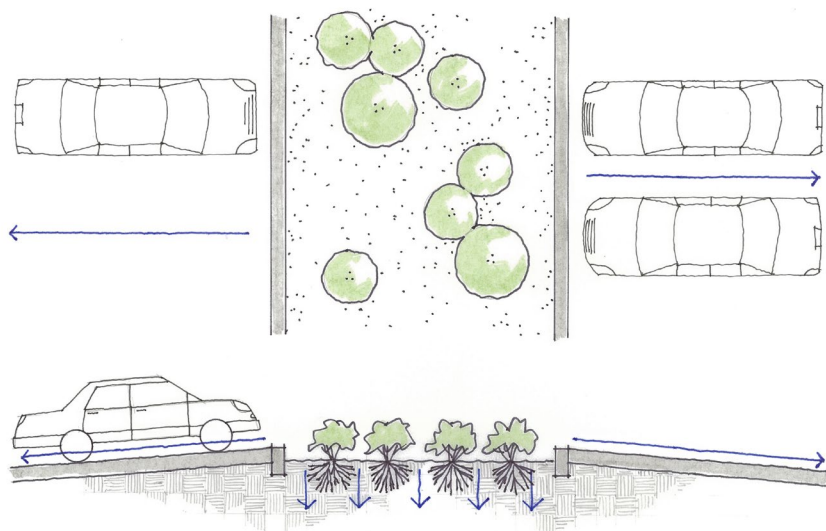


FIGURE 3-2. SELF-RETAINING AREAS are depressed pervious areas that produce no runoff.

**#3. Areas draining to self-retaining areas.**

Runoff from impervious or partially pervious areas can be managed by routing it to self-retaining pervious areas. See Figure 3-3. For example, roof downspouts can be directed to lawns, and driveways can be sloped toward landscaped areas.

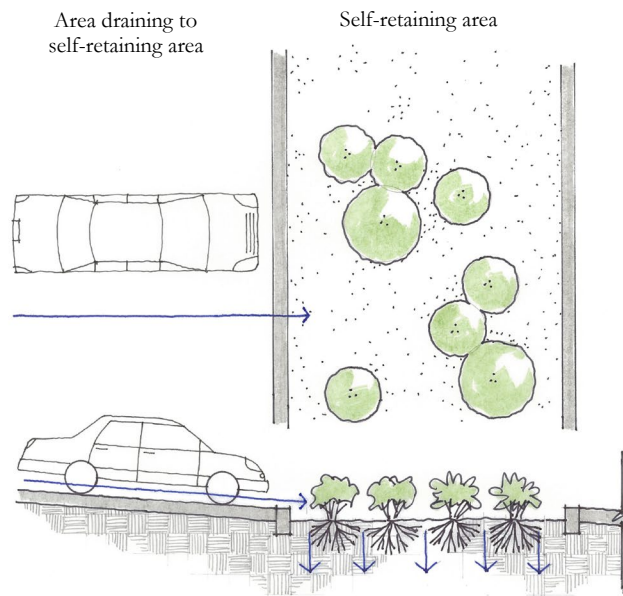
The maximum ratio is two parts impervious area for

every one part pervious area if only treatment requirements apply to the development project. If HM requirements also apply, and/or if it is desired to mitigate increases in peak flows, the maximum ratio is one part impervious area for every one part pervious area. The drainage from the impervious area must be directed to and dispersed within the pervious area, and the entire area must be designed to retain an inch of rainfall without flowing off site. For example, if the maximum ratio of two parts impervious area into one part pervious area is used, then the pervious area must absorb 3 inches of water over its surface before overflowing to an offsite drain.

**Derivation of HM Criteria**

A computer model was used to continuously simulate rainfall, infiltration, and runoff at an hourly time-step over 30 years. Results indicate drainage areas using the 1:1 ratio will not exceed pre-project peaks and durations.

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.



**FIGURE 3-3. AREAS DRAINING TO SELF-RETAINING AREAS.**

The maximum ratio is two parts impervious to one part pervious, or one-to-one if HM requirements apply.

If pervious pavement is designed and constructed to be self-retaining—that is, according to the criteria in Chapter 4—adjacent roofs or impervious pavement may drain onto the pervious pavement with the same maximum ratios. A gravel base course four or more inches deep will ensure an adequate proportion of rainfall is infiltrated into native soils (including clay soils) rather than producing runoff. Consult with a qualified engineer regarding infiltration rates, pavement stability, and suitability for the intended traffic, especially when considering draining impervious areas on to pervious pavement.

A partially pervious area may be drained to a self-retaining area. For example, a driveway composed of unit pavers may drain to an adjacent lawn. In this case, the maximum ratios are, for treatment-only sites:

$$(\text{Runoff factor}) \times (\text{tributary area}) \leq 2 \times (\text{self-retaining area}) \quad \text{Equation 3-1}$$

For sites subject to HM requirements:

$$(\text{Runoff factor}) \times (\text{tributary area}) \leq 1 \times (\text{self-retaining area}) \quad \text{Equation 3-2}$$

Use the runoff factors in Table 3-2.

TABLE 3-2. RUNOFF FACTORS FOR EVALUATING DRAINAGE TO SELF-RETAINING AREAS AND FOR SIZING IMPS.

Surface	Treatment and Flow Control	Treatment only
Roofs	1.0	1.0
Concrete or Asphalt	1.0	1.0
Pervious Concrete	0.1	0.1
Porous Asphalt	0.1	0.1
Grouted Unit Pavers	1.0	1.0
Solid Unit Pavers Set in Sand	0.5	0.2
Open and Porous Pavers	0.1	0.1
Crushed Aggregate	0.1	0.1
Decomposed Granite*	0.1	0.1
Turfblock	0.1	0.1
Landscape, Group A Soil	0.1	0.1
Landscape, Group B Soil	0.3	0.1
Landscape, Group C Soil	0.5	0.1
Landscape, Group D Soil	0.7	0.1



**#4. Areas draining to IMPs** are used to calculate the required size of the bioretention facility or other IMP. On densely developed sites—such as commercial and mixed-use developments and small-lot residential subdivisions—most DMAs will drain to IMPs.

The CCCWP has developed sizing factors (ratios of IMP area to impervious DMA area). For each IMP design, factors are provided for:

- Treatment-only.
- Treatment-plus-HM.

Treatment-only IMPs are smaller and simpler in design.

More than one drainage management area can drain to the same IMP. However, because the minimum IMP sizes are determined by ratio to drainage area size, one drainage area may not drain to more than one IMP. See Figure 3-4.

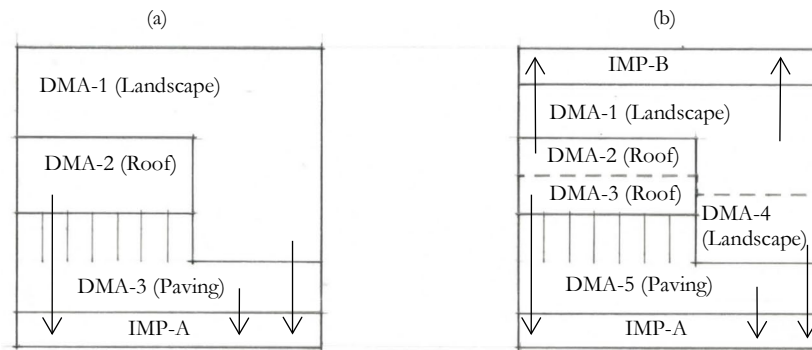


FIGURE 3-4. DELINEATE EACH SURFACE AS A SEPARATE DMA.

(a) More than one DMA can drain to an IMP. (b) If another IMP is added, divide the DMAs as necessary so that each DMA drains to only one IMP.

If it is necessary to include turf, landscaping, or pervious pavements within the area draining to an IMP, list each surface as a separate DMA. A runoff factor (similar to a “C” factor used in the rational method) is applied to account for the reduction in the quantity of runoff. For example, when a turf or landscaped drainage management area drains to an IMP, the resulting increment in IMP size is:

$$(\text{pervious area}) \times (\text{runoff factor}) \times (\text{sizing factor}).$$

Use the runoff factors in Table 3-2.

**► STEP 3: TABULATE DRAINAGE MANAGEMENT AREAS**

Prepare a table of DMAs, using the format in Table 3-3, and include it in your Stormwater Control Plan. Proceed to Step 4 to check that the IMPs can be sized to fit your preliminary site plan.

TABLE 3-3. FORMAT FOR TABULATION OF DRAINAGE MANAGEMENT AREAS

<i>DMA Name</i>	<i>DMA Type</i>	<i>Description</i>	<i>Area (square feet)</i>

**► STEP 4: SELECT AND LAY OUT IMPs ON SITE PLAN**

Select from the IMPs in Table 3-4. Note that flow-through planters may be used only on elevated plazas and other locations where it is not feasible to allow the facility to infiltrate to underlying soil.

TABLE 3-4. IMP SELECTION

	Treatment Only				Treatment + Flow Control			
Hydrologic Soil Group	A	B	C	D	A	B	C	D
Bioretention	✓	✓	✓	✓	✓	✓	✓	✓
Flow-through Planter	✓	✓	✓	✓			✓	✓
Dry Well	✓	✓			✓	✓		
Cistern + Bioretention					✓	✓	✓	✓
Bioretention + Vault					✓	✓	✓	✓

See the requirements for laying out IMPs on pages 30-32. Descriptions, illustrations, designs, and design criteria for the IMPs are in Chapter 4. Once you have laid out the IMPs, calculate the square footage you have set aside on your site plan for each IMP.

► **STEP 5: CALCULATE MINIMUM IMP AREA AND VOLUMES**

Most projects are for **treatment only**, and standard sizing criteria apply. The minimum IMP areas and volumes are determined by summing up the contributions of each tributary DMA and multiplying times the factors shown in Table 3-5.

Note that the minimum areas are the wetted area and **do not include side slopes**.

TABLE 3-5. MINIMUM IMP AREAS AND VOLUMES FOR TREATMENT ONLY

Hydrologic Soil Group	A	B	C	D
Bioretention Facility Area	0.04	0.04	0.04	0.04
Flow-through Planter Area	0.04	0.04	0.04	0.04
Dry Well (treatment only) Area	0.02	0.04	N/A	N/A
Volume	0.068	0.136	N/A	N/A
Area = ft <sup>2</sup> of IMP footprint per ft <sup>2</sup> of impervious tributary area (unitless)				
Volume = ft <sup>3</sup> per ft <sup>2</sup> of tributary area (ft.)				
Apply runoff factors from Table 3-2 for landscape or other pervious surfaces.				

Tree-box-type high-flowrate biofilters and vault-based high-flowrate media filters may be used on portions of a project only for projects that meet the criteria on page 50, including a demonstration that it is infeasible to use LID to treat 100% of runoff.

For **treatment-and-HM**, the minimum area and minimum storage volumes are found by summing up the contributions of each tributary DMA and applying sizing factors and equations. The configuration of area ( $A$ ), surface reservoir volume ( $V_1$ ), and subsurface reservoir volume ( $V_2$ ) for bioretention facilities and flow-through planters is shown in Figure 3-5.

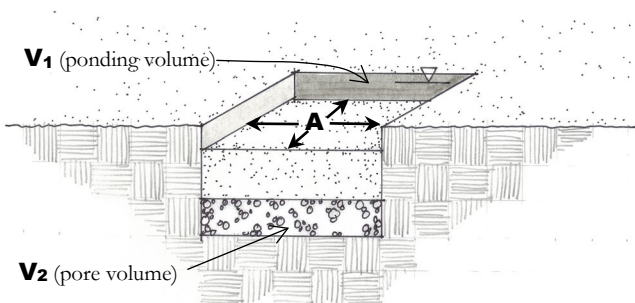


FIGURE 3-5.  $A$ ,  $V_1$ , and  $V_2$ .

$V_2$  is the free pore volume. For gravel, use an assumed porosity of 0.4.

$V_1$  is the floodable volume above the soil layer (that is, the total volume of surface storage when the facility just begins to overflow).  $V_2$  is the storage volume below the soil layer. If gravel fill is used, **multiply the volume of gravel by an assumed porosity of 0.4** to obtain the subsurface volume.

Sizing factors for treatment-only IMPs do not require any adjustment for differing rainfall patterns. However, for treatment-plus-HM IMPs, area ( $A$ ) and volume ( $V_1$ ,  $V_2$ ) sizing factors must be adjusted to account for the effects of differing rainfall patterns on pre-project and post-project runoff. Cisterns and dry wells have a single storage volume  $V$ .

Note these volumes can be configured in a variety of practical combinations of depth and area to best fit into your landscape design. For example, if a bioretention facility were designed with double the minimum value of  $A$ , then the depth of the surface reservoir and the depth of the subsurface reservoir could both be halved. Some other strategies to achieve the required minimum values of  $V_1$  and  $V_2$  are described in the design sheets in this chapter.

The minimum values of A, V<sub>1</sub>, and V<sub>2</sub> are calculated by Equation 3-3. **These calculations are incorporated into the IMP Sizing Calculator** and are provided here for purposes of investigating and validating calculator results.

Equation 3-3

$$\text{Min. IMP Area or Volume} = \sum \left( \frac{\text{DMA}}{\text{Square Footage}} \times \frac{\text{DMA}}{\text{Runoff Factor}} \right) \times \left( \frac{\text{IMP}}{\text{Sizing Factor}} \right) \times \left( \frac{\text{Rain}}{\text{Adjustment Factor}} \right)$$

IMP Sizing Factors and equations for calculating Rain Adjustment Factors are in Tables 3-6 and 3-7.

TABLE 3-6. FACTORS FOR CALCULATING IMP Area and Storage Volumes (Treatment-and-flow-control)

Facility Design	Soil Group	Area (ft <sup>2</sup> /ft <sup>2</sup> )	Volume V <sub>1</sub> (ft <sup>3</sup> /ft <sup>2</sup> )	Volume V <sub>2</sub> (ft <sup>3</sup> /ft <sup>2</sup> )	Rainfall Adjustment for Surface Area	Rainfall Adjustment for Storage Volume	Maximum Release Rate
Bioretention Facility	A	0.07	0.058	No min.	Eq. 3-6	Eq. 3-6	No orifice
	B	0.11	0.092	No min.	Eq. 3-7	Eq. 3-7	No orifice
	C	0.06	0.050	0.066	Eq. 3-8	Eq. 3-8	Eq. 3-10
	D	0.05	0.042	0.055	Eq. 3-9*	Eq. 3-9	Eq. 3-11
Flow-through Planter	A	Not permitted in “A” soils					
	B	Not permitted in “B” soils					
	C	0.06	0.050	0.066	Eq. 3-8	Eq. 3-8	Eq. 3-10
	D	0.05	0.042	0.055	Eq. 3-9*	Eq. 3-9	Eq. 3-11
Dry Well	A	0.05	0.130	N/A	Eq. 3-6	Eq. 3-6	No release
	B	0.06	0.204	N/A	Eq. 3-7	Eq. 3-7	No release
	C	Not permitted in “C” soils					
	D	Not permitted in “D” soils					
Cistern + Bioretention	A	0.020	0.193	N/A	Eq. 3-13	Eq. 3-6	Eq. 3-17
	B	0.009	0.210	N/A	Eq. 3-14	Eq. 3-7	Eq. 3-12
	C	0.013	0.105	N/A	Eq. 3-15	Eq. 3-8	Eq. 3-10
	D	0.017	0.063	N/A	Eq. 3-16	Eq. 3-9	Eq. 3-11
Bioretention + Vault	A	0.04	N/A	0.096	N/A	Eq. 3-6	No release
	B	0.04	N/A	0.220	N/A	Eq. 3-7	Eq. 3-12
	C	0.04	N/A	0.152	N/A	Eq. 3-8	Eq. 3-10
	D	0.04	N/A	0.064	N/A	Eq. 3-9	Eq. 3-11

Area = ft<sup>2</sup> of IMP footprint per ft<sup>2</sup> of tributary impervious area (unitless)

V<sub>1</sub>, V<sub>2</sub> = ft<sup>3</sup> per ft<sup>2</sup> of equivalent tributary impervious area (ft.) Cisterns, dry wells, and vaults have only one volume.

\*If MAP is 25 inches or greater, this equation will yield a rainfall adjustment less than 0.8 and a bioretention facility area less than 0.04 times the tributary area. In that case, use 0.04 times the tributary area to calculate the minimum allowable bioretention facility area. Equation 3-9 may still be used to adjust minimum required storage volumes.

TABLE 3-7. EQUATIONS TO BE USED in calculating IMP sizes and outflow rates.\*

Equation 3-6	$\text{Rain Adjustment} = \frac{0.0009 \times (\text{MAP}_{\text{project site}} - 20.2) + 0.07}{0.07}$
Equation 3-7	$\text{Rain Adjustment} = \frac{-0.0005 \times (\text{MAP}_{\text{project site}} - 20.2) + 0.11}{0.11}$
Equation 3-8	$\text{Rain Adjustment} = \frac{-0.0022 \times (\text{MAP}_{\text{project site}} - 20.2) + 0.06}{0.06}$
Equation 3-9	$\text{Rain Adjustment} = \frac{-0.0022 \times (\text{MAP}_{\text{project site}} - 20.2) + 0.05}{0.05}$
Equation 3-10	$\text{Flow (cfs per ft}^2\text{)} = \frac{0.093 \times (\text{MAP}_{\text{project site}} - 20.2) + 1.42}{10^6}$
Equation 3-11	$\text{Flow (cfs per ft}^2\text{)} = \frac{0.122 \times (\text{MAP}_{\text{project site}} - 20.2) + 1.85}{10^6}$
Equation 3-12	$\text{Flow (cfs per ft}^2\text{)} = \frac{0.071 \times (\text{MAP}_{\text{project site}} - 20.2) + 0.91}{10^6}$
Equation 3-13	$\text{Area Ratio} = \frac{0.151 \times (\text{MAP}_{\text{project site}} - 20.2) + 2.30}{2.30}$
Equation 3-14	$\text{Area Ratio} = \frac{0.071 \times (\text{MAP}_{\text{project site}} - 20.2) + 0.91}{0.91}$
Equation 3-15	$\text{Area Ratio} = \frac{0.093 \times (\text{MAP}_{\text{project site}} - 20.2) + 1.42}{1.42}$
Equation 3-16	$\text{Area Ratio} = \frac{0.122 \times (\text{MAP}_{\text{project site}} - 20.2) + 1.85}{1.85}$
Equation 3-17	$\text{Flow (cfs per ft}^2\text{)} = \frac{0.151 \times (\text{MAP}_{\text{project site}} - 20.2) + 2.30}{10^6}$

MAP = Mean Annual Precipitation, determined from Contra Costa County Public Works Figure B-166.

\*There are no Equations 3-4 or 3-5 in this edition; this was done to preserve equation numbering from a previous edition.

► **STEP 6: DETERMINE IF IMP AREA AND VOLUME ARE ADEQUATE**

Sizing and configuring IMPs may be an iterative process. After computing the minimum IMP area using Steps 1–5, review the site plan to determine if the reserved IMP area is sufficient.

If so, the planned IMPs will meet the Provision C.3 sizing requirements. 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 IMPs which may have excess capacity.
- Making tributary landscaped DMAs self-treating or self-retaining (may require changes to grading).
- Expanding IMP surface area.
- Using a different IMP. The cistern + bioretention and bioretention + vault options were created to achieve HM **in a smaller footprint** than bioretention alone. Note these options are more costly and complex to build and operate.

Revisions to square footage of an IMP typically require a corresponding revision to the square footage of the surrounding or adjacent DMA.

Once a design with adequate area is achieved, review the IMP configuration to confirm the required minimum volumes are met. If not, revisions to  $V_1$  may include adjusting depth or side slopes and extending the floodable storage area to include adjacent paved or landscaped areas. Revisions to  $V_2$  may include adjusting width or depth or incorporating buried pipes or arches in the gravel layer.

► **STEP 7: COMPUTE MAXIMUM ORIFICE FLOW RATE**

This step applies only to:

- **treatment-and-HM** bioretention facilities and flow-through planters built on native Group C and Group D soils.
- cistern + bioretention-facilities built in all soils.
- bioretention + vault facilities built on Group B, Group C, and Group D native soils.

See Table 3-4. The IMP Sizing Calculator performs this calculation.

**Treatment-only** bioretention facilities and flow-through planters are equipped with underdrains, but there is no restriction on the rate of outflow. For the **treatment-and-HM** IMPs listed above, the underdrain has a flow control orifice sized to ensure rates and durations of flows do not exceed pre-project conditions.

For a cistern + bioretention-facility, the flow-control orifice is placed on the outlet from the cistern where it discharges to the bioretention facility. For DMAs with Group B, C, or D soils, the bioretention facility must have an underdrain, but no flow-control orifice is required on the underdrain.

For a bioretention + vault facility, the flow-control orifice is placed on the discharge from the vault.

Find the appropriate equation in Tables 3-6 and 3-7 to determine the maximum underdrain flow. Sum the total area draining to an IMP (including all tributary DMAs). **Do not use runoff factors.** Compute the maximum orifice release rate, and then apply the orifice equation (Eq. 3-18) to determine the required orifice area. Then use Eq. 3-19 to determine the diameter of the flow control orifice.

*Equation 3-18*

$$\text{Orifice Area (in feet)} = \frac{\text{UnderdrainMaxFlow}}{c \times \sqrt{64.4 \times H}}$$

where  $c$  is the orifice coefficient (unitless), which may be approximated as 0.6.  $H$  is the height of the storage above the orifice in feet. Underdrain Max Flow is in cubic feet per second, and 64.4 is 2 multiplied by the acceleration due to gravity in feet per second per second.

*Equation 3-19*

$$\text{Orifice Diameter (in inches)} = 12 \times \sqrt{\frac{4 \times \text{Orifice Area}}{\pi}}$$

Where orifice area is in feet.

#### ► STEP 8: PRESENT IMP SIZING CALCULATIONS

Review the output from the IMP Sizing Calculator. Coordinate and cross-check your presentation of DMAs and calculation of minimum IMP sizes with the Stormwater Control Plan Exhibit (labeled to show delineation of DMAs and locations of IMPs) and with your Stormwater Control Plan report, which should incorporate a brief description of each DMA and each IMP.



Tabulate and sum the total area of all DMAs and IMPs listed and show it is equal to the total project area. This step will include adjusting the square footage of some DMAs to account for area used for IMPs. **Note the minimum square footage for IMPs does not include the area of transitions or slopes adjacent to the IMP.**

### *Integrating Your LID Design into Your Project*

Before completing your Stormwater Control Plan exhibit and report, perform another check to ensure your stormwater control design is fully coordinated with the site plan, grading plan, and landscaping plan being proposed for the site.

Information submitted and presentations 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 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 facilities and other IMPs do not create conflicts with pedestrian access between parking and building entrances.
- Vaults and utility boxes will be accommodated outside bioretention facilities and will not be placed within bioretention facilities.
- The visual impact of stormwater facilities, including planter boxes 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 bioretention facilities, and the plant requirements are consistent with the engineered soils and conditions in the bioretention facilities.
- Renderings and representation of street views incorporate any stormwater facilities located in street-side buffers and setbacks.
- Any potential conflicts with local development standards have been identified and resolved.

Review Chapter 4 to anticipate additional requirements for design and construction of IMPs.

### Reduced Bioretention Sizing

Bioretention facilities for **treatment only** must be sized so that the area of engineered soil mix that is flooded at the point of overflow (see page 44) is a minimum 4% of tributary equivalent impervious area. See Tables 3-2 and 3-5 and the accompanying instructions.

Reduced sizing (less than 4% of tributary equivalent impervious area) can only be used for road reconstruction projects that follow requirements outlined in MRP 3.0 Provision C.3.b.ii (5)(c), or that are non-regulated projects under C.3.b. For further detail on applicability of reduced bioretention sizing, visit <https://www.cccleanwater.org/development-infrastructure/green-infrastructure/resources>. All facilities must be at least as large as the minimum sizes determined by the following equation:

$$\text{Sizing Factor} = 0.00060 \times \text{MAP} + 0.0086$$

where MAP = Mean Annual Precipitation in inches, per Contra Costa County Public Works Figure B-166, which can be found on the [CCCWP web page](#).

It should be noted, however, the reduced sizing factor calculation for bioretention facilities does not satisfy full trash capture.

**Bioretention Facility Characteristics.** The bioretention facility must be surrounded by vertical walls or curbs rather than side slopes. The facility must conform to all *Guidebook* design and construction criteria, including the following:

- Each layer of the facility must be level throughout, and construction drawings must show elevations for facility rim, overflow grate, top of soil layer (TSL), top of gravel layer (TGL), and bottom of gravel layer (BGL).
- Facilities must be inspected at each stage of construction.

### Non-LID Treatment (Special Projects)

LID has been found to be feasible for nearly all development sites. If you believe LID design may be infeasible for part of or your entire development site, you should consult with municipal staff and seek additional technical assistance for incorporating LID into your site before considering non-LID options.

#### ► SPECIAL PROJECTS

“Special Projects” that meet the criteria in [Table 3-8](#) (page 55) may, subject to local staff review and approval and subject to a demonstration that it is infeasible to use

4% or Smaller?  
Appendix E includes technical background and a policy rationale for Contra Costa municipalities' treatment-only sizing criteria.

LID to treat 100% of runoff, use the following non-LID treatment systems for up to the specified proportion of the total impervious area on the site:

- Tree-box-type high-flowrate biofilters.
- Vault-based high-flowrate media filters.

► **TECHNICAL CRITERIA FOR NON-LID FACILITIES**

General:

- Inflow rate is that generated by a continuous rainfall intensity of 0.2 inches per hour.
- Landscape and non-impervious surfaces should be self-treating or self-retaining and should not drain to treatment facilities, if feasible.
- Use the runoff factors in Table 3-2.
- The applicant's Stormwater Control Plan must include as an attachment a letter from the manufacturer stating the manufacturer has reviewed the Stormwater Control Plan, and the proposed device meets these technical criteria. Check with your local municipality for warranty requirements.

High-Flowrate Tree-Box-Type Biofilters:

- Maximum design surface loading rate of 50 inches per hour.
- Precast concrete construction.
- Inlet design to capture flows at least up to the maximum design surface loading rate and to bypass high flows.
- Minimum media depth of 1.8 feet (may be reduced, but maintaining the same media volume, if required because of inadequate head to discharge point).
- Media and facility configuration supports a healthy tree or other vegetation.

Vault-Based High-Flowrate Media Filters:

- Replaceable cartridge filters.
- Maximum design filter surface loading rate of 1 gallon per minute per square foot (gpm/ft<sup>2</sup>)

- Storage volume detains runoff and allows settling of coarse solids prior to filtration.
- Flow through the cartridge filters is controlled by an orifice or other device so that the design surface loading rate is not exceeded.

Example Calculations:

Given a project with the following DMAs draining to a non-LID facility:

DMA 1: 2,050 ft<sup>2</sup> roof, runoff factor 1.0

DMA 2: 3,035 ft<sup>2</sup> asphalt, runoff factor 1.0

DMA 3: 250 ft<sup>2</sup> solid unit pavers set in sand, runoff factor 0.5

High-Flowrate Tree-Box-Type Biofilter:

Equivalent Impervious Area =  $(2,050 \text{ ft}^2 + 3,035 \text{ ft}^2) \times 1.0 + (250 \text{ ft}^2 \times 0.5) = 5,210 \text{ ft}^2$

Sizing factor = 0.2 inches per hour ÷ 50 inches per hour = 0.004

Minimum biofilter surface area =  $0.004 \times 5,210 \text{ ft}^2 = 20.84 \text{ ft}^2$

Vault-Based High-Flowrate Media Filter:

Design flowrate =  $((3,035 + 2,050) \text{ ft}^2 \times 1.0 + (250 \text{ ft}^2 \times 0.5)) \times 0.2 \text{ inches per hour} \times 1 \text{ foot}/12 \text{ inches} \times 1 \text{ hour}/60 \text{ minutes} \times 7.48 \text{ gallons}/\text{cubic foot} = 54 \text{ gallons per minute [gpm]}$

Cartridge surface area = 10.7 ft<sup>2</sup>/cartridge (obtain from manufacturer and verify)

Number of cartridges required =  $54 \text{ gpm}/1 \text{ gpm}/\text{ft}^2 \div 10.7 \text{ ft}^2/\text{cartridge} = 5.04 \text{ cartridges (round to 5)}$

If flow-control (HM) requirements apply, also review the options for compliance in Chapter 1. Then consult with municipal staff before preparing an alternative design for stormwater treatment and HM.

#### ► DEMONSTRATION OF INFEASIBILITY IS REQUIRED

To obtain approval to use any non-LID treatment systems, the applicant must demonstrate, to the satisfaction of the municipal reviewer, that it is infeasible to treat runoff from the same area using bioretention facilities, either sized to 4% of tributary equivalent impervious area, or as may be justifiable for the site and for specific DMAs, reduced bioretention sizing (see preceding section).

For all non-LID designs, the applicant must submit a complete Stormwater Control Plan, including an exhibit showing the entire site divided into discrete Drainage

Management Areas, and text and tables showing how drainage is routed from each DMA to a treatment facility.

In addition, to establish the **infeasibility of implementing LID on the entire site**, include in the Stormwater Control Plan an explanation of how routing of drainage has been optimized so that as much runoff as possible goes to LID features and facilities (if any). For DMAs draining to tree-box-type high-flow-rate biofilters and/or high-flow-rate media filters, briefly describe all areas not covered by buildings. Note the uses of all impervious paved areas and why LID treatment is precluded for these areas.

For any landscaped areas, note and briefly describe the following technical constraints as applicable:

- Inadequate size to accommodate bioretention facilities that meet sizing requirements for the tributary area.
- Slopes too steep to terrace.
- Environmental constraints (for example, landscaped area is within a riparian corridor and applicable regulations prohibit bioretention facilities within that corridor)
- High groundwater (within 2 feet of ground surface) or shallow bedrock
- Conflict with subsurface utilities.
- Cap over polluted soil or groundwater.
- Lack of head or routing path to route runoff to the landscaped area or from a bioretention underdrain to the municipal storm drain.
- Other conflicts, including required uses that preclude use for stormwater treatment (describe in detail).

Also include in your Stormwater Control Plan a narrative discussion of **infeasibility of offsite treatment**:

- Describe whether the project proponent owns or otherwise controls land within the same watershed of the project that can accommodate in perpetuity offsite bioretention facilities adequately sized to treat the runoff volume of the primary project.
- Identify any regional LID stormwater mitigation programs available to the project for in-lieu C.3 compliance.

## CONTRA COSTA CLEAN WATER PROGRAM

### References and Resources

- [\*Municipal Regional Permit\*](#) Provision C.3.e.
- [\*Special Projects Proposal\*](#) (BASMAA, 2010)

## STORMWATER C.3. COMPLIANCE

TABLE 3-8. NON-LID TREATMENT SYSTEMS may be allowed in these “Special Projects,” subject to a demonstration of the infeasibility of using 100% LID and local staff review and approval. Note: This table is a summary only. Consult with local staff regarding applicability to your project.

Category	Impervious Area	Project Characteristics	Criteria (Acreage refers to total site acreage)	LID Credit	Comments		
<b>A</b> Lot Line to Lot Line	X ≤ ½ Ac	Urban/Pedestrian design <sup>1</sup> in Business/ Downtown Districts <sup>2</sup>	No density criterion	100%	Zero surface parking <sup>1</sup> ≥ 85% Site Coverage <sup>1</sup>		
<b>B</b> High Density	X ≤ 2 Ac	Urban/Pedestrian design <sup>1</sup> in Business/ Downtown Districts <sup>2</sup>	Floor Area Ratio <sup>1</sup> (FAR) ≥ 2:1; OR for Residential (Res) projects, ≥ 50 Dwelling Units (DU)/Acre <sup>1</sup> ; OR either for mixed-use projects.	50%	Zero surface parking <sup>3</sup> ≥ 85% Site Coverage <sup>4</sup>		
			FAR ≥ 3:1; OR Res ≥ 75 DU/Acre	75%			
			FAR ≥ 4:1; OR Res ≥ 100 DU/Acre	100%			
<b>C</b> Affordable Housing	No limit	Primarily a residential project, gross density ≥ 40 DU/acre. Affordable housing units must be preserved housing with deed restrictions running at least 55 years; rent/ mortgage rates (including utilities) ≤ 30% total household income. Total credit is the sum of 4 credits: 1. Location 2. Density 3. Parking 4. Affordable housing.	1. Location Credits (count only one)				
			within ¼ mi of transit hub <sup>1</sup>	5%			
			within a Priority Development Area	10%			
			2. Density/FAR Credits				
			≥ 30 DU/Acre	5%			
			≥ 60 DU/Acre	10%			
			≥ 100 DU/Acre	15%			
			3. Minimized Parking Credits				
Zero surface parking <sup>3</sup>	5%						
		Minimum Percent of Dwelling Units (DUs) at or below each income level (per CA DHCD)					
4. Affordable Housing Credits		100%	75%	50%	25%	15%	5%
LID credit = 70%		Moderate	Low	Very Low	Extremely Low		
LID credit = 50%			Moderate	Low	Very Low	Extremely Low	
LID credit = 25%				Moderate	Low	Very Low	Extremely Low

<sup>1</sup> Built as part of a municipality's stated objective to preserve or enhance a pedestrian-oriented type of urban design.

<sup>2</sup> Located in a municipality's designated central business district, downtown core area or downtown core zoning district, neighborhood business district or comparable pedestrian-oriented commercial district, or historic preservation site and/or district.

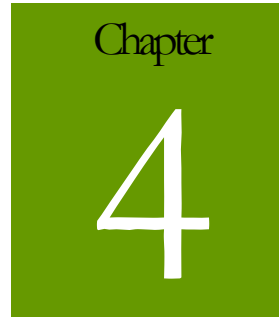
<sup>3</sup> Incidental parking allowed: surface parking for emergency vehicle access, ADA accessibility, and passenger and freight loading zones.

<sup>4</sup> Remaining portion to be used for safety access, parking structure entrances, trash and recycling service, utility access, pedestrian connections, public uses, landscaping, and stormwater treatment.

<sup>5</sup> Floor Area Ratio (FAR) is the ratio of total floor area on all floors of all buildings at a project site (except floor areas dedicated to parking) to the total project site area.

<sup>6</sup> Gross Density (DU/Acre) is the total number of residential units divided by the acreage of the entire site area, including land occupied by public right-of-way, recreational, civic, commercial, and other non-residential uses.

<sup>7</sup> Transit hub is a rail, light rail, or commuter rail station, or bus transfer station served by 3 or more bus routes. A bus stop with no supporting services does not qualify. A planned transit hub is a station on the Metropolitan Transportation Commission's Regional Transit Expansion Program's list.



## Design and Construction of Bioretention Facilities and Other Integrated Management Practices

*Guidance for preparing construction documents  
and overseeing construction of IMPs*

Details of construction are critical to ensuring stormwater facilities work properly. A misplaced inlet, an overflow at the wrong elevation, or the wrong soil mix can make a bioretention facility useless or ineffective even before it comes on-line and could result in delays to project approvals and additional expense.

Your Stormwater Control Plan is intended for the planning phase and must contain, at minimum, enough detail to demonstrate your planned LID features and that facilities are feasible and are coordinated with the project site plan, architectural renderings, landscape design, grading and drainage plan, and other information submitted with your application for development approvals.

At plan check, reviewers will examine the construction documents to ensure the site design features and the construction of bioretention facilities and other IMPs will meet the criteria in this chapter and throughout the *Guidebook*.

Following are design sheets for:

- Self-treating and self-retaining areas,
- Pervious pavements,
- Bioretention facilities,
- Flow-through planters,



- Dry wells,
- Cisterns + bioretention, and
- Bioretention + vaults.

These design sheets include recommended configurations and details, and example applications, for these features and facilities. **The information in these design sheets 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 features and facilities is the responsibility of the applicant. Effective operation of facilities throughout the project's lifetime will be the responsibility of the property owner.

### What to Show on Construction Plans

With few exceptions, the plan set should include separate sheets specifically incorporating the features and facilities described in the Stormwater Control Plan. 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.

On the grading and drainage plan, or on a separate stormwater control plan sheet showing the grading and drainage plan (and possibly the roof plan) screened as background, show how DMAs follow grade breaks and are consistent with the grading plan and the Stormwater Control Plan.

#### ► SHOW KEY ELEVATIONS

On the grading and drainage plan, or in a detailed plan view, call out the following elevations:

- Bottom of gravel layer (BGL, or the bottom of the excavation), top of gravel layer (TGL), and top of soil layer (TSL). Note that each of these is consistent (flat) throughout the facility.
- The top of curbs or walls surrounding the facility, and spot elevations of adjacent pavement.
- At curb cut inlets, show the top of paving, top of curb, and bioretention TSL.
- At overflow grates, show the grate elevation and the adjacent TSL.
- Call out elevations of piped inlets.

For treatment-and-flow-control IMPs, demonstrate how the minimum surface volume  $V_1$  is attained by the design.

► **SHOW HOW RUNOFF FLOWS**

As needed for clarity, show the direction of runoff flow across roofs and pavement and into IMPs. 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 IMP.

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

► **SHOW IMPS IN CROSS-SECTION**

For many installations, a not-to-scale cross-section view can be used to illustrate the dimensions and placement of the soil and gravel layers, surrounding walls, and overflow structures. Where needed, use detailed, specific cross-section drawings to show edge treatments, inlet elevations, overflow grates, rock for energy dissipation, moisture barriers, and other information.

Use the design sheets as a general guide, but do not just copy and paste the illustrative drawings there on to your construction drawings.

► **ADD NOTES TO IMP DETAILS**

On cross-section drawings, incorporate the following notes (see pages 62 through 74).

- Gravel drainage layer shall be “Class 2 permeable,” Caltrans specification 68-2.02(F)(3).
- Soil mix shall meet “Specification of Soils for Biotreatment or Bioretention Facilities,” dated April 18, 2016.
- Underdrain shall be [4 inch minimum] Standard Dimensional Ratio (SDR) 35 or equivalent, perforations facing down. Lay in groove at top of gravel layer.
- Underlying soil is to be uncompacted and ripped to loosen.

### What to Show on Landscaping Plans

Show the footprints of the IMPs precisely on the landscaping plan, consistent with the grading plan and other plans in the submittal.

Include a planting plan and an irrigation plan suitable for the soils and other special conditions of bioretention facilities. See page 93 for guidance on plantings and irrigation and the plant list in Appendix B for ideas on a plant palette.

Review and revise your landscaping general notes to ensure the notes are consistent with the special requirements of bioretention facilities.

Include the following notes on the landscaping plan sheets:

- No soil amendments, fertilizers, or synthetic pesticides are to be used within bioretention facilities. Use only approved bioretention soil mix and aged compost mulch.
- Maintain top of soil elevation following planting.

#### References and Resources

- San Francisco [\*Stormwater Management Requirements and Design Guidelines\*](#)
- Central Coast Low Impact Development Center [\*Bioretention Standard Details and Specifications\*](#)

# Runoff Reduction Measures

1. **Self-Treating Areas**
2. **Self-Retaining Areas**
3. **Areas Draining to Self-Retaining Areas**

Runoff-reduction site-design measures are the most effective and least expensive way to implement LID.

- Manage drainage from pervious landscaped areas separately, so that it doesn't run on to adjacent pavement.
- Further reduce runoff by dispersing runoff from impervious roofs and pavement to landscaped areas.

To incorporate these features into your project, **delineate and classify the Drainage Management Areas** (DMAs) appropriately on your Stormwater Control Plan Exhibit. See page 35.

Follow the criteria below in your Exhibit and grading and drainage plan.

**Note:** Runoff from drainage management areas that do not meet the criteria for self-treating areas, self-retaining areas, or areas draining to self-retaining areas must be directed to bioretention facilities or other IMPs.

## Best Uses

- Sites with extensive landscaping

## Advantages

- Low cost
- No maintenance verification requirement
- Complements site landscaping

## Limitations

- Requires substantial square footage
- Grading requirements must be coordinated with landscape design



CONTRA COSTA  
**CLEAN WATER**  
P R O G R A M

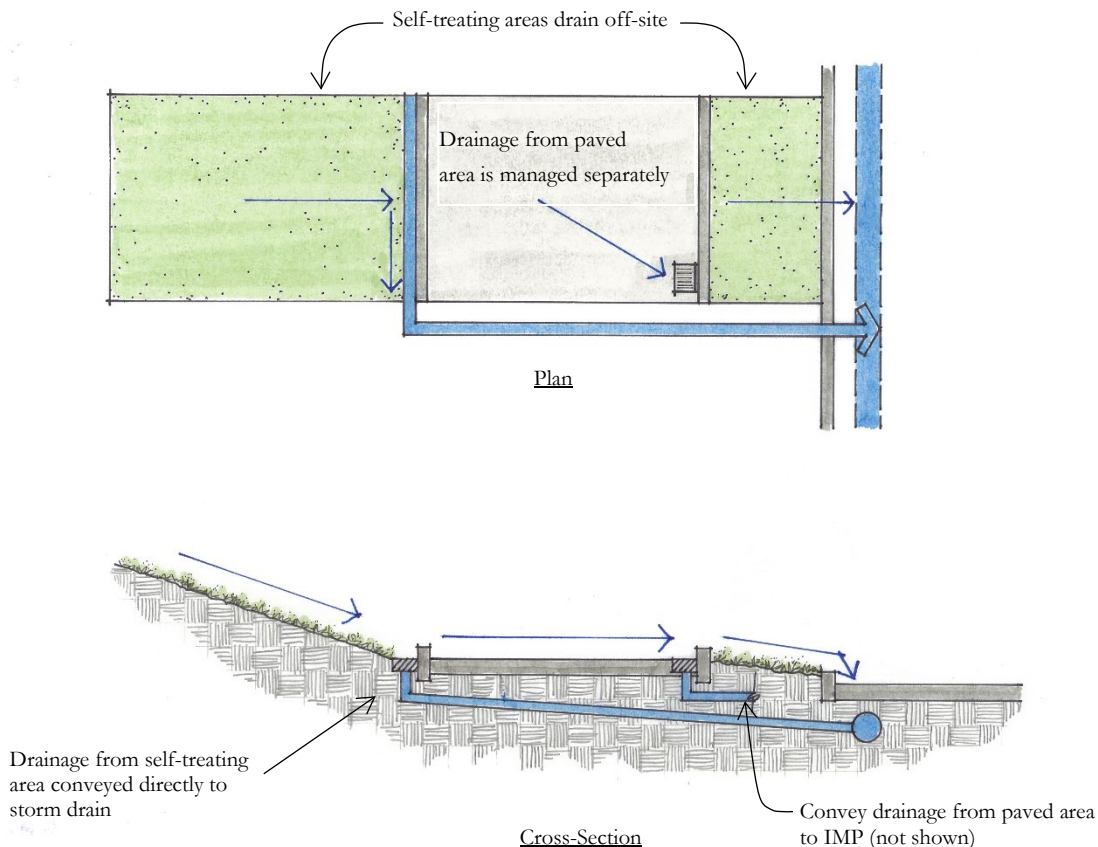
*Stormwater C.3  
Guidebook*

[www.cccleanwater.org](http://www.cccleanwater.org)

## 1. Self-Treating Areas

Self-treating drainage management areas are natural, landscaped, or turf areas that drain directly off site or to the storm drain system. Examples include upslope undeveloped areas from which runoff is piped or ditched and drained around a development and grassed slopes that drain offsite to a street gutter. Self-treating areas must not drain on to adjacent paved areas within the project.

Drainage from self-treating areas must flow to off-site streets or storm drains without flowing on to paved areas within the project. Lawn or landscaped areas adjacent to streets can be considered self-treating areas. Pavement within a self-treating area must not exceed 5% of the total area.



### ► CRITERIA FOR SELF-TREATING AREAS

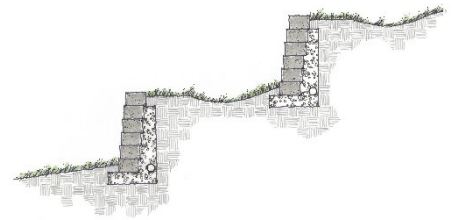
- ☐ Runoff from the self-treating area does not enter an IMP or another drainage management area, but goes directly offsite or to the storm drain system.
- ☐ The self-treating area is at least 95% lawn or landscaping (not more than 5% impervious).
- ☐ Re-graded or re-landscaped areas have amended soils, vegetation, and irrigation as may be required to maintain soil stability and permeability.

## 2. Self-Retaining Areas

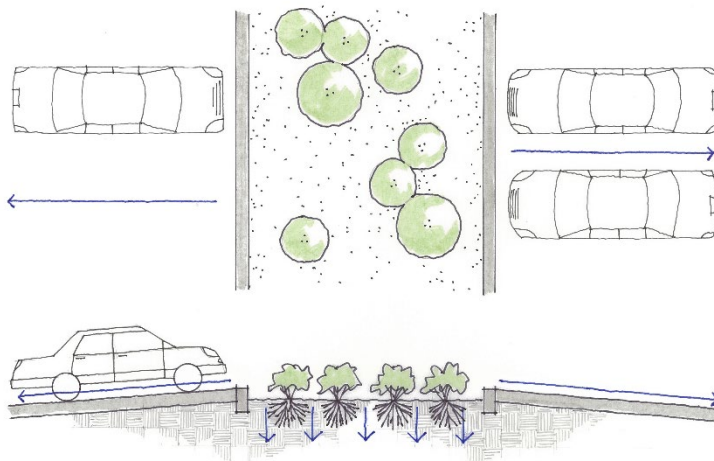
Where a landscaped area is upslope from or surrounded by paved areas, a self-retaining drainage management area (also called a zero-discharge area) may be created. Self-retaining areas are designed to retain the first one inch of rainfall without producing any runoff. The technique works best on flat, heavily landscaped sites. It may be used on mild slopes if there is a reasonable expectation that the first inch of rainfall would produce no runoff.

To create self-retaining turf and landscape areas in flat areas or on terraced slopes, berm the area or depress the grade into a concave cross-section so that these areas will retain the first inch of rainfall.

Self-retaining areas can also be created by depressing lawn and landscape below surrounding sidewalks and plazas. Leave enough reveal (elevation difference) to accommodate buildup of turf or mulch.

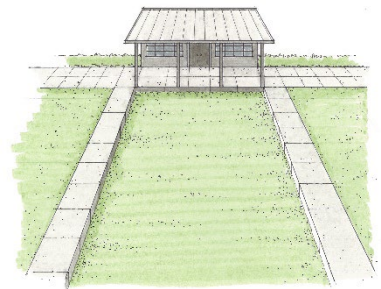


Slope terraced to create a self-retaining area



### ► CRITERIA FOR SELF-RETAINING AREAS

- ☐ Area is bermed all the way around or graded concave.
- ☐ Slopes do not exceed 4%.
- ☐ Entire area is lawn, landscaping, or pervious pavement (see criteria for pervious pavement).
- ☐ Area has amended soils, vegetation, and irrigation as may be required to maintain soil stability and permeability.
- ☐ Any area drain inlets are at least 3 inches above surrounding grade.
- ☐ Overflow (which may occur during high-intensity events) is conveyed safely.



Lawn depressed to create a self-retaining area

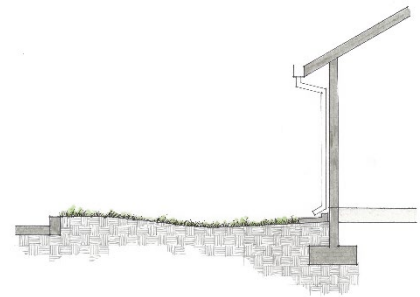
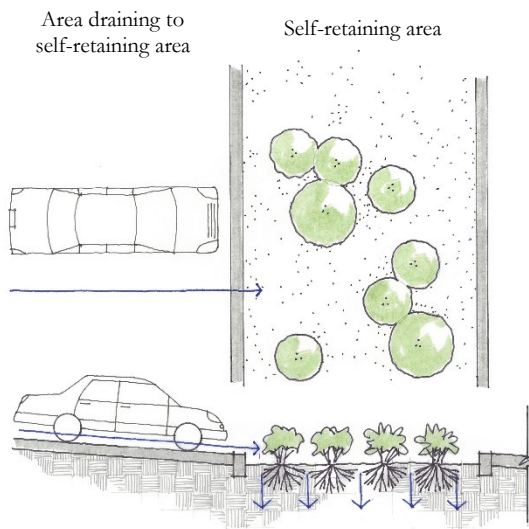
### 3. Areas draining to self-retaining areas

Drainage from roofs and paving can be directed to self-retaining drainage management areas and allowed to infiltrate into the soil. The maximum ratios are:

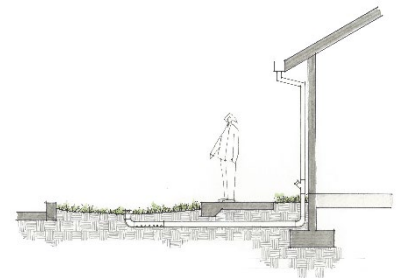
Site requirement	Maximum allowable ratio
Treatment only	2 parts impervious: 1 pervious
Treatment and flow-control	1 part impervious: 1 pervious

The self-retaining area must be bermed or depressed to retain an inch of rainfall including the flow from the tributary impervious area. Inlets of area drains, if any, should be set 3 inches above the low point to allow ponding. Self-retaining areas should be designed to promote even distribution of ponded runoff over the area.

Runoff from walkways or driveways in parks and park-like areas can sheet-flow to self-retaining areas. Roof leaders can be connected to self-retaining areas by piping beneath plazas and walkways. If necessary, a “bubble-up” can be used.



Roof runoff is directed to an adjacent self-retaining landscaped area.



A roof leader extends to a bubble-up to convey roof runoff to a self-retaining area.

#### ► CRITERIA FOR AREAS DRAINING TO SELF-RETAINING AREAS

- ☐ Ratio of tributary impervious area to self-retaining area is not greater than 2:1 (1:1 if flow-control requirements apply).
- ☐ Roof leaders collect runoff and route it to the self-retaining area.
- ☐ Paved areas are sloped so drainage is routed to the self-retaining area.
- ☐ If runoff is concentrated where it enters the self-retaining area, there are appropriate measures to protect against erosion and promote flow across the self-retaining area.

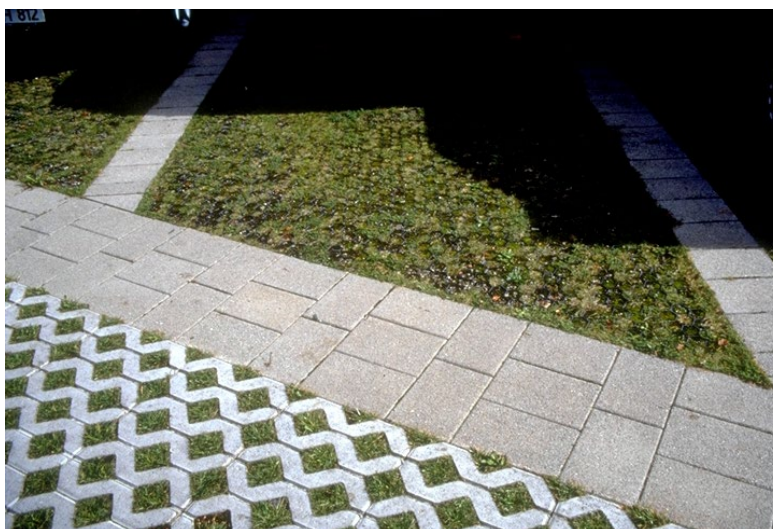


## Pervious Pavements



Impervious roadways, driveways, and parking lots account for much of the hydrologic impact of land development. Pervious pavements allow rainfall to collect in a gravel or sand base course and infiltrate into native soil instead of creating runoff.

Pervious pavements are often costly to build and maintain when compared to conventional pavement draining to bioretention facilities. However, in some applications the aesthetic or practical benefits of a flat surface unbroken by drainage structures may be worth the additional cost.



### Best Uses

- Flat areas (< 2% slope)
- Areas with competent, permeable native soils
- Low-traffic areas
- Where aesthetic quality can justify higher cost

### Advantages

- No maintenance verification requirement for installations < 3000 square feet
- Surface treatments can complement landscape design

### Limitations

- Initial cost
- Placement requires specially trained crews
- Geotechnical concerns, especially in clay soils
- Concerns about pavement strength and surface integrity



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**Pervious pavements are not treatment facilities.** However, they may be configured as self-retaining areas. In specific, limited circumstances, pervious pavements configured as self-retaining areas may receive some runoff from roofs or conventional pavement—if it can be shown that the required amount of runoff, as well as rain falling on the pervious pavement, will infiltrate into the underlying soil.

Solid unit pavers—such as bricks, stone blocks, or precast concrete shapes—are considered to reduce runoff compared to impervious pavement, when the unit pavers are set in sand or gravel with 3/8-inch gaps between the pavers. Joints must be filled with an open-graded aggregate free of fines.

If pervious pavement areas drain to Integrated Management Practices (IMPs), use the runoff factors in Table 3-2 when sizing the IMPs.

#### ► DETAILS

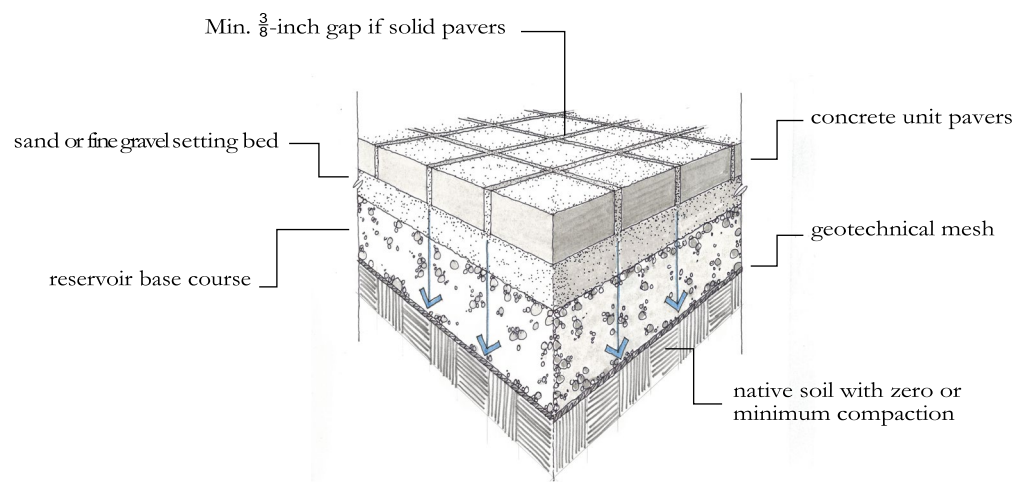
Permeable pavements can be used in clay soils; however, special design considerations, including an increased depth of base course, typically apply and will increase the cost of this option. Geotechnical fabric between the base course and underlying clay soil is recommended.

Permeable pavements are best used on grades from flat to approximately 2%. Installations on steeper grades, particularly on clay soils, require cut-off trenches lateral to the slope—to intercept, store, and infiltrate drainage from the base course.

Pavement strength and durability typically determines the required depth of base course. If underdrains are used, the outlet elevation must be a minimum of 3 inches above the bottom elevation of the base course.

Pervious concrete and porous asphalt must be installed by crews with special training and tools. Industry associations maintain lists of qualified contractors.

Parking lots with crushed aggregate or unit pavers may require signs or bollards to organize parking.



**TYPICAL CONFIGURATION** for a pervious pavement. The base course is a minimum 3-inch depth for runoff retention. A deeper base course is typically required for pavement stability.

► **CRITERIA FOR PERVIOUS PAVEMENTS**

- ☐ Installation is flat or < 2% grade.
- ☐ No erodible areas drain on to pavement.
- ☐ Subgrade is uniform and slopes are not so steep that subgrade is prone to erosion. Compaction is minimal.
- ☐ Reservoir base course is of open-graded crushed stone. Base depth is adequate to retain rainfall and support design loads.
- ☐ If a subdrain is provided, outlet elevation is a minimum of 3 inches above highest point of bottom of base course.
- ☐ Rigid edge is provided to retain granular pavements and unit pavers.
- ☐ Solid unit pavers, if used, are set in sand or gravel with minimum 3/8-inch gaps between the pavers. Joints are filled with an open-graded aggregate free of fines.
- ☐ **Permeable concrete and porous asphalt, if used, are installed by qualified professionals according to vendor's recommendations.**
- ☐ Selection and location of pavements incorporates Americans with Disabilities Act requirements, site aesthetics, and uses.
- ☐ Pavement design and/or grading design incorporates management of design flows to avoid local flooding (typically a 10-year storm).

► **RESOURCES**

National Ready Mix Concrete Association  
<http://www.perviouspavement.org/>.

National Asphalt Pavement Association  
[www.asphaltpavement.org](http://www.asphaltpavement.org).

Interlocking Concrete Pavement Institute  
<http://www.icpi.org/>.

*Start at the Source Design Manual for Water Quality Protection*, pp. 47-53. <http://www.cccleanwater.org/c3-resources.html>.

*Porous Pavements*, by Bruce K. Ferguson. 2005. ISBN 0-8493-2670-2.

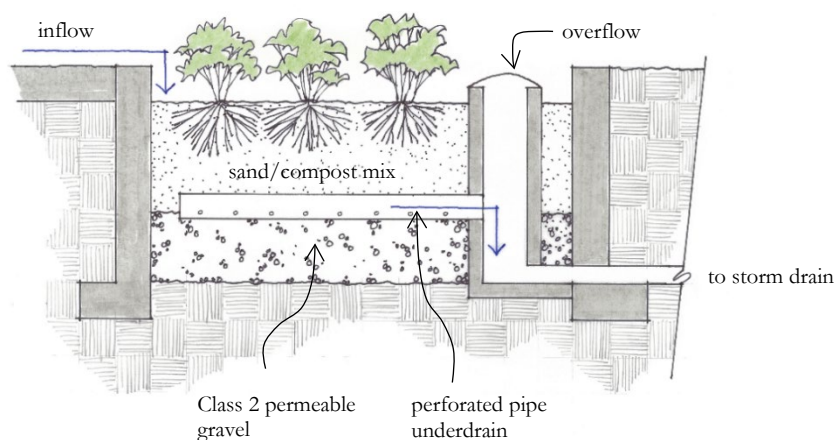
Caltrans. 2013. *Pervious Pavement Design Guidance*.  
[http://www.dot.ca.gov/hq/oppd/stormwtr/bmp/DG-Pervious-Pvm\\_082114.pdf](http://www.dot.ca.gov/hq/oppd/stormwtr/bmp/DG-Pervious-Pvm_082114.pdf).

## Bioretention Facilities



Bioretention facilities can be rectangular, linear, or nearly any shape.  
*Photo by Scott Wikstrom*

Bioretention facilities capture runoff in a shallow reservoir on the soil surface, then filter the runoff through plant roots and a biologically active soil mix. The treated runoff then trickles into a subsurface gravel layer. Runoff is held in the gravel layer until it infiltrates it into the ground. If the entire gravel layer becomes saturated, an underdrain conveys excess treated runoff to a storm drain or to surface drainage.



### Best Uses

- Commercial areas
- Residential subdivisions
- Industrial facilities
- Roadways
- Parking lots
- Fit in setbacks, medians, and other landscaped areas

### Advantages

- Can be any shape
- Low maintenance

### Limitations

- Require 4%-15% of tributary impervious square footage
- Typically require 3-4 feet of head
- Irrigation may be required



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## LAYOUT AND SITE DRAINAGE

See the guidance on page 32-33 regarding how to incorporate bioretention facilities into your site. Also see “Integrating Your LID Design into Your Project” on page 49, and ideas on applications and ancillary uses on page 73. Place bioretention facilities in visible, well-trafficked areas and make them a focal point in the landscape.

- On flatter sites, use surface drainage, rather than underground pipes, to convey runoff to the bioretention facility inlets. The top of soil elevation should be as high as possible—typically 6 to 12 inches below surrounding grade.
- Where possible, design site drainage so only impervious roofs and pavement drain to the bioretention facility. Avoid high walls or steep slopes adjacent to bioretention facilities. Avoid side slopes within bioretention areas as much as possible. The bioretention soil mix will tend to rill even on very mild slopes (>8:1).
- Integrate bioretention facilities with the landscape design.
- Make the bioretention facilities level around their perimeter.
- Where possible, grade tributary paved areas to sheet flow runoff and disperse it among curb cuts, rather than concentrating flow at one inlet location.
- Place each facility in a common, accessible area. Avoid locating facilities on private residential lots.

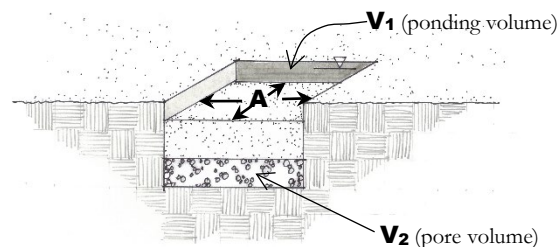
### ► DIMENSIONS

For development projects subject only to **runoff treatment requirements**, the following minimum dimensions apply.

Parameter	Criterion
Surface reservoir mean depth	6-inch minimum
Soil mix surface area	0.04 × equivalent tributary impervious area (or per reduced sizing if applicable, see p. 50).
Soil mix depth	18-inch minimum
Gravel layer	12-inch minimum Class 2 permeable
Underdrain discharge	At top of gravel layer

Where **flow-control requirements** also apply, the bioretention facility must be designed to meet the minimum surface area ( $A$ ), surface volume ( $V_1$ ), and subsurface volume ( $V_2$ ) using Equation 3-3 and the sizing factors and equations in Tables 3-6 and 3-7.

Use the IMP Sizing Calculator for sizing and to show calculations.



**Surface storage and overflow.** In treatment-and-flow-control facilities, the overflow elevation must be set to achieve the minimum surface storage volume calculated using Equation 3-3 and the  $V_1$  sizing factor. The  $V_1$  volume is based on the required area times a 12-inch depth, but the designer can also meet  $V_1$  volume by a larger than required area and reducing depth.

**Minimum subsurface volume.** For treatment-and-flow-control facilities the minimum subsurface volume  $V_2$  specified in Table 3-6 is the void space, not the entire volume of gravel. Where the native soils are Hydrologic Soil Group C or D,  $V_2$  may be achieved by a 30-inch deep layer of gravel **of 40% porosity**, extending under the minimum footprint “A”. Note that if the facility area is increased, the required depth to achieve the same volume is correspondingly decreased.

If desired, voids created by buried structures such as pipes or arches, may be substituted, as long as the voids are hydraulically interconnected and the minimum subsurface volume calculated by Equation 3-3 is achieved.

#### ► FACILITY DETAILS

Prepare details and include notes on construction drawings as appropriate to your design.

**Inlets.** Curb cuts should be wide (12 inches is recommended) to avoid clogging with leaves or debris. Allow for a minimum reveal of 6 inches between the inlet and soil mix elevations to ensure turf or mulch buildup does not block the inlet. In addition, place an apron of stone or concrete, a foot square or larger, inside each inlet to prevent vegetation from growing up and blocking the inlet.

If the linear slope along the curb is greater than the orthogonal slope of the gutter pan, runoff flows will not enter the inlet efficiently. Use a drop inlet with a grate instead.

Where runoff is concentrated and conveyed to the facility via pipes or swales, protect the plants and soil mix from high-velocity flows with energy-dissipating cobble of appropriate

size. In larger installations, provide cobble-lined channels to better distribute flows throughout the facility.

“Bubble ups” can be used to dissipate energy when runoff is piped from roofs and up-gradient paved areas.

**Overflow structure.** A precast concrete catch basin or manhole is required except in small and protected facilities. The overflow elevation is critical and must be designed to achieve the surface reservoir requirements. The outlet should be designed to exclude floating mulch and debris. An atrium-style or beehive grate is recommended and may be required.

**Underdrains.** Underdrains must have their discharge elevation set at the top of gravel layer elevation. Perforated pipe can be laid in a shallow groove dug across the top of the gravel layer, holes facing down, and connected to the overflow structure. Underdrains must be constructed of rigid pipe (SDR 35 or equivalent) and provided with a cleanout.

**Flow-control orifice.** For treatment-and-flow-control facilities, the underdrain must be routed through a device designed to limit flows to that specified in Equation 3-10 or 3-11 (page 46). Typically, a section of solid pipe is designed to protrude slightly into the overflow structure. The pipe is threaded and fitted with a standard cap; a hole of the specified diameter is drilled into the cap. The cap can then be easily removed for cleaning or adjustment and reinstalled.

**Vaults, utility boxes, backflow preventers, and light standards.** Utility features and structures must be located outside the bioretention facility.

**Emergency overflow.** The site grading plan should anticipate extreme events and potential clogging of the overflow and should route emergency overflows safely.

## ► SOIL, PLANTING, AND IRRIGATION

**Gravel underlayer.** Use “Class 2 permeable,” Caltrans specification 68-2.02(F)(3). Open-graded crushed rock, washed, may be used as an alternative, but requires 4- to 6-inch washed pea gravel be substituted at the top of the crushed rock layer. **Do not use filter fabric** to separate the soil mix from the gravel drainage layer or the gravel drainage layer from the native soil.

**Planting Soil Mix.** The required mix of sand and compost is specified in BASMAA’s April 2016 “Specification of Soils for Biotreatment or Bioretention Facilities.” The mix is similar to a loamy sand and must maintain a minimum percolation rate

of 5 inches per hour throughout the life of the facility. It is suitable for maintaining plant life with no (or very little) fertilizer use. Use of the specified (rather than “alternative”) soil mix is strongly encouraged.

At their sole discretion, municipal construction inspectors may accept test results and certification for a “brand-name” mix from a soil supplier. Batch-specific testing is required for installations of over 100 cubic yards.

Submittals for the soil mix must include and follow the CCCWP “Soil Mix for Bioretention Specification Verification Checklist.” The checklist, soil mix specification, and a list of suppliers are available on the [CCCWP C.3 web page](#).

Ensure the soil mix is installed level and at the specified elevation, and that the elevation does not change when plants are installed. Place the bioretention soil in 8- to 12-inch lifts. Lifts are **not to be compacted** but are placed to reduce the possibility of excessive settlement. Allow time for natural compaction and settlement prior to planting. Bioretention soil may be watered to encourage compaction.

**Planting.** Species in Appendix B were selected for:

- Adaptation to Contra Costa’s climate
- Drought tolerance
- Adaptation to well-drained soils
- Adaptation to low soil fertility
- Allow infiltration
- Not invasive weeds
- Do not have aggressive roots

Characteristics noted in the table, including irrigation preferences and ability to tolerate heat, coastal conditions, flooding, and wind should be considered when selecting plants.

This list is not comprehensive, nor will all these species succeed at every site. Selection for a particular site should be done by experienced professionals familiar with the plants and site conditions. Avoid planting species on the California Invasive Plant Council’s invasive plant inventory list.

Trees and large shrubs installed in bioretention facilities are susceptible to blowing over before roots are established. They



should be staked securely. Three stakes per tree are recommended at windy sites. Straps should be inspected once or twice a year and removed once trees are established to prevent girdling.

**Mulch** is not required but is recommended for the purpose of retaining moisture, preventing erosion and minimizing weed growth. Compost meeting the specification for use in the planting soil mix is recommended for use as mulch. This “aged mulch” has less tendency to float compared to bark mulch.

**Irrigation.** Bioretention soils have a high infiltration rate and require a different irrigation system design than the designs typically used for heavy clay soils in Contra Costa County. Irrigation systems must be designed to minimize water use, avoid overwatering, and prevent underdrain discharges during dry weather.

Bioretention facilities and planter boxes may need to be irrigated more than once a day, for shorter periods. Irrigation controls should allow separate control of times and durations of irrigation for bioretention facilities and planter boxes vs. other landscape areas.

Smart irrigation controllers are strongly encouraged. Available controllers may access weather stations, use sensors to measure soil temperature and moisture, and allow input of soil types, plant types, root depth, light conditions, slope, and usable rainfall.

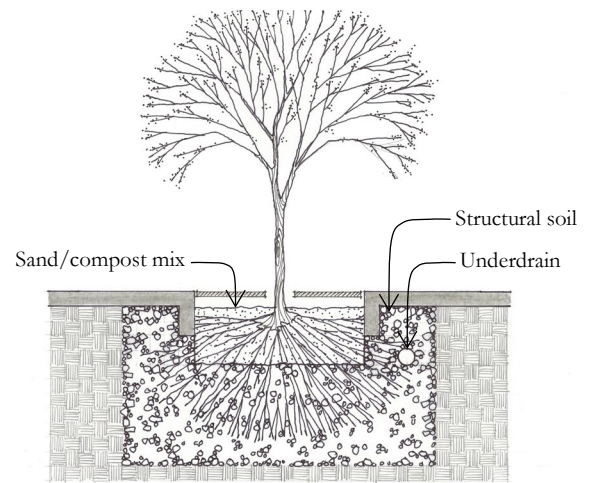
Drip emitters are strongly recommended over spray irrigation. Use multiple, lower-flow (1/2 to 2 gallons per hour) emitters in fast-draining bioretention soils. Use two or more emitters for perennials, ground covers, and bunchgrasses. Four to six emitters may be needed for larger shrubs and trees. Some types of emitters encourage horizontal distribution of water.

Spray heads must be positioned to avoid direct spray into bioretention facility or planter box outlet structures.

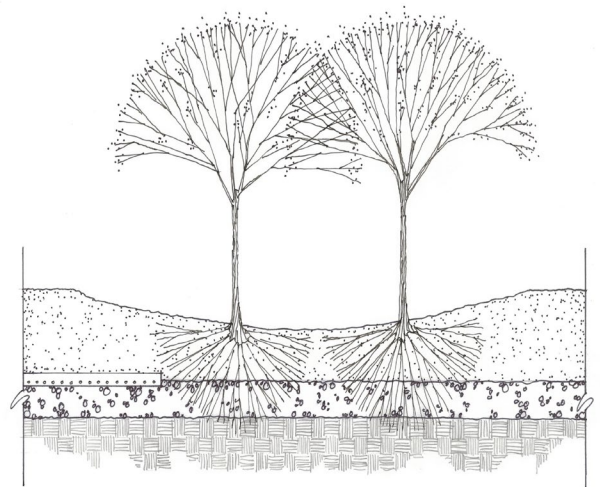
**Trees.** Bioretention areas can accommodate small or large trees within the minimum areas and volumes calculated by Equation 3-3. Tree canopies intercept rain, and tree roots maintain soil permeability and help retain runoff. Normal maintenance of a bioretention facility should not affect tree lifespan.

Consider the following when designing bioretention facilities to accommodate trees, especially large trees:

- The bioretention facility requires 18 inches of soil mix over the minimum surface area. Trees can be planted in this soil mix; the area occupied by the tree counts toward the minimum area requirement.
- Trees require sufficient rooting volume to thrive. [Structural soils](#) can be used below or around the soil mix.
- Most tree roots extend horizontally near the soil surface.
- The bioretention soil mix has low moisture-holding capacity. Consider planning for tree roots to access native clay soils through the side walls as the tree grows. However, where needed, adjacent paving or structures can be protected with a root barrier.
- A podium of native soil is sometimes constructed so that the root ball can be installed at the correct elevation (so that bioretention soil mix and mulch do not cover the tree's root collar).
- Large trees should be spaced appropriately for their size at maturity.
- Trees may need to be staked for longer because the bioretention soil mix provides little structural support against trees being toppled by wind.



Bioretention facility configured as a tree well.



Larger bioretention facility with trees.

## ► APPLICATIONS AND ANCILLARY USES

**Multi-purpose landscaped areas.** Bioretention facilities are easily adapted to serve multiple purposes. The loamy sand soil mix will support either turf or a plant palette suitable to the location and a well-drained soil.

**Residential subdivisions.** In the design of many subdivisions, it has proven easiest and most effective to drain roofs and driveways to the streets (in the conventional manner) and then drain the streets to bioretention areas, with one bioretention area for each 1 to 10 lots, depending on subdivision layout and topography.



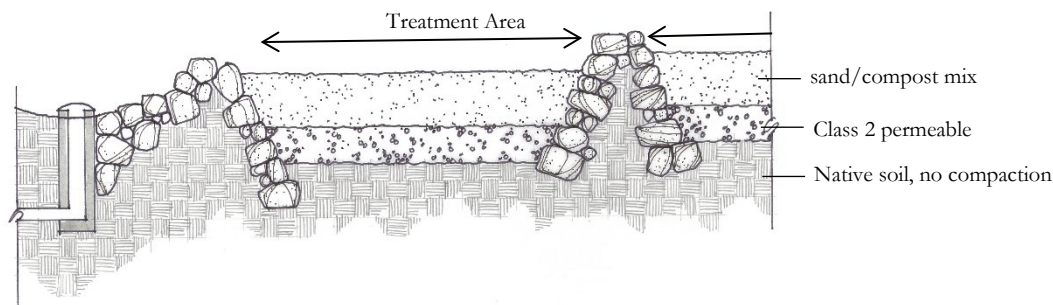
Bioretention facility in El Cerrito with active and passive recreational uses.

Bioretention areas should be placed in common areas or on one or more separate, dedicated parcels with joint ownership.

**Sloped sites.** Bioretention facilities must be constructed as a basin or as a series of basins, with the circumference of each basin level.

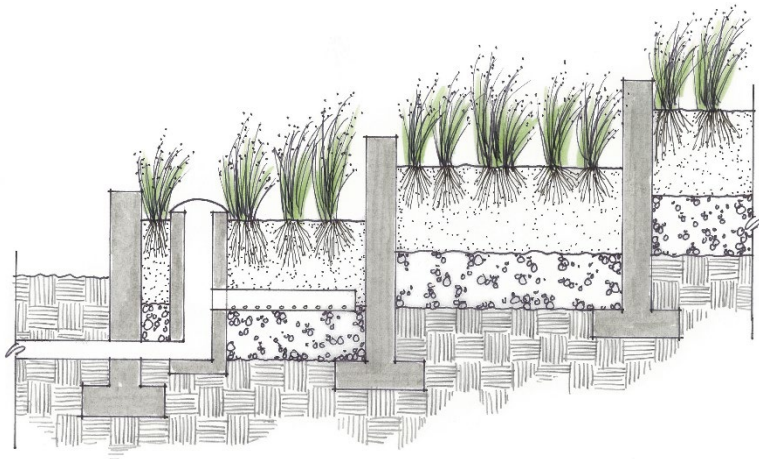
On the surface, a bioretention facility should be one level, shallow basin—or a series of basins. As runoff enters each basin, it should flood and fill throughout before runoff overflows to the outlet or to the next downstream basin. This helps prevent movement of surface mulch and soil mix.

Swales can be used on mild slopes. Check dams should be placed every 4 to 6 inches of elevation change and so that the lip of each dam is at least as high as the toe of the next upstream dam.



Swale with check dams. Not suitable for steeper slopes. Movement of soil can be a problem even at mild slopes. Design must ensure ponding behind each check dam.

A series of planters is a more robust solution and is required for steeper slopes.



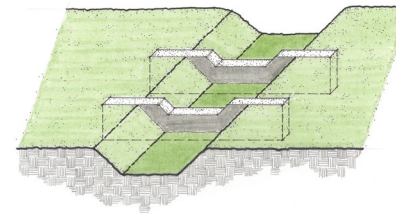
Concrete check dams are a better solution on steeper slopes.

**Solutions for surface storage.** Placing a steep-sided depression in an urban landscape poses aesthetic challenges as well as practical challenges. First, use sheet flow, valley gutters, and trench drains, instead of pipes, to move runoff to the bioretention facility, so that inlets can be at or near ground level.

To further avoid the effects of high and steep drop offs, consider:

- Increasing the facility area and reducing the surface depth accordingly.
- Incorporating steps down into the facility.
- Specifying taller, woody plants to block or discourage entry.

Mulch can be mounded a few inches deeper at walkway edges to transition to the top of soil elevation.



Key check dams into bottom and side slopes.

## References and Resources

- [Model Biotreatment Soil Media Specifications—MRP 2.0 Provision C.3.c.i.\(2\)\(c\)\(ii\)](#)
- *Recommendations for Soils Specification, Planting, and Irrigation of Bioretention Facilities*, WRA Environmental Consultants, November 5, 2008.
- [US Composting Council](#)
- [ASTM International](#)
- *Plant List and Planting Guidance for Landscape-Based Stormwater Measures*. Appendix B in the *Alameda County Clean Water Program C.3 Technical Guidance* (2016).
- *Plants and Landscapes for Summer Dry Climates*. Nora Harlow, Ed. East Bay Municipal Utility District, Oakland.
- *California Native Plants for Your Garden and Wildlife*. Las Pilitas Nursery, 2008.
- *Native Treasures: Gardening with the Plants of California*. M. Nevin Smith, 2016. University of California Press.
- *The Calflora Database, 2008*.
- [California Invasive Plant Council](#)
- *A Guide to Estimating Irrigation Water Needs of Landscape Plantings in California*, University of California Cooperative Extension and California Department of Water Resources.
- [Our Water Our World](#), website developed to assist consumers in managing home and garden pests in a way that helps protect water.
- [Bay-Friendly Best Practices for Landscape Professionals](#), a whole systems approach to the design, construction, and maintenance of the landscape to support the integrity of the San Francisco Bay watershed.
- [University of California Statewide Integrated Pest Management \(IPM\) Program](#)

## Criteria for Bioretention

- ☐ Bioretention facilities are located in a visible, well-trafficked area.
- ☐ Top of soil elevation is as high as possible. High walls and steep slopes adjacent to the facility are avoided.
- ☐ Location and footprint of facility are congruent on the site plan, landscaping plan, and grading plan.
- ☐ Bioretention area is designed as a basin (level edges) or a series of basins, and grading plan is consistent with these elevations. Check dams, if any, are set so the lip or weir of each dam is at least as high as the toe of the next upstream dam.
- ☐ Volume or depth of surface reservoir meets or exceeds minimum. Freeboard above overflow (1 to 2 inches recommended) is not included in surface reservoir volume.
- ☐ 18-inch depth specified soil mix.
- ☐ Area of soil mix meets or exceeds minimum.
- ☐ Perforated pipe (PVC SDR 35 or approved equivalent) underdrain with discharge elevation **at the top** of the “Class 2 perm” layer. Holes facing downward. Connection and sufficient head to storm drain or approved discharge point.
- ☐ No filter fabric.
- ☐ Underdrain has a clean-out port consisting of a vertical, rigid, non-perforated PVC pipe, with a minimum diameter of 4 inches and a watertight cap.
- ☐ Curb inlets are 12-inch wide, have 4 to 6-inch reveal and an apron or other provision to prevent blockage when vegetation grows in, and energy dissipation as needed.

- ☐ Overflow catch basin or manhole connected to a downstream storm drain or approved discharge point.
- ☐ Emergency spillage will be safely conveyed overland.
- ☐ Plantings are suitable to the climate, exposure, and a well-drained soil, and occasional inundation during large storm events.
- ☐ Irrigation system with connection to water supply, on a separate zone.
- ☐ Vaults, utility boxes, backflow preventers, and light standards are located outside the minimum soil mix surface area.

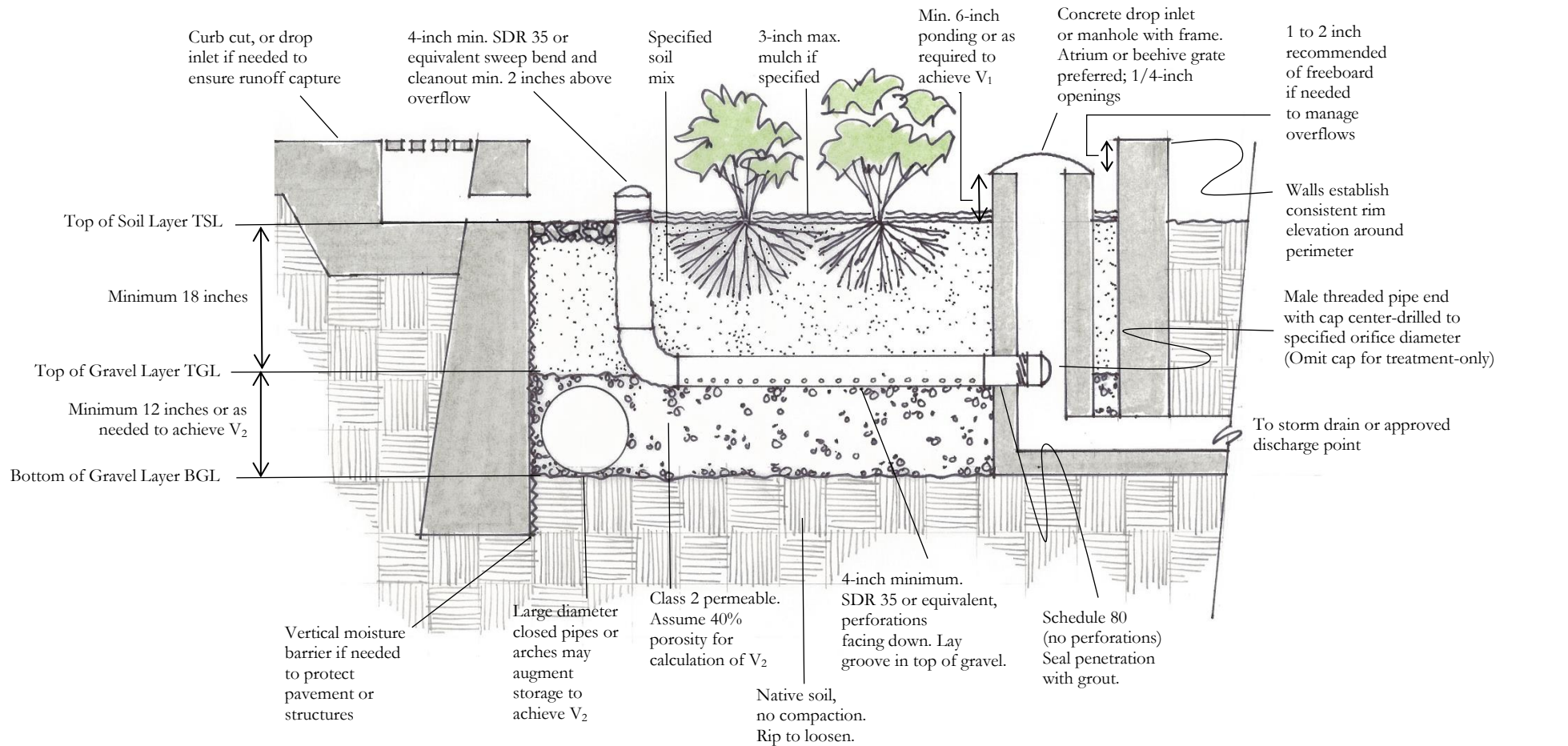
**For treatment-and-flow-control facilities only**

- ☐ Volume of surface storage meets or exceeds minimum ( $V_1$ ).
- ☐ Volume of subsurface storage meets or exceeds minimum ( $V_2$ ).
- ☐ In “C” and “D” native soils, underdrain is connected to discharge through an appropriately sized orifice or other flow-limiting device.



# Bioretention Facility

Cross-section  
Not to Scale

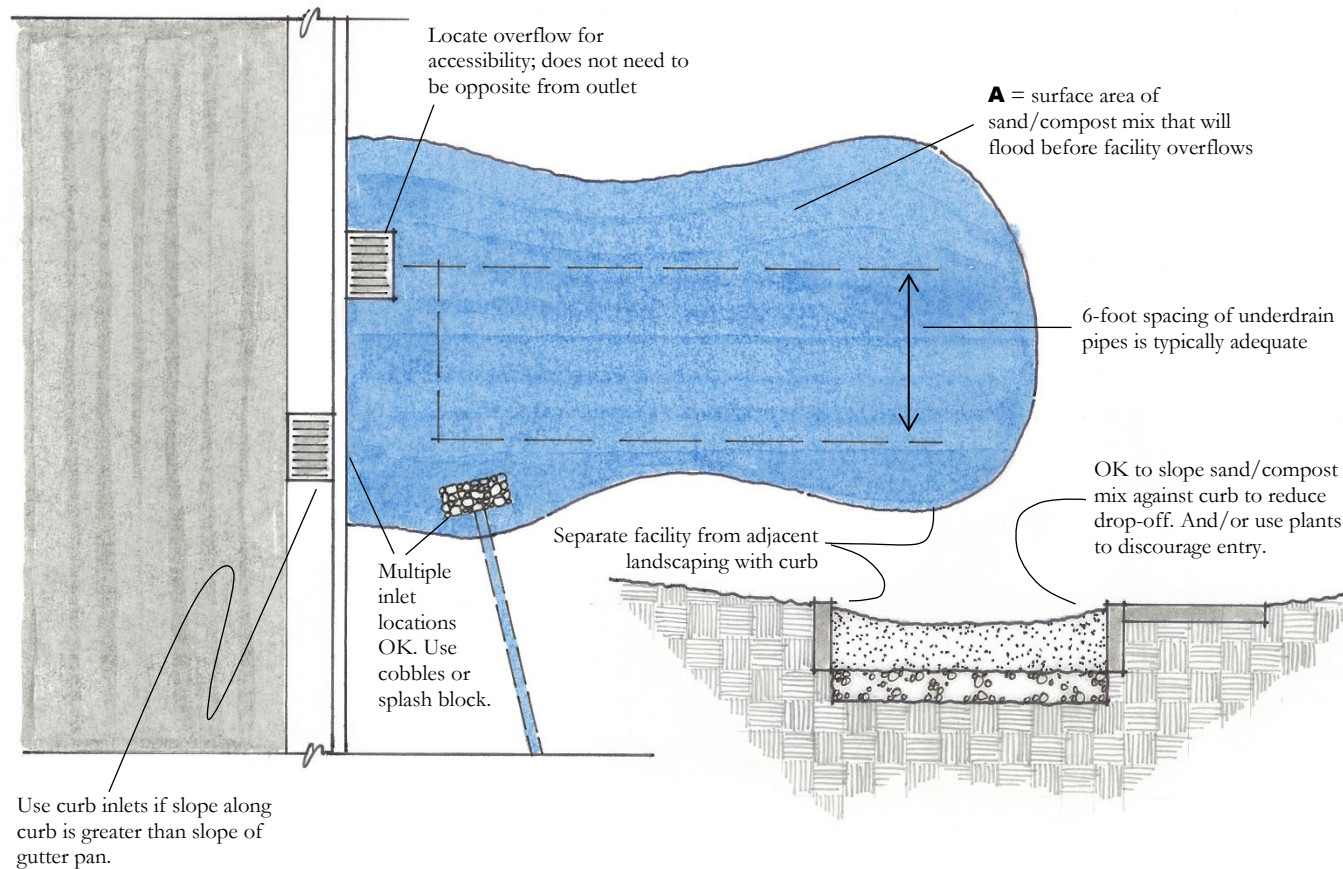


## Notes:

- No liner, no filter fabric, no landscape cloth.
- Maintain BGL, TGL, TSL throughout facility area at elevations to be specified on drawing.
- Class 2 perm layer may extend below and underneath drop inlet.
- Invert elevation of perforated pipe underdrain discharge is at TGL.
- See Chapter 3 for factors and equations used to calculate  $V_1$ ,  $V_2$  and orifice diameter.

# Bioretention Facility

Plan  
Not to Scale





## Flow-through Planter

Unlike bioretention facilities, flow-through planters are designed to discharge all influent runoff following treatment, rather than infiltrating some treated runoff into the underlying soil.

Flow-through planters are contained within a concrete box, or plastic liners may be used on the sides and bottom. An underdrain is constructed with the discharge elevation near the bottom of the gravel layer (that is, there is no “dead” storage).”

Flow-through planters may be used as an alternative to bioretention under certain conditions:

- Upper-story plazas
- Where bioretention facilities could cause mobilization of pollutants in soil or groundwater.
- Other situations where infiltration is a concern, such as locations with potential geotechnical hazards that cannot be mitigated except by preventing infiltration.

### Best Uses

- Management of roof runoff
- Podium-style developments
- On building plazas

### Advantages

- Versatile
- Can be any shape
- Low maintenance

### Limitations

- Can only be used where infiltration is not possible
- May not be used for flow control (HM) where underlying soils are Hydrologic Soil Group “A” or “B”
- Requires underdrain
- Requires 3 to 4 feet of head



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## ► DIMENSIONS AND MATERIALS

**Treatment only.** For development projects subject only to runoff treatment requirements, the following criteria apply:

Parameter	Criterion
Surface reservoir depth	6-inch minimum
Soil mix surface area	$0.04 \times$ tributary impervious area
Soil mix depth	18-inch minimum
Gravel layer	12-inch minimum Class 2 permeable
Underdrain	At bottom of gravel layer

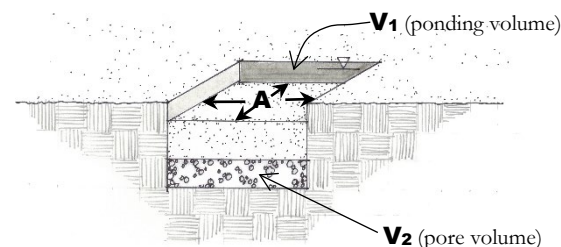
Where **flow-control requirements** also apply, the flow-through planter must be designed to meet the minimum surface area ( $A$ ), surface volume ( $V_1$ ), and subsurface volume ( $V_2$ ) using Equation 3-3 and the sizing factors and equations in Tables 3-6 and 3-7. The IMP Sizing Calculator should be used.

**Minimum surface and subsurface volume.** In a vertical-sided box-like planter for treatment-and-flow-control with the minimum surface area  $A$ , the minimum surface volume  $V_1$  can be achieved with an overflow height of 10 inches (12-inch total height of walls with 2 inches of freeboard).

For treatment-and-flow-control facilities the minimum subsurface volume  $V_2$  specified in Table 3-8 is the void space, not the entire volume of gravel. The minimum subsurface volume  $V_2$  can be achieved with a gravel (Class 2 permeable) depth of 30 inches. This combination results in a planter approximately 5' high. The planter height can be reduced by incorporating void-creating underdrain pipes, other pipes, or arches, or by increasing the planter area so that the minimum  $V_2$  is achieved.

**Gravel.** “Class 2 permeable,” Caltrans specification 68-2.02(F)(3), is preferred. Open-graded crushed rock, washed, may be used, but requires 4- to 6-inch washed pea gravel be substituted at the top of the crushed rock layer. **Do not use filter fabric** to separate the soil mix from the gravel drainage layer or the gravel drainage layer from the native soil.

If desired, voids created by buried structures such as pipes or arches may be substituted, as long as the voids are hydraulically interconnected and the minimum subsurface volume calculated by Equation 3-3 is achieved.



**Soil mix.** Criteria for the required mix of sand and compost are in Appendix B. It is similar to a loamy sand and must maintain a minimum percolation rate of 5 inches per hour throughout the life of the facility, and it must be suitable for maintaining plant life with a minimum of fertilizer use. A list of suppliers is on the C.3 web pages.

**Underdrains.** Underdrains must have their discharge elevation set as flush with the planter bottom as possible. Underdrains must be constructed of rigid pipe (SDR 35 or equivalent) and provided with a cleanout.

**Flow-control orifice.** For treatment-and-flow-control facilities, the underdrain must be routed through a device designed to limit flows to that specified in Equation 3-10 or 3-11 (page 46). Typically, a section of solid pipe is designed to protrude slightly into the overflow structure. The pipe is threaded and fitted with a standard cap; a hole of the specified diameter is drilled into the cap. The cap can then be easily removed for cleaning or adjustment and reinstalled.

## ► APPLICATIONS

**At plaza level.** Flow-through planters have been successfully incorporated into podium-style developments, with the planters placed on the plaza level and receiving runoff from the tower roofs above. Runoff from the plaza level is typically managed separately by additional flow-through planters or bioretention facilities located at street level.

**Adjacent to buildings.** Designers should aim to use bioretention facilities (that is, facilities open at the bottom to allow infiltration) adjacent to buildings. An impermeable vertical cutoff wall between the facility and the building may be incorporated. Where it is not feasible to adjust the building and foundation design, flow-through planters may be used. Planter vegetation can soften the visual effect of the building wall. A setback with a raised planter box may be appropriate even in some neo-traditional pedestrian-oriented urban streetscapes.

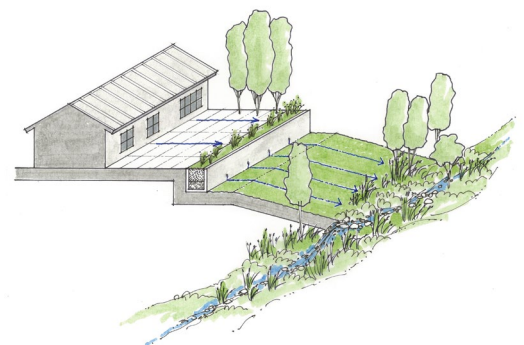
**Steep slopes.** Flow-through planters provide a means to detain and treat runoff on very steep slopes that cannot accept infiltration from a bioretention facility. The planter can be built into the slope similar to a retaining wall. The design should consider the need to access the planter for maintenance. Flows from the planter underdrain and overflow must be directed in accordance with local requirements. It is sometimes possible to disperse these flows to the downgradient hillside.



Flow-through planters on the plaza level of a podium-style development.



Bioretention facility adjacent to building. An impermeable cutoff wall between the facility and the building may be incorporated.



Flow-through planter built into a hillside. Flows from the underdrain and overflow must be directed in accordance with local requirements.

## Design Checklist for Flow-through Planter

- ☐ Location and footprint of facility are shown on site plan and landscaping plan.
- ☐ Planter is set level.
- ☐ Location is on an upper-story plaza, adjacent to a building foundation, where mobilization of pollutants in soil or groundwater is a concern, or where potential geotechnical hazards are associated with infiltration.
- ☐ Volume or depth of surface reservoir meets or exceeds minimum.
- ☐ 18-inch depth specified soil mix (reference *Guidebook* Appendix B).
- ☐ Area of soil mix meets or exceeds minimum.
- ☐ “Class 2 perm” drainage layer.
- ☐ No filter fabric.
- ☐ Perforated pipe (PVC SDR 35 or approved equivalent) underdrain with outlet located flush or nearly flush with planter bottom.
- ☐ Connection with sufficient head to storm drain or discharge point.
- ☐ Underdrain has a clean-out port consisting of a vertical, rigid, non-perforated PVC pipe, with a minimum diameter of 4 inches and a watertight cap.
- ☐ Overflow outlet connected to a downstream storm drain or approved discharge point.
- ☐ Emergency spillage will be safely conveyed overland.
- ☐ Plantings are suitable to the climate, exposure, and a well-drained soil.
- ☐ Irrigation system with connection to water supply, on a separate zone. See Appendix B.

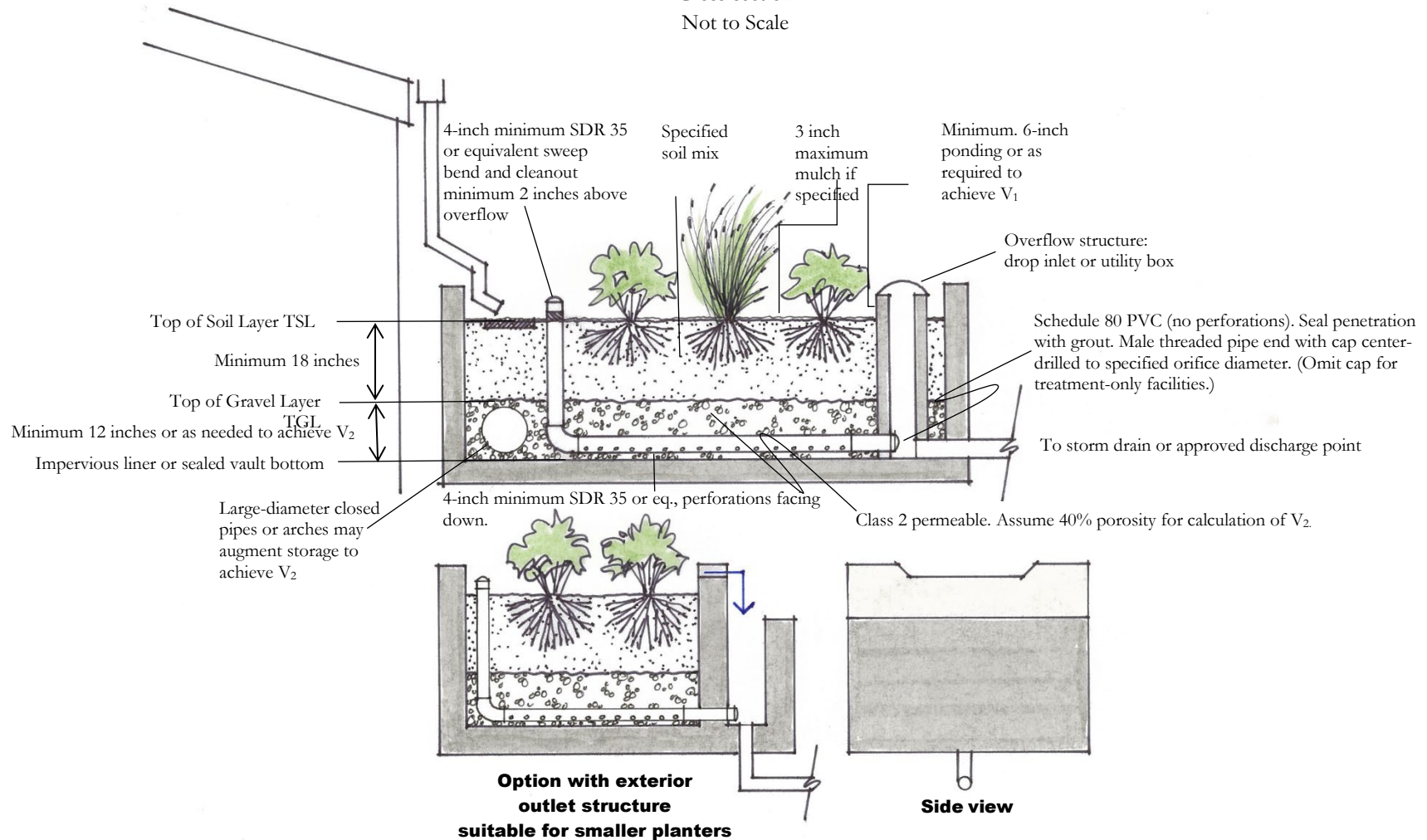
### For treatment-and-flow-control flow-through planters only

- ☐ Volume of surface storage meets or exceeds minimum.
- ☐ Volume of subsurface storage meets or exceeds minimum.
- ☐ Underdrain is connected via an appropriately sized orifice or other flow-limiting device.

# Flow-through Planter

Cross-section

Not to Scale



## Notes:

- Underdrain to be minimum 4-inch PVC SDR 35 or equiv. with holes facing down.
- Locate underdrain as close as possible to bottom.
- No filter fabric, no landscape cloth.
- See Appendix B for soil mix specification, planting and irrigation guidance.
- See Chapter 3 for factors and equations used to calculate  $V_1$   $V_2$  and orifice diameter.



## Dry Wells and Infiltration Basins

The typical dry well is a prefabricated structure, such as an open-bottomed vault or box, placed in an excavation or boring. The vault may be empty, which provides maximum space efficiency, or may be filled with rock.

An infiltration basin has the same functional components—a volume to store runoff and sufficient area to infiltrate that volume into the native soil—but is open rather than covered.

### ► CRITERIA

Dry wells and infiltration basins must be designed with the minimum volume and infiltrative area calculated by Equation 3-3 using the sizing factors in Table 3-6.

Consult with the local municipal engineer regarding the need to verify soil permeability and other site conditions are suitable for dry wells and infiltration basins. Some proposed criteria are on Page 5-12 of Caltrans' 2004 *BMP Retrofit Pilot Study Final Report* (CTSW-RT-01-050).

### ► DETAILS

Dry wells should be sited to facilitate maintenance and allow for the potential future need for removal and replacement.

In locations where native soils are coarser than a medium sand, the area directly beneath the facility should be over-excavated by 2 feet and backfilled with sand as a groundwater protection measure.

### Best Uses

- Projects on sites with permeable soils

### Advantages

- Compact footprint
- Can be installed in paved areas

### Limitations

- Can be used only on sites with Group “A” or Group “B” soils
- Requires minimum of 10 feet from bottom of facility to seasonal high groundwater
- Not suitable for drainage from some industrial areas or arterial roads
- Must be maintained to prevent clogging
- Typically, not as aesthetically pleasing as bioretention facilities

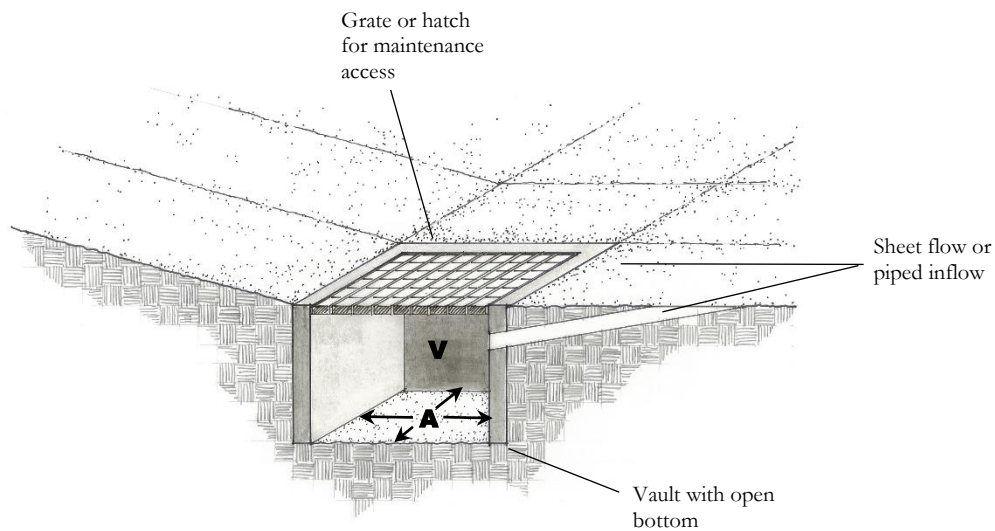


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## Criteria for Dry Wells and Infiltration Basins

- ☐ Volume (V) and infiltrative area (A) meet or exceed minimum.
- ☐ Emergency spillage will be safely conveyed overland.
- ☐ Depth from bottom of the facility to seasonally high groundwater elevation is  $\geq 10$  feet.
- ☐ Areas tributary to the facility do not include automotive repair shops; areas subject to high vehicular traffic (25,000 or greater average daily traffic on main roadway or 15,000 or more average daily traffic on intersecting roadway), car washes; fleet storage areas (bus, truck, etc.); nurseries, or other uses that may present an exceptional threat to groundwater quality.
- ☐ Underlying soils are in Hydrologic Soil Group A or B. Infiltration rate is sufficient to ensure a full basin will drain completely within 72 hours. Soil infiltration rate has been confirmed.
- ☐ 10-foot setback from structures or as recommended by structural or geotechnical engineer.





## Cistern + Bioretention Facility

A cistern in series with a bioretention facility or flow-through planter can meet treatment and flow-control requirements where space is limited. The cistern includes an orifice for flow control. The downstream bioretention facility or flow-through planter is sized to accommodate the maximum flow from the cistern orifice.

### ► CRITERIA

**Cistern.** Size the cistern using Equation 3-3 (page 45) and the factors and rainfall adjustment equations in Tables 3-6 and 3-7. The cistern must also include an orifice or other device to limit outflow to the calculated maximum release rate.

**Bioretention facility.** Size the bioretention facility or flow-through planter based on the cistern maximum release rate and a maximum surface loading rate of 5 inches per hour.

### ► DETAILS

**Preventing mosquito harborage.** Cisterns should be designed to drain completely, leaving no standing water. Drains should be located flush with the bottom of the cistern. Alternatively—or in addition—all entry and exit points should be provided with traps or sealed or screened to prevent mosquito entry. Note mosquitoes can enter through openings 1/16 inch or larger and will fly for many feet through pipes as small as 1/4 inch.

**Exclude debris.** Provide leaf guards and/or screens to prevent debris from accumulating in the cistern.

**Ensure access for maintenance.** Design the cistern to allow for cleanout. Avoid creating the need for maintenance workers to enter a confined space. Ensure the outlet orifice can be easily accessed for cleaning and maintenance.

### ► APPLICATIONS

**Shallow ponding on a flat roof.** The “cistern” storage volume can be designed in any configuration, including simply storing rainfall on the roof where it falls and draining it away slowly. In sites with Group “D” soils, the required average depth amounts to about 3/4 inch.

### Best Uses

- To meet flow-control requirements in limited space
- Management of roof runoff
- Dense urban areas

### Advantages

- Storage volume can be in any configuration
- Small footprint

### Limitations

- Somewhat complex to design, build, and operate
- Requires head for both cistern and bioretention facility



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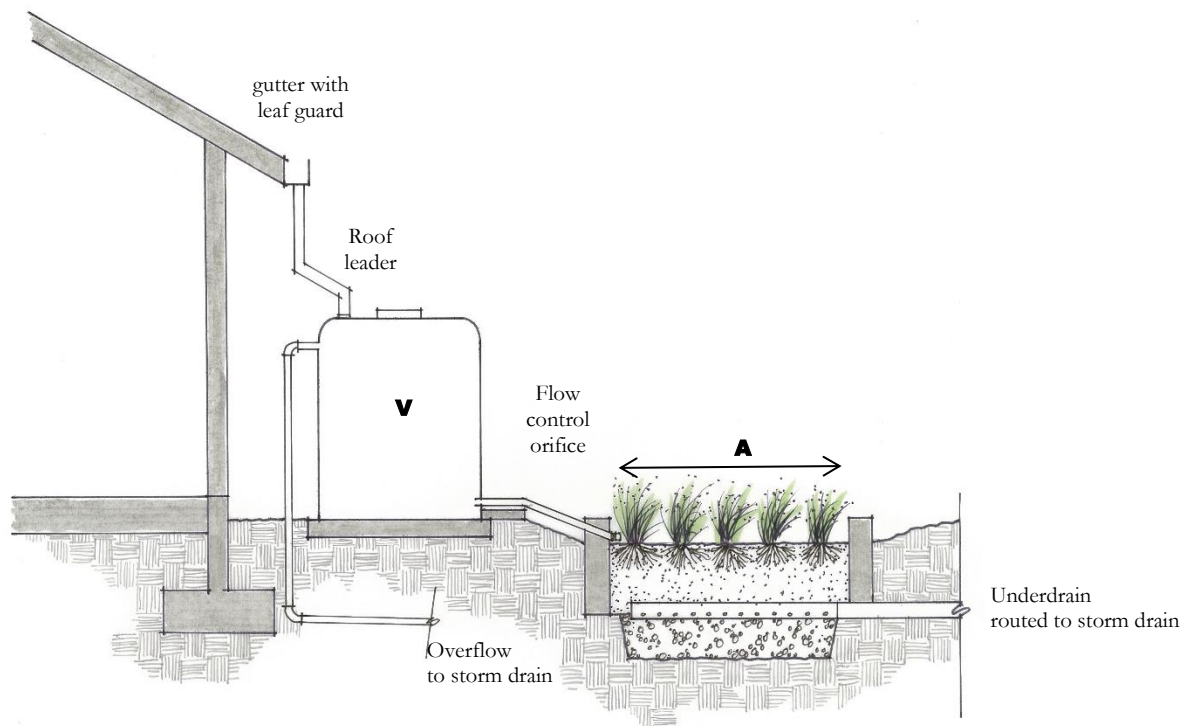
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### **Cistern attached to a building and draining to a planter.**

This system for treatment-and-flow-control can be constructed with a flow-through planter at a height as low as 30 inches.

#### **Criteria for Cistern + Bioretention**

- ☐ Cistern volume meets or exceeds calculated minimum  $V$  (Eq. 3-3).
- ☐ Cistern outlet with orifice or other flow-control device restricts flow to calculated maximum. A drilled, threaded cap is suggested for easy maintenance.
- ☐ Cistern outlet is piped to bioretention area or flow-through planter.
- ☐ Bioretention surface area meets or exceeds the calculated minimum.
- ☐ Except for surface area, bioretention facility is designed to the criteria for “treatment only” in the “Bioretention Facility” design sheet (p. 66) or “Flow-through Planter” design sheet (p. 79).
- ☐ Cistern is designed to drain completely and/or sealed to prevent mosquito harborage.
- ☐ Design provides for exclusion of debris and accessibility for maintenance.
- ☐ Overflow connected to a downstream storm drain or approved discharge point.
- ☐ Emergency spillage will be safely conveyed overland.



## Bioretention + Vault

A bioretention facility in series with a vault can meet treatment and flow-control requirements where space is limited. In this configuration, the bioretention facility is sized to a minimum of 4% of the tributary impervious area. The underdrain and overflow from the bioretention facility are routed to a storage vault, which can be located beneath a plaza, sidewalk, or parking area. An orifice limits the rate of discharge from the vault to the storm drain system.

### ► CRITERIA

**Bioretention facility.** Size and design the bioretention facility to the treatment-only criteria (see Bioretention Facility design sheet, p. 66.)

**Vault.** Size the vault using Equation 3-3 (page 45) and the factors and rainfall adjustment equations in Tables 3-6 and 3-7. The vault must include an orifice or other device to limit outflow.

Dead storage in the bioretention facility (volume of the gravel pore space or other free volume below the elevation of the underdrain discharge) may be credited toward the required  $V_2$ .

### ► DETAILS

**Preventing mosquito harborage.** Vaults must be designed to drain completely, leaving no standing water, and have an open bottom to allow infiltration into the native soil.

**Ensure access for maintenance.** Design the vault to allow for cleanout. Avoid creating the need for maintenance workers to enter a confined space. Ensure the outlet orifice can be easily accessed for cleaning and maintenance.

### ► APPLICATIONS

**Parking lot.** Because the required landscaped bioretention facilities is only 4% of the tributary impervious area, the bioretention component can in many cases be integrated into parking lot medians and islands. The vault component can be located beneath aisles or driveways.

### Best Uses

- To meet flow-control requirements in limited space
- Parking lots
- Dense urban areas

### Advantages

- Smaller footprint than bioretention facility sized for flow control

### Limitations

- Somewhat complex to design, build, and operate
- Requires head for both bioretention facility and vault



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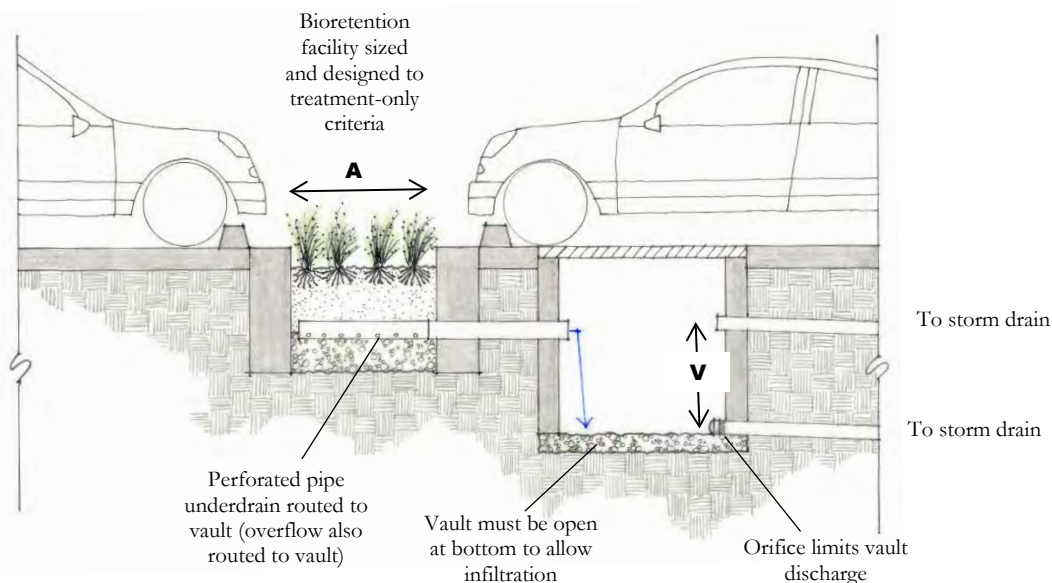
### Multiple bioretention facilities draining to a single vault.

Two or more bioretention areas can be connected to a single vault. The vault minimum volume and outlet maximum flow rate are the sum of those calculated for each individual bioretention facility.

**Vault with pumped discharge.** Where insufficient head exists, vaults may be equipped with pumps to discharge (at a rate no greater than the calculated maximum) to a storm drain or approved discharge point.

### Design Checklist for Bioretention + Vault

- ☐ Bioretention facility is designed to the treatment-only criteria in the “Bioretention Facility” design sheet (pp. 66-78).
- ☐ Vault retention volume meets or exceeds calculated minimum.
- ☐ Vault outlet with orifice or other flow-control device restricts flow to calculated maximum.
- ☐ Bioretention facility underdrain is routed to the vault.
- ☐ Bioretention facility overflow is routed to the vault.
- ☐ Sufficient head exists to convey flow from the underdrain to the vault and from the vault to the discharge point.
- ☐ Bottom of vault is open to allow infiltration.
- ☐ Vault design provides for exclusion of debris and accessibility for maintenance.
- ☐ Vault outlet and overflow are connected to a downstream storm drain or approved discharge point.
- ☐ Emergency spillage will be safely conveyed overland.



### Items to Be Inspected During Construction

Successful construction of IMPs 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 cleanup and inspection.

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

- Runoff flow from the intended tributary DMA must flow into the facility.
- The surface reservoir must fill to its intended volume during high inflows.
- Runoff must filter rapidly through the layer of imported soil mix.
- Filtered runoff must infiltrate into the native soil to the extent possible (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.

### Bioretention Soil Submittals

Bioretention soils must meet the region-wide “[Specification of Soils for Biotreatment or Bioretention Facilities](#)” (2016).

At their sole discretion, municipal construction inspectors may choose to accept test results and certification for a “brand name” mix from a soil supplier. Tests must be conducted within 120 days prior to the date soil is delivered to the project site. Batch-specific test results are required for projects that install more than 100 cubic yards of soil mix.

Submittals, whether for the “brand name” mix or batch-specific, must include a minimum 1-gallon sample and the completed CCCWP Bioretention Soil Mix Specification Submittal Verification Checklist.

The inspector should examine by look and feel each delivery of the soil mix prior to installation and verify the following:

- The delivered mix closely resembles the submitted mix.

## **CONTRA COSTA CLEAN WATER PROGRAM**

- The mix has a grainy, gritty texture and does not clump when dry.
- If formed in the hand when damp, the mix may be slightly spongy but breaks apart easily.
- After manipulating the mix, there is no smearing or discoloration on the hand.

IMP CONSTRUCTION CHECKLIST

LAYOUT (to be confirmed prior to beginning excavation)

- ☐ Square footage of the facility meets or exceeds minimum shown in Stormwater Control Plan
- ☐ Site grading and grade breaks are consistent with the boundaries of the tributary Drainage Management Area(s) (DMAs) shown in the Stormwater Control Plan
- ☐ Inlet elevations of the facility are low enough and inlets 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 and are outside of the facility footprint
- ☐ 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 1/4 inch openings recommended)
- ☐ Overflow is connected to storm drain via appropriately-sized piping
- ☐ Bottom of overflow structure has positive drainage into storm drain (no ponding)

UNDERGROUND CONNECTION TO STORM DRAIN/OUTLET ORIFICE

(to be confirmed prior to backfilling IMP 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) or orifice (treatment-and-flow-control)
- ☐ Underdrain pipe discharge invert elevation is at top of gravel layer elevation. Pipe is set holes facing down in a groove dug in the top of the gravel layer (In approved flow-through planters, underdrain 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 on next page)

### IMP CONSTRUCTION CHECKLIST (CONTINUED)

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

- ☐ Class 2 permeable, Caltrans specification 68-2.02(F)(3). 4-inch to 6-inch depth of pea gravel atop drain rock may be substituted with inspectors' approval
- ☐ Rock is smoothed to a consistent top elevation and depth and top elevation (TGL) are as shown in plans
- ☐ Perimeter curb is installed to prevent sloughing of native soils into the facility
- ☐ No filter fabric is placed between the subdrain and soil mix layers

#### SOIL MIX

- ☐ Soil mix is as specified. Submittal is complete and quality of delivered mix is verified by visual and tactile examination and comparison to submitted sample
- ☐ Mix installed in 8-inch to 12-inch lifts
- ☐ 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 inches minimum) and top elevation are as shown in plans, accounting for depth of mulch to follow and required reservoir depth (allow time for natural compaction and settlement prior to planting)

#### 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 to 2 inches of 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

- ☐ DMAs 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



## **CONTRA COSTA CLEAN WATER PROGRAM**

- The mix has a grainy, gritty texture and does not clump when dry.
- If formed in the hand when damp, the mix may be slightly spongy but breaks apart easily.
- After manipulating the mix, there is no smearing or discoloration on the hand.

IMP CONSTRUCTION CHECKLIST

LAYOUT (to be confirmed prior to beginning excavation)

- ☐ Square footage of the facility meets or exceeds minimum shown in Stormwater Control Plan
- ☐ Site grading and grade breaks are consistent with the boundaries of the tributary Drainage Management Area(s) (DMAs) shown in the Stormwater Control Plan
- ☐ Inlet elevations of the facility are low enough and inlets 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 and are outside of the facility footprint
- ☐ 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 1/4 inch openings recommended)
- ☐ Overflow is connected to storm drain via appropriately-sized piping
- ☐ Bottom of overflow structure has positive drainage into storm drain (no ponding)

UNDERGROUND CONNECTION TO STORM DRAIN/OUTLET ORIFICE

(to be confirmed prior to backfilling IMP 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) or orifice (treatment-and-flow-control)
- ☐ Underdrain pipe discharge invert elevation is at top of gravel layer elevation. Pipe is set holes facing down in a groove dug in the top of the gravel layer (In approved flow-through planters, underdrain 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 on next page)

### IMP CONSTRUCTION CHECKLIST (CONTINUED)

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

- ☐ Class 2 permeable, Caltrans specification 68-2.02(F)(3). 4-inch to 6-inch depth of pea gravel atop drain rock may be substituted with inspectors' approval
- ☐ Rock is smoothed to a consistent top elevation and depth and top elevation (TGL) are as shown in plans
- ☐ Perimeter curb is installed to prevent sloughing of native soils into the facility
- ☐ No filter fabric is placed between the subdrain and soil mix layers

SOIL MIX

- ☐ Soil mix is as specified. Submittal is complete and quality of delivered mix is verified by visual and tactile examination and comparison to submitted sample
- ☐ Mix installed in 8-inch to 12-inch lifts
- ☐ 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 inches minimum) and top elevation are as shown in plans, accounting for depth of mulch to follow and required reservoir depth (allow time for natural compaction and settlement prior to planting)

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 to 2 inches of 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

- ☐ DMAs 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

## Operation & Maintenance of Stormwater Facilities

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

Stormwater NPDES Permit Provision C.3.e requires each municipality verify stormwater treatment and flow-control facilities, and impervious pavement installations 3,000 ft<sup>2</sup> and greater in area, are adequately maintained. Municipalities must report the results of inspections to the Water Board annually.

Facilities you install as part of your project will be incorporated into the local municipality'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 Stormwater Control Plan. The Stormwater Control Plan must also identify the means by which ongoing maintenance will be assured (for example, a maintenance agreement that runs with the land).
2. Identify typical maintenance requirements, allow for these requirements in your project planning and preliminary design, and document the typical maintenance requirements in your Stormwater Control Plan.
3. Prepare an **Operations 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 municipality prior to building permit final and issuance of a certificate of occupancy. Local requirements vary as to schedule. Check with municipal staff.
4. **Maintain** the facilities 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 should be consistent with local municipality requirements.
6. Maintain the facilities in perpetuity and comply with your municipality's self-inspection, reporting, and verification requirements.

See the schedule for these stages in Table 5-1. **Again, local requirements will vary.**

TABLE 5-1. SCHEDULE FOR PLANNING operation and maintenance of stormwater treatment and flow-control facilities

<i>Stage</i>	<i>Description</i>	<i>Where documented</i>	<i>Schedule</i>
1	Determine facility ownership and maintenance responsibility	Stormwater Control Plan	Discuss with planning staff at pre-application meeting
2	Identify typical maintenance requirements	Stormwater Control Plan	Submit with planning & zoning application
3	Develop detailed operations and maintenance plan	O&M Plan	Submit draft with Building Permit application; final due before building permit final and applying for a Certificate of Occupancy
4	Interim operations and maintenance of facilities	As required by municipal O&M verification program	During and following construction including warranty period
5	Formal transfer of operations & maintenance responsibility	As required by municipal O&M verification program	On sale and transfer of property or permanent occupancy
6	Ongoing maintenance and compliance with inspection & reporting requirements	As required by municipal O&M verification program	In perpetuity

### Stage 1: Ownership and Responsibility

Your Stormwater Control Plan must specify a means to **finance and implement maintenance** of treatment and flow-control facilities **in perpetuity**.

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

- Execution of a maintenance agreement that “runs with the land.”
- Creation of a homeowner’s association (HOA) and execution of an agreement by the HOA to maintain the facilities as well as an annual inspection fee.
- Formation of a new community facilities district or other special district, or addition of the properties to an existing special district.
- Dedication of fee title or easement transferring ownership of the facility (and the land under it) to the municipality.

Ownership and maintenance responsibility for treatment and flow-control facilities should be discussed at the **beginning of project planning**, typically at the pre-application meeting for planning and zoning review. Experience has shown provisions to finance and implement maintenance of treatment and flow-control facilities can be a major stumbling block to project approval, particularly for **small residential subdivisions**. (See “Applying C.3 to New Subdivisions” in Chapter 1.)

### ► PRIVATE OWNERSHIP AND MAINTENANCE

The municipality may require—as a condition of project approval—that a maintenance agreement be executed.

The CCCWP has prepared the following model agreements:

- Operation and Maintenance Agreement for a Single Parcel with a Stormwater Management Facility.
- Operation and Maintenance Agreement for Subdivisions with Stormwater Management Facilities.
- Operation and Maintenance Agreement for Subdivisions with Stormwater Management Facilities and a Homeowners Association.
- CC&R and Subdivision Map Provisions for Subdivisions with Stormwater Management Facilities.
- CC&R Provisions for Subdivisions with Stormwater Management Facilities and a Homeowners Association.

The model agreements “run 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 agreements provide the municipality may collect a management and/or inspection fee established by the standard fee schedule. In addition, the agreements provide that, if the property owner fails to maintain the stormwater facility, the municipality may enter the property, restore the stormwater facility to good working order, and obtain reimbursement, including administrative costs, from the property owner.

To augment and enforce maintenance requirements, the County established a two-tiered Community Facilities District (Mello-Roos) throughout the unincorporated area to cover the costs of inspections, reporting to the Water Board and, if necessary, code enforcement and maintenance and repair of individual facilities. Some cities and towns may have similar districts.

#### ► TRANSFER TO PUBLIC OWNERSHIP

Municipalities may sometimes choose to have a treatment and flow-control facility deeded to the public in fee or as an easement and maintain the facility as part of the municipal storm drain system. The municipality may recoup the costs of maintenance through a special tax, assessment district, or similar mechanism.

Locating an IMP in a public right-of-way or easement creates an additional design constraint—along with hydraulic grade, aesthetics, landscaping, and circulation. However, because sites typically drain to the street, it may be possible to locate a bioretention swale parallel with the edge of the parcel. The facility may complement or substitute for an underground storm drain system.

Local  
Requirements  
Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

Even if the facility is to be deeded or transferred to the municipality after construction is complete, it is still the responsibility of the builder to identify general operations and maintenance requirements, prepare a detailed operation and maintenance plan, and to maintain the facility until that responsibility is formally transferred.

## Stage 2: General Maintenance Requirements

Include in your Stormwater Control Plan 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.
- Initial maintenance and replacement of facility plantings is incorporated into landscaping contracts and guarantees.

A fact sheet available on the CCCWP C.3 web page describes general maintenance requirements for bioretention facilities.

### Stage 3: Stormwater Facilities 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 municipality, and incorporate new information and changes developed during project construction. Submit a revised, **final** O&M plan before construction is complete.

**Your O&M Plan must be submitted to and approved by your municipality before your building permit can be made final and a certificate of occupancy issued.**

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

MRP 3.0 Provision C.3.h requires Contra Costa municipalities periodically verify operations and maintenance (O&M) of facilities installed in their jurisdiction. Each year, they must report to the Water Board the facilities inspected that year and the status of each.

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.

#### ► TOOLS AND ASSISTANCE

The following step-by-step instructions—and forms available on the [CCCWP website](#)—will help you prepare your O&M Plan. You may use, adapt, and assemble these documents to prepare your own O&M Plan, which will be customized to the specific needs of your site.

The available tools and assistance includes:

- A form for stating or updating key contact information for responsible individuals.
- A format for an Inspection and Maintenance Log.



- Sample contents of an inspector's report.
- A Fact Sheet incorporating a suitable maintenance plan for bioretention facilities and flow-through planters.

Additional useful references, including links to additional documents, are available in “References and Resources” at the end of this chapter.

#### ► YOUR O&M PLAN: STEP BY STEP

The following step-by-step guidance will help you prepare each required section of your O&M Plan.

Preparation of the plan will require familiarity with your stormwater facilities as they have been constructed and a fair amount of thinking through plans for their operations 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 municipal inspectors and should sign self-inspection reports and any correspondence with the municipality regarding verification inspections.
- Employees or contractors who will report to the designated contact and are responsible for carrying out BMP O&M.
- The corporate officer authorized to negotiate and execute any contracts that might be necessary for future changes to O&M 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.

It is recommended to use the form available on the [CCCWP website](#) to list this information. **Updated contact information must be provided to the municipality immediately whenever a property is sold and whenever designated individuals or contractors change.** Complete a new form—and send a copy to the municipality—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** O&M will be assured, including sources of funds, budget category for expenditures, process for establishing the annual maintenance budget, and the 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 facilities 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 Stormwater Control Plan into your O&M Plan:

- Figures delineating and designating pervious and impervious areas.
- Figures showing locations of stormwater facilities on the site.
- Tables of pervious and impervious areas served by each facility.

Review the Stormwater Control Plan 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 FACILITIES “AS BUILT”**

Include the following information from final construction drawings:

- Plans, elevations, and details of all facilities. Annotate if necessary with designations used in the Stormwater Control Plan.
- Design information or calculations submitted in the detailed design phase (i.e., not included in the Stormwater Control Plan).
- Specifications of construction for facilities, 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 offsite discharge.
- Depths and layering of soil, sand, or gravel.

- Placement of filter fabric or geotextiles (not recommended between soil and gravel layers of bioretention facilities).
- 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 facilities 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, municipal staff, or other sources.
- Operation and Maintenance Fact Sheet for Bioretention Facilities and Flow-through Planters (available on the [C.3 Web Page](#))

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

Also include manufacturers' 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 this general outline:

- 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 treatment and flow control facilities
- 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 Facilities
  - A. Drainage Areas
    - (1) Drawings showing pervious and impervious areas (copied or adapted from Stormwater Control Plan)
    - (2) Designation and description of each drainage area and how flow is routed to the corresponding facility
  - B. Treatment and Flow Control Facilities
    - (1) Drawings showing location and type of each facility
    - (2) General description of each facility (Consider a table if more than two facilities)

- (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 O&M Plan)
- B. Manufacturers’ 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 municipality, and at least one copy kept on site. Here are some suggestions for formatting the O&M Plan:

- Format plans to 8½ by 11 inches 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 O&M Plan will be a living document.

O&M 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 updated.

Updates may be transmitted to your municipality at any time. However, at a minimum, updates to the O&M Plan must accompany the annual inspection report. These updates should reference the sections of the O&M Plan being changed and should be placed in reverse chronological order (most recent 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

In accordance with MRP 3.0 Provision C.3.e.ii, include the following statement in your Stormwater Control Plan:

The property owner accepts responsibility for interim operation and maintenance of stormwater treatment and flow-control facilities until such time as this responsibility is formally transferred to a subsequent owner.

Applicants will typically be required to warranty stormwater facilities against lack of performance due to flaws in design or construction following completion of construction. The warranty may need to be secured by a bond or other financial instrument. The warranty should be consistent with local municipality requirements.

### 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 municipality when this transfer of responsibility takes place.

### Stage 6: Operation & Maintenance Verification

Each Contra Costa municipality implements a Stormwater Treatment Measures Operation and Maintenance Verification Program, including periodic site inspections.

Local stormwater ordinances state municipalities may require an annual certificate of compliance certifying operations and maintenance of treatment and flow-control facilities. To obtain a certificate of compliance, the responsible party must request and pay for an inspection from the municipality each year. Alternatively, owners or lessees may arrange for inspection by a private company authorized by the

municipality. Based on the results of the inspection, the municipality may issue a certificate, issue a conditional certificate requiring correction of noted deficiencies by a specific date, or deny the certificate.

Some municipalities have established alternative procedures. Check with local staff for requirements.

### *Design to Minimize Long-Term Maintenance*

The design criteria on page 107 have been developed and refined, based on accumulated experience, to ensure constructed bioretention facilities are robust and resilient. When properly designed and constructed, bioretention facilities require little intervention beyond cleanup, pruning, and occasional replanting, at a level of effort similar to that required for any vegetated area.

Table 5-2 on the following page identifies how certain design criteria optimize operation and minimize long-term maintenance needs.

#### **► TYPICAL MAINTENANCE PROGRAM**

The Stormwater Facility Operation and Maintenance Fact Sheet: Bioretention Facilities and Flow-through Planters is available on CCCWP's Stormwater C.3 Guidebook web page. The fact sheet provides a typical maintenance program for bioretention facilities. The same typical maintenance program is incorporated into the template, also available on CCCWP's Stormwater C.3 Guidebook web page, for a Stormwater Facility O&M Plan.

The typical maintenance program includes:

- General maintenance rules, including a prohibition on using synthetic fertilizers, pesticides, or any soil amendments other than aged compost mulch or the approved sand/compost mix.
- Routine trash removal and weeding.
- Observations and corrections following significant rain events.
- Annual vegetation and other maintenance during winter.

TABLE 5-2. SUMMARY OF DESIGN CRITERIA adopted to ensure facility longevity and reduce required maintenance.

<i>Feature</i>	<i>Page #</i>	<i>Operation and Maintenance-Related Benefit</i>
Facility is in a high-visibility, well-trafficked location		Facility is valued for aesthetic and other ancillary benefits and is more likely to be maintained consistently
In subdivisions, facility is in an accessible common area and not on an individual lot		Avoids potential alterations to facility after construction and resulting conflicts with individual homeowners over need to restore the facility to original condition.
Consistent cross-section, configuration, and specifications for all bioretention facilities throughout County		Facilitates inspection, evaluation, and repairs if needed.
Soil mix specification		Avoids infiltration failure and ensures minimum infiltration rate (facility treatment capacity) is achieved over the long term.
Underdrain pipe specifications		Discharge elevation at top of gravel layer maximizes amount of treated runoff that is stored and infiltrated. Holes facing down prevents accumulation of soil within the underdrain pipe. Specified pipe can be rooted if needed.
Plants are required		Plant roots and associated biological activity keep soil pores open, facilitating percolation and preventing blinding/clogging of the surface and resulting loss of infiltration capacity. Aesthetic qualities of planted areas help ensure owners' attention to and engagement with the facility. Biological activity helps break down and/or immobilize pollutants.
Gravel (Class 2 permeable) specification		Resists migration of fines from overlying soil mix, eliminates need for filter fabric (which tends to clog) or additional layer atop gravel.
Top of soil elevation is flat		Maximizes surface reservoir, avoids rills in mulch and in bioretention soil mix that result from flow.
Overflow is precast concrete with frame and grate		Helps ensure overflow is at proper elevation, which ensures ponding, rather than flow, across the entire facility surface. Resistant to accidental damage (compared to an upturned plastic pipe).
Concrete curb or other hardscaped rim delineates edge of facility		Clearly shows facility boundary to guide landscape maintenance crews. Helps prevent fine sediments from adjacent slopes from entering the bioretention soil mix.



## CONTRA COSTA CLEAN WATER PROGRAM

### References and Resources

- [\*Model Stormwater Ordinance\*](#) (CCCWP, 2005)
- [\*Start at the Source\*](#) (BASMAA, 1999) pp. 139-145.
- [\*Urban Runoff Quality Management\*](#) (WEF/ASCE, 1998). pp 186-189.
- Contra Costa Clean Water Program [\*Vector Control Plan\*](#)

## Retrofitting with Green Infrastructure

*How to identify and evaluate opportunities to integrate  
LID features and facilities into existing drainage systems*

Retrofitting streets and paved areas with LID is difficult. Elevations and grades are fixed constraints—unlike a new development or fully redeveloped site, where the layout and grades of future buildings, pavement, and landscape can be adjusted during the design.

Some built locations present striking opportunities for retrofit. For many other locations, retrofitting with LID is a practical impossibility.

In a retrofit, options for LID are mostly the same as in a land development project:

- Convert impervious areas to landscape.
- Replace impervious pavement with pervious pavement.
- Disperse runoff from impervious areas to landscaped areas.
- Intercept flow in an existing swale, gutter, or pipe, direct it to a bioretention facility, and direct the underdrain and overflow from the bioretention facility to a downstream storm drain, culvert, or swale.

Design guidance and criteria for these features and facilities are in Chapter 4. Further design guidance can be found in references cited at the end of this chapter.

This chapter will help guide the process of identifying and evaluating LID opportunities in the built landscape.

## Project Identification

The most cost-effective projects involve dispersing runoff from paved areas to **self-retaining areas** via sheet flow, gutters, swales, or pipes. The receiving self-retaining area needs to be large enough—the 2:1 impervious-to-pervious ratio applies—and lower than the low point of the tributary impervious area. In an urban setting, such potential opportunities are rare. When found, as they sometimes are along landscaped medians or shoulders of suburban arterial roadways, or in plazas, parks, and golf courses, the opportunity should be investigated.

More typically, runoff from an existing catchment is diverted from the street or gutter to a **bioretention facility** built at or near an existing storm drain inlet.

## Follow these Steps

To identify and evaluate Green Infrastructure retrofit opportunities, follow these steps:

1. Locate the low points (usually existing storm drain inlets).
2. Review existing and potential landscape use adjacent to low points.
3. Evaluate the tributary catchment.
4. Calculate minimum sizes of the planned LID feature or facility.
5. Sketch and evaluate a preliminary footprint of the feature or facility.
6. Check facility inlet and outlet elevations.

### ► STEP 1: LOCATE LOW POINTS

Existing conventional drainage systems typically convey runoff via sheet flow and gutters to storm drain inlets, which connect to underground pipes. These storm drain inlets are candidate locations for LID features and facilities. Sometimes the storm drain inlet itself can be repurposed as a bioretention facility overflow with the same grate elevation.

Many municipal utility maps and geographic information system (GIS) maps include the location and size of storm drain pipes, but unfortunately do not typically include storm drain inlets. This makes the maps of little use for green infrastructure planning. Fortunately, inlet locations can often be found using satellite and street view imagery available online. A site visit may be needed to confirm inlet locations, particularly if street curbs and parking lots are parked up in the images.

### ► STEP 2: REVIEW AREAS ADJACENT TO LOW POINTS

Most low points (typically storm drain inlets) are in locations where it isn't practical to retrofit the surrounding area for bioretention.

- Many storm drain inlets are near street intersections—where sidewalks, pedestrian crossings, utilities, and other uses converge, and space is at a premium.
- In parking lots, inlets are typically centered in the drive aisle.

Traffic medians and islands are often, but not always, located at high points within the right-of-way and are rarely adjacent to storm drain inlets.

Some situations where inlet locations may create retrofit opportunities:

- Excessive street width.
- Wide parkway strip.
- Abandoned turn lane or other lane.
- Unused right-of-way at oddly configured intersection.
- Triangular area within a roadway gore (nose).
- Street narrowed (or to be narrowed) for pedestrian crossing (bulb-out).
- Adjacent to a park or green space.
- Adjacent to a utility easement
- Unused/abandoned right-of-way, for example, from a realigned roadway or former streetcar line.

Existing drainage swales or ditches, including short runs between culverts, are typically ineligible to be converted for bioretention treatment because of restrictions in Clean Water Act Sections 401 and 404.

### ► STEP 3: EVALUATE THE TRIBUTARY CATCHMENT

Once a potential location for a bioretention facility has been identified, the next step is to determine whether the facility can be sized adequately to receive the amount of runoff draining to that location.

Storm drain inlets are seldom shown on municipal utility maps, and the areas tributary to each inlet are generally not mapped. Typically, it is necessary to survey and evaluate each catchment in the field.

Catchment boundaries may be easy or difficult to discern. A field visit is typically required, especially in areas with older infrastructure. On a street with a gradient, an upgradient storm drain inlet may mark a boundary. Street crowns are usually catchment boundaries, and are mostly, but not always, at the street centerline. In flatter terrain, it may be helpful to use a rotating laser level to find high points along a gutter line or to locate an off-center crown.

In neighborhoods built before about 1980, especially on alluvial slopes (common in the San Francisco Bay Area), one storm drain inlet may receive runoff from an entire block in a street grid. Or there may be additional inlets which were apparently added later to solve nuisance flooding at low points. Also, look for concrete swales connecting the drainage from the low corner of one block to the next block downgradient.

The catchment typically extends to a grade break at the back of sidewalk. However, in low-density residential neighborhoods, and in older commercial/industrial neighborhoods, parcels may be configured to drain to the gutter via curb outlets or via sheet flow over driveways. Look for these features to ascertain whether to include the parcels in the tributary area. Estimate the relative imperviousness of the parcel (typically 85-100% for commercial/industrial and 35-50% for low-density residential).

To quickly estimate the catchment area, trace catchment boundaries in Google Earth or other GIS.

#### ► **STEP 4: CALCULATE MINIMUM FACILITY SIZES**

For potential self-retaining areas, size at one-half the tributary equivalent impervious area.

For bioretention facilities, multiply the tributary equivalent impervious area by 0.04. This size is generally workable in parking lots, where stalls can be reconfigured or eliminated to accommodate the facility.

Reduced sizing (less than 4% of tributary equivalent impervious area) can only be used for road reconstruction projects that follow requirements outlined in MRP 3.0 Provision C.3.b.ii (5)(c), or that are non-regulated projects under C.3.b. For projects that meet these requirement, bioretention sizing can be calculated using the following sizing factor:

$$\text{Sizing Factor} = 0.00060 \times \text{MAP} + 0.0086$$

Where MAP=Mean Annual Precipitation in inches, per Contra Costa County Public Works Figure B-166.

This will provide a reasonable range for trial-sizing bioretention facilities to treat impervious area drainage. Larger facilities will overflow less frequently and will

provide more robust performance over time. However, the reduced sizing factor calculation for bioretention facilities does not satisfy full trash capture requirements.

► **STEP 5: SKETCH AND EVALUATE A PRELIMINARY FACILITY FOOTPRINT**

Edges—transitions between the bioretention soil surface and the surrounding pavement—are often challenging design problems. Each facility requires its own solutions. Here are some problems and considerations that are often encountered:

- **Slopes.** The standard street section descends from crown to curb and rises again to back of sidewalk. The street may slope in the longitudinal direction as well. A bioretention facility typically requires that the top-of-soil be flat and six inches below the elevation of the existing storm drain inlet. As a result, the transition to the surrounding street and/or sidewalk requires a perimeter curb or wall. Depending on the drop to the top of soil, perimeter curbs or fences may be required to prevent vehicles or pedestrians from falling into the facility. It is useful to estimate the required wall heights when first envisioning how the bioretention facility might fit into the existing topography. This can be done in the field by checking existing elevations around the perimeter with a rotating laser level and rod.
- **Traffic control.** For bioretention facilities built as sidewalk extensions or bulb-outs, the shape of the transition within the lane may be specified by municipal standards.
- **Compatibility with plans for multi-modal transportation.** Planned upgrades to the street configuration—for traffic calming, road diet, bike lanes, or “complete streets”—may conflict with the ideal bioretention facility footprint. Bioretention facilities typically need to be at the gutter, either extending into a parking lane or straddling the existing curb and also replacing some parkway strip. Many bike lane configurations use this same alignment along the gutter.
- **Property ownership or control.** Whether to pursue a green infrastructure retrofit at the location may depend on the quality of working relationships with private parties, utilities, or other agencies having jurisdiction. Sometimes the area near a storm drain (or even at the storm drain) seems within the public right-of-way but is on a privately owned parcel—or the area is under the jurisdiction of a municipal department other than transportation, such as a parks department or surplus lands. And sometimes the opportunity may exist to divert runoff to landscaped area within an existing utility easement, or to extend a bioretention facility into the easement.

- Access for maintenance. Routine maintenance of bioretention facilities requires the same tools and access as for other landscaping. Maintenance access can be an issue for facilities on arterial streets, especially if a temporary lane closure is required.
- Water for irrigation. While not a requirement, an available connection to water expands the choices of plant palette.
- Utility conflicts. Existing subsurface utility lines can sometimes be moved. Sometimes, utilities can be left in place and a bioretention facility built around the line. However, large-diameter pipes or ducts can make building at an otherwise promising location impracticable. And any occurrence of utilities within the potential facility's footprint will add to project costs and potential delays.

### Design, Construction, and Maintenance

Detailed design, construction, and maintenance of retrofit bioretention facilities—including street retrofits—are generally the same as for facilities in newly developed or redeveloped sites. For criteria and requirements, see Chapters 4 and 5 in this *Guidebook*.

For additional design resources, including example details useful for integration into streets and streetscapes, see the references and resources below and on the CCCWP [Green Infrastructure Planning Resources webpage](#).

#### References and Resources

- Chapter 4, Design and Construction of Bioretention Facilities and Other Integrated Management Practices
- Chapter 5, Operation and Maintenance of Stormwater Management Facilities
- San Francisco Public Utilities Public Utilities Commission [Stormwater Management Requirements and Design Guidelines Appendix B: Typical Details](#)
- CASQA/Central Coast Low Impact Development Institute [Standard LID Design Plans and Specifications](#)
- City of San Jose [Green Stormwater Infrastructure Maintenance Field Guide](#)

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## Local Exceptions & Requirements

*Municipality-specific procedures, policies, and submittal requirements.*

*Obtain from your municipal planning and community development department.*

The [Contra Costa Clean Water Program C.3 web page](#) includes links to each Contra Costa municipality's C.3 information.





## **Plant Recommendations for Bioretention Facilities and Planter Boxes**



## Appendix B — Plant Recommendations for Bioretention Facilities and Planter Boxes

Grasses and Grass-like Plants															
Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
<i>Bromus carinatus</i> California brome	✓			2	1	✓			ok	✓		✓	✓	✓	
<i>Bouteloua gracilis</i> blue grama	✓			1.5	1	✓				✓		✓	✓		Tolerates no summer water, good for non-irrigated remote sites
<i>Carex densa</i> dense sedge	✓			1	1		✓	✓	✓	✓		✓		✓	
<i>Carex obnupta</i> slough sedge	✓			2	1		✓	✓	✓	✓	✓	✓	✓	✓	
<i>Carex praeegracilis</i> clustered field sedge	✓	✓		1.5	1.5		✓	✓	✓	✓	✓	✓	✓	✓	
<i>Carex subfusca</i> rusty sedge	✓	✓		1	1		✓		ok	✓	✓	✓	✓	✓	Great for swales
<i>Carex divulsa</i> Berkeley sedge		✓	✓	1	1		✓		ok		✓	✓	✓	✓	AKA <i>Carex tumulicola</i> ,. Full sun along coast.
<i>Deschampsia cespitosa</i> tufted hairgrass	✓			2	1		✓		ok			✓	✓	✓	Can look weedy
<i>Distichlis spicata</i> salt grass	✓			0.3	3		✓	✓	✓	✓	✓	✓	✓	✓	Looks like bermuda grass, withstands foot traffic, for soils with high salt
<i>Eleocharis palustris</i> creeping spikerush	✓			1	1		✓	✓	ok	✓	✓	✓	✓	✓	
<i>Elymus glaucus</i> blue wildrye	✓			1.5	2		✓	✓	ok	✓	✓	✓	✓	✓	good for grazing, difficult to mow, messy looking lawn
<i>Festuca californica</i> California fescue	✓	✓	✓	2	2	✓			ok	✓	✓		✓	✓	
<i>Festuca idahoensis</i> Idaho fescue	✓	✓		1	1	✓	✓		ok	✓	✓		✓	✓	Can mow. Needs light summer water at hot sites
<i>Festuca rubra</i> red fescue	✓	✓		1	1.5	✓	✓		ok	✓	✓	✓	✓	✓	Can mow. Lawn alternative
<i>Festuca rubra</i> 'molate' molate fescue	✓	✓		1	1.5	✓	✓		ok	✓	✓		✓	c	Can mow. Lawn alternative

## Appendix B — Plant Recommendations for Bioretention Facilities and Planter Boxes

<i>Hordeum brachyantherum</i> meadow barley	✓	✓		1.5	1		✓	✓	ok	✓	✓		✓	✓	
<i>Juncus patens</i> blue rush	✓			2	1		✓	✓	✓	✓		✓		✓	
<i>Leymus triticoides</i> creeping wildrye	✓	✓		3	1	✓	✓		ok	✓	✓	✓	✓	✓	Can mow. Recommended for swales.
<i>Melica californica</i> California melica	✓	✓		1	1	✓				✓			✓	✓	
<i>Melica imperfecta</i> melic	✓	✓		1	1	✓			ok		✓	✓		✓	Part shade inland, light water in Summer to keep green or goes dormant
<i>Muhlenbergia rigens</i> deergrass	✓			3	3	✓	✓		ok	✓		✓		✓	
<i>Nasella pulchra</i> purple needlegrass	✓	✓		2	1	✓	✓		ok	✓		✓	✓	✓	
<i>Nassella lepida</i> foothill needlegrass	✓	✓	✓	1.5	1	✓	✓		ok	✓	✓		✓	✓	
<i>Phalaris californica</i> California canarygrass		✓	✓	1.5	1		✓	✓	ok		✓	✓	✓	✓	Can be aggressive spreader



## Appendix B — Plant Recommendations for Bioretention Facilities and Planter Boxes

Herbaceous Perennials and Groundcovers															
Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
<i>Achillea filipendulina</i> fernleaf yarrow	✓			3	3	✓			✓	✓					
<i>Achillea millefolium</i> common yarrow	✓			1.5	1	✓			ok	✓				✓	Good for hot sites
<i>Achillea tomentosa</i> woolly yarrow	✓	✓		1	1.5	✓	✓		ok	✓			✓		
<i>Aloe striata</i> coral aloe	✓	✓		2	2	✓			ok						Sun along coast, afternoon shade inland
<i>Arctostaphylos hookeri</i> Monterey manzanita	✓	✓		1	4	✓	✓		ok		✓		✓	✓	Better in part shade in hot sites
<i>Arctostaphylos uva-ursi</i> kinnick-kinnick	✓	✓		1	15	✓	✓		ok		✓		✓	✓	Full sun at coast, part shade inland. Cultivars to try include 'emerald carpet,' 'Point Reyes,' 'San Bruno Mountain' depending on site
<i>Ceratostigma plumbaginoides</i> dwarf plumbago		✓		0.75	5	✓	✓		✓	✓					
<i>Epilobium canum</i> California fuchsia	✓	✓		1	4	✓			ok					✓	
<i>Eriogonum fasciculatum</i> flattop buckwheat	✓			3	4	✓				✓				✓	
<i>Eschscholzia californica</i> California poppy	✓			1	1	✓			ok	✓	✓	✓	✓	✓	
<i>Fragaria chiloensis</i> beach strawberries	✓	✓	✓	0.3	2	✓			ok		✓			✓	
<i>Gazania spp.</i> treasure flower	✓			0.5	2	✓	✓		✓	✓			✓		
<i>Iris douglasiana</i> Douglas iris	✓	✓		1.5	2	✓	✓		ok	✓			✓	✓	Also, Iris hybrids
Scientific name	Light Preference			Size (feet)		Watering				Tolerates					Other Notes

## Appendix B — Plant Recommendations for Bioretention Facilities and Planter Boxes

Common name	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind	CA Native	
<i>Lotus scoparius</i> deerweed	✓			4	3	✓				✓		✓		✓	
<i>Lupinus bicolor</i> miniature lupine	✓			1	1	✓					✓	✓		✓	Adds nitrogen
<i>Mimulus aurantiacus</i> common monkeyflower	✓	✓		3	3	✓			ok			✓		✓	
<i>Mimulus cardinalis</i> scarlet monkeyflower	✓	✓	✓	3	3	✓	✓	✓	✓			✓		✓	Aggressive seeder
<i>Polygonum capitatum</i> pink knotweed	✓	✓		0.5	4	✓			✓	✓	✓		✓		
<i>Prunella vulgaris</i> self heal	✓	✓				✓	✓		ok		✓	✓	✓	✓	
<i>Rudebeckia californica</i> California coneflower	✓			3	2	✓	✓		ok	✓		✓		✓	
<i>Salvia clevelandii</i> Cleveland sage						✓									
<i>Scaevola 'mauve clusters'</i> fan flower	✓	✓		1	4	✓				✓			✓		
<i>Sedum spathulifolium</i> stone crop	✓					✓			ok	✓			✓	varies	For above the high water line
<i>Sisyrinchium bellum</i> blue eyed grass				1	1	✓			ok	✓	✓	✓	✓	✓	
<i>Sisyrinchium californicum</i> yellow eyed grass	✓	✓		1	1		✓		✓	✓	✓	✓	✓	✓	
<i>Solidago californica</i> California goldenrod		✓		3	2	✓	✓		ok	✓		✓		✓	
<i>Stachys byzantine</i> lamb's ears	✓	✓		1	3	✓			ok	✓	✓		✓		
<i>Verbena tenuisecta</i> moss verbena	✓			0.5	5	✓			ok	✓	✓		✓		

## Appendix B — Plant Recommendations for Bioretention Facilities and Planter Boxes

Small Shrubs															
Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
<i>Artemisia californica</i> California sagebrush	✓			2-5	4-5	✓				✓	✓		✓	✓	Will not tolerate sprinklers
<i>Baccharis pilularis</i> 'Twin Peaks' or Pigeon Point' dwarf coyote brush	✓			2	6	✓	✓		ok	✓	✓	✓	✓	c	
<i>Cistus skanbergii</i> hybrid rockrose	✓			3	5	✓	✓		✓	✓	✓	✓	✓		Best with annual shearing
<i>Correa</i> 'Carmine Bells' or 'Ivory bells' Australian fuchsia	✓	✓		3	6	✓	✓		✓	✓			✓		Ivory bells does not tolerate wind. Attracts hummingbirds. Sunset Zones 16-17 (not recommended for E. Contra Costa)
<i>Erigeron glaucus</i> seaside daisy	✓			1	1.5				ok		✓			✓	
<i>Eriogonum crocatum</i> saffron buckwheat	✓			1.5	1.5	✓				✓	✓		✓	✓	
<i>Eriogonum umbellatum</i> sulfur buckwheat	✓			0.7	3	✓			ok	✓			✓	✓	
<i>Grevillea lanigera</i> woolly grevillea	✓			4	6	✓				✓			✓		Sunset Zones 15-24 (not recommended for E. Contra Costa)
<i>Lavendula</i> spp. lavender	✓			1.5	1.5	✓			ok	✓	✓				
<i>Mahonia pinnata</i> California holly grape	✓	✓	✓	4	4	✓	✓			✓		✓	✓	✓	
<i>Mahonia repens</i> creeping Oregon grape	✓	✓		2	3	✓	✓		ok		✓	✓		✓	
<i>Rosmarinus officinalis</i> rosemary	✓			2.5	5	✓			✓	✓	✓		✓		
<i>Rubus ursinus</i> California blackberry		✓	✓	3	5		✓	✓	ok	✓	✓	✓	✓	✓	Thorns. Harbors beneficial insects

## Appendix B — Plant Recommendations for Bioretention Facilities and Planter Boxes

<i>Symphoricarpos albus</i> common snowberry	✓	✓	✓	4	4	✓	✓	✓	ok	✓				✓	Adaptable to many conditions
<i>Westringia fruticosa</i> coast rosemary	✓			4	8	✓				✓	✓		✓		
<i>Whipplea modesta</i> whipplevine		✓	✓	0.5	3		✓	✓	✓		✓	✓		✓	Sunset zones 16-17, 19-24 only (not recommended E. Contra Costa), best for moist shady spots
<b>Large Shrubs</b>															
Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
<i>Alyogyne huegelii</i> blue hibiscus	✓			6	5	✓				✓					Very low water after second year, Sunset zones 15-17 & 20-24 (not recommended E. Contra Costa)
<i>Arctostaphylos densiflora</i> 'Howard McMinn' McMinn manzanita	✓	✓		3	7	✓				✓			✓	c	
<i>Baccharis pilularis</i> coyote brush	✓			6	7	✓	✓		ok	✓	✓	✓	✓		Fast-growing, short-lived
<i>Berberis darwinii</i> Darwin's barberry	✓	✓		6	6	✓				✓		✓	✓		Sprinklers will kill foliage
<i>Carpenteria californica</i> Bush anemone	✓	✓		6	4	✓	✓		✓	✓				✓	Interior climate with occasional water otherwise low water needs
<i>Ceanothus</i> spp. Various ceanothus	✓	✓		varies	varies	✓			□	✓			✓	✓	fast-growing but short-lived
<i>Cercis occidentalis</i> western redbud	✓			12	8	✓			□	✓		✓	✓	✓	Prune low branches for small tree form, susceptible to disease if overwatered
<i>Cotinus coggygia</i> smoke bush	✓			15	15	✓			□			✓	✓		No water after second year
<i>Eriogonum arborescens</i> Santa Cruz Island buckwheat	✓			3	5	✓			✓	✓	✓	✓	✓	✓	Low water after second year

## Appendix B — Plant Recommendations for Bioretention Facilities and Planter Boxes

Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
<i>Eriogonum giganteum</i> St. Catherines lace	✓			5	6	✓					✓	✓	✓	✓	best at coast, tolerant of unwatered inland garden
<i>Fremontodendron californicum</i> flannel bush	✓			20	14	✓				✓		✓		✓	Fast-growing, short-lived
<i>Garrya elliptica</i> Coast silktassel	✓	✓		8	8	✓	✓		✓	✓		✓	✓	✓	'Evie' is compact variety
<i>Heteromeles arbutifolia</i> toyon	✓	✓	✓	7	5	✓	✓		✓	✓	✓	✓		✓	Doesn't respond well to pruning low branches
<i>Juniperus chinensis</i> 'Mint Julep' mint julep juniper	✓	✓		3	6	✓	✓		✓	✓	✓	✓	✓		
<i>Lonicera hispidula</i> California honeysuckle	✓	✓	✓	4	2		✓	✓	✓		✓	✓		✓	Climbing vine-like. Best in part shade. Attracts birds
<i>Lonicera involucrate</i> twinberry honeysuckle	✓	✓	✓	6	3		✓	✓	✓		✓	✓		✓	Best in part shade. Attracts birds
<i>Nandina domestica</i> heavenly bamboo	✓	✓		4	3	✓	✓		✓	✓		✓			
<i>Philadelphus coronaries</i> sweet mock orange	✓	✓		10	10		✓		✓				✓		Best with annual pruning
<i>Physocarpus capitatus</i> Pacific ninebark	✓	✓		5	5	✓	✓	✓	ok		✓	✓		✓	Part shade and summer water required in hot locations
<i>Pittosporum eugenioides</i> Pittosporum	✓	✓		40	15	✓	✓		✓	✓		✓	✓		shear to control height
<i>Pittosporum tenuifolium</i> Pittosporum	✓	✓		40	15	✓	✓		✓	✓		✓	✓		shear to control height
<i>Prunus illicifolia</i> holly leaf cherry	✓	✓		15	15	✓	✓			✓	✓	✓	✓	✓	
<i>Prunus lyonii</i> Catalina cherry	✓	✓		15	15	✓	✓			✓	✓	✓	✓	✓	
<i>Rhamnus californica</i> California coffeeberry	✓	✓		3-15	6	✓			✓	✓		✓	✓	✓	'Eve Case' is compact with broad foliage

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<i>Rhus integrifolia</i> lemonade berry	✓	✓		8	6	✓			✓	✓			✓	✓	Shear to hedge if desired
<i>Ribes malvaceum</i> chaparral currant	✓	✓		5	5	✓	✓		ok	✓				✓	
<i>Ribes sanguineum</i> flowering currant		✓	✓	5-12	5-12	✓	✓		✓	✓	✓			✓	Needs good air movement to avoid white fly
<i>Ribes speciosum</i> fuchsia-flowered gooseberry	✓	✓	✓	3-6	3-6	✓	✓		✓	✓	✓			✓	
<i>Rosa californica</i> California wild rose	✓	✓		3	3-6		✓	✓	ok	✓	✓	✓	✓	✓	hooked thorns not compatible with foot traffic
<i>Rosa gymnocarpa</i> wood rose	✓	✓		2	3		✓		ok	✓	✓	✓		✓	
<i>Vitis californica</i> California grape	✓	✓		10	2-10	✓	✓		✓	✓	✓	✓	✓	✓	Climbing vine. Best in full sun. Can be aggressive in moist area.
<i>Vitis girdiana</i> desert grape	✓			8	2-11	✓	✓		✓	✓		✓	✓	✓	Climbing vine. May be more suited to biofilter soils than californica.

### Small Trees

Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
<i>Acer Negundo</i> box elder	✓	✓	✓	30	30	✓	✓		ok	✓	✓	✓	✓	✓	Tough shade tree, deciduous
<i>Arbutus unedo</i> strawberry tree	✓	✓				✓	✓		✓	✓	✓	✓			'Elfin King' is dwarf from 6' tall
<i>Arctostaphylos manzanita</i> common manzanita	✓			6-15	8-12	✓				✓			✓	✓	Prune to be small tree. "Dr. Hurd" is more tolerant of summer water.
<i>Cercis occidentalis</i> western redbud	✓	✓		12	8	✓				✓			✓	✓	Prune low branches for small tree form; susceptible to disease if overwatered.
<i>Eriobotrya deflexa</i> bronze loquat	✓	✓		18	25	✓	✓		✓	✓		✓			Monthly deep watering
<i>Eriobotrya japonica</i> Japanese loquat	✓	✓		25	20	✓	✓		✓	✓		✓			Susceptible to blight under stress
<i>Fraxinus angustifolia</i> Raywood ash	✓			30	30		✓		✓	✓					Fall color
<i>Fraxinus dipetala</i> California ash	✓	✓		20	20				ok	✓		✓		✓	

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Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
<i>Fraxinus latifolia</i> Oregon ash	✓	✓	✓	30	25	✓			✓	✓	✓	✓		✓	
<i>Fraxinus velutina</i> velvet ash	✓			25	15	✓	✓		ok	✓		✓	✓		
<i>Garrya elliptica</i> coast silk tassel	✓	✓		20	20	✓	✓		ok		✓				Afternoon shade inland, responds well to pruning
<i>Laurus 'Saratoga'</i> hybrid laurel	✓	✓		12-40	12-40	✓				✓		✓	✓		prune for tree form
<i>Myrica californica</i> Pacific wax myrtle	✓	✓	✓	10-30	10-30	✓	✓				✓				best at coast
<i>Pinus thumbergiana</i> Japanese black pine	✓	✓		25	20	✓			✓	✓	✓			✓	Asymmetrical, often leaning habit
<i>Pittosporum undulatum</i> victorian box	✓	✓		15	15	✓	✓		✓	✓					Sunset zones 16-17, 21-24 only (not recommended E. Contra Costa. Prune low branches for tree form.
<i>Prunus ilicifolia</i> holly leaf cherry	✓	✓		15	15	✓	✓			✓	✓		✓	✓	
<i>Prunus lyonii</i> Catalina cherry	✓	✓		15	15	✓	✓			✓	✓		✓	✓	
<i>Prunus serrulata</i> "shirofugen" cherry	✓			25	25		✓				✓	✓	✓		Additional cultivars

## Appendix B — Plant Recommendations for Bioretention Facilities and Planter Boxes

### Key

<b>Water Preference- Low/Moderate/High</b>	We have provided recommendations for irrigation. All plants should be watered with more frequency during the first two years after planting. After this establishment period, Low water use plants will only need supplemental irrigation at the hottest and driest sites. Plants with Moderate irrigation needs will be best with occasional supplemental water (once per week to once per month) and plants with High irrigation needs will be best with more frequent watering especially during periods of drought in the cooler seasons.
<b>Water Preference- Summer Irrigation</b>	Plants with a check in this column will not withstand a long period of summer drought without irrigation. Plants with an 'ok' in this column are tolerant of, but do not require, frequent summer irrigation. Plants with nothing in this column may not tolerate summer irrigation.
<b>Tolerates Heat</b>	A check in the heat column indicates that the plant will tolerate hot sites. It should not be confused with a plants preference for sun. Absence of the check indicates it should only be used in areas close to the Bay or other cool sites.
<b>Tolerates Coast</b>	The coast column indicates plants that perform well within 1,000 feet of the ocean or bay. Most of these plants tolerate some amount of salt air, fog, and wind.
<b>Tolerates Flooding</b>	
<b>Tolerates Wind</b>	A check in the wind column means that the plant will tolerate winds of ten miles per hour or more.
<b>CA Native - c</b>	Cultivar of California native. Cultivars offer habitat benefits to native wildlife and are adapted to the local climate but have reduced genetic diversity.
<b>Other Notes - Sunset Climate Zones</b>	Under the Other Notes category, we have indicated appropriate Sunset Climate Zones only for plants that will not do well across all of Contra Costa County. Please refer to the <i>Sunset Western Garden Book</i> which defines climate zones in the Bay Area based on elevation, influence of the Pacific Ocean, presence of hills and other factors.





## **Preparing a Stormwater Control Plan for a Small Land Development Project**

*Instructions and template for preparing a submittal for a project creating or replacing more than 2,500 square feet but less Than 5,000 square feet of impervious area (10,000 square feet for one single-family residence that is not a part of a larger plan of development)*

The template is available in Word format on the Contra Costa Clean Water Program website.





# Preparing a Stormwater Control Plan for a Small Land Development Project

## ► INTRODUCTION

Development projects that create or replace 2,500 square feet or more of impervious surface (roofs or pavement) must incorporate one or more specified measures to reduce runoff. The type and extent of runoff-reduction measures required for any specific project will be determined by local staff consistent with a maximum extent practicable standard.

Projects that create or replace 5,000 square feet or more (the threshold is 10,000 square feet or more for one single-family home that is not part of a larger plan of development) of impervious surface are “Regulated Projects,” and require a more comprehensive Stormwater Control Plan. See the Contra Costa Clean Water Program (CCCWP) *Stormwater C.3 Guidebook*.

These requirements are part of municipalities’ comprehensive effort to reduce runoff pollution. The “Small Projects” requirement is mandated by Provision C.3.i. in the California Regional Water Quality Control Board for the San Francisco Bay Region’s [Municipal Regional Stormwater Permit](#).

It is fairly easy to achieve compliance with the stormwater requirements for small land development projects. Compliance for each project must be carefully documented. Please complete the following form and submit it as directed by municipal staff.

## ► STEP-BY-STEP INSTRUCTIONS

1. Fill out the Project Data Form (below) and select one or more runoff reduction measures.
2. Prepare a site plan or sketch. Specify and design the runoff reduction measures you will use to meet the stated minimum requirements.
3. Complete your submittal, which will include:
  - Project Data Form
  - Site Plan or Sketch
  - Completed checklist for each Runoff Reduction Measure selected

► **STEP 1: PROJECT DATA FORM AND RUNOFF REDUCTION MEASURE SELECTION**

Complete all fields.

<b>Project Name/Number</b>	
<b>Application Submittal Date</b> [to be verified by municipal staff]	
<b>Project Location</b> [Street Address if available, or intersection and/or APN]	
<b>Name of Owner or Developer</b>	
<b>Project Type and Description</b> [Examples: “Single Family Residence,” “Parking Lot Addition,” “Retail and Parking”]	
<b>Total Project Site Area (acres)</b>	
<b>Total New Impervious Surface Area (square feet)</b> [Sum of currently pervious areas that will be covered with new impervious surfaces]	
<b>Total Replaced Impervious Surface Area</b> [Sum of currently impervious areas that will be covered with new impervious surfaces.]	
Total Pre-Project Impervious Surface Area	
Total Post-Project Impervious Surface Area	
Runoff Reduction Measures Selected  (Check one or more)	<input type="checkbox"/> 1. Disperse runoff to vegetated area <input type="checkbox"/> 2. Pervious pavement <input type="checkbox"/> 3. Cisterns or Rain Barrels <input type="checkbox"/> 4. Bioretention Facility or Planter Box

► **STEP 2: DELINEATE IMPERVIOUS AREAS AND LOCATIONS OF RUNOFF REDUCTION MEASURES**

**Delineate the impervious area.** On a site plan or sketch, show the impervious area—for example, a roof, or portion of a roof, or a paved area—that will drain to your runoff reduction measure. Typically these delineations follow roof ridge lines or grade breaks. Alternatively, show the type and extent of pervious paving. An example sketch is attached.

**Indicate the location and kind of runoff reduction measure you have selected.** At least one option, designed to manage runoff from some amount of impervious area—or to avoid creating runoff—is required.

For each option selected, there is a brief checklist to confirm your design and your submittal meet minimum requirements.

► **STEP 3: COMPLETE AND SUBMIT YOUR PLAN**

Consult with municipal staff about when and how to submit your Stormwater Control Plan for Small Projects.

**Option 1: Disperse runoff from roofs or pavement to vegetated areas.**

This is the simplest option. Downspouts can be directed to vegetated areas adjacent to buildings, or extended via pipes to reach vegetated areas further away. Paved areas can be designed with curb cuts, or without curbs, to direct flow into surrounding vegetation.

On the site plan, show:

- ☐ Each impervious area from which runoff will be directed, and its square footage.
- ☐ The vegetated areas that will receive runoff, and the approximate square footage of each.
- ☐ If necessary, explain in notes on the plan how runoff will be routed from impervious surfaces to vegetated areas.

Confirm the following standard specifications are met:

- ☐ Tributary impervious square footage in no instance exceeds twice the square footage of the receiving pervious area.
- ☐ Roof areas collect runoff and route it to the receiving pervious area via gutters and downspouts.
- ☐ Paved areas are sloped so drainage is routed to the receiving pervious area.
- ☐ Runoff is dispersed across the vegetated area (for example, with a splash block) to avoid erosion and promote infiltration.
- ☐ Vegetated area has amended soils, vegetation, and irrigation as required to maintain soil stability and permeability.
- ☐ Any drain inlets within the vegetated area are at least 3 inches above surrounding grade.



Connecting a roof leader to a vegetated area. The head from the eave height makes it possible to route roof drainage some distance away from the building.

## Option 2: Permeable Pavement

This option can be easy to install and maintain, cost-effective, and can add aesthetic value to your project. Permeable pavements may include pervious concrete, pervious asphalt, porous pavers, crushed aggregate, open pavers with grass or plantings, open pavers with gravel, or solid pavers.

Show on your site plan:

- ☐ Location, extent and types of pervious pavements.



Confirm the following standard specifications are met:

- ☐ No erodible areas drain on to permeable pavement.
- ☐ Subgrade compaction is minimal.
- ☐ Reservoir base course is of open-graded crushed stone. Base depth is adequate to retain rainfall (3 inches is adequate) and support design loads (more depth may be required).
- ☐ No subdrain is included or, if a subdrain is included, outlet elevation is a minimum of 3 inches above bottom of base course.
- ☐ Subgrade is uniform and slopes are not so steep that subgrade is prone to erosion.
- ☐ Rigid edge is provided to retain granular pavements and unit pavers.
- ☐ Solid unit pavers, if used, are set in sand or gravel with minimum 3/8-inch gaps between the pavers. Joints are filled with an open-graded aggregate free of fines.
- ☐ Permeable concrete or porous asphalt, if used, are installed by industry-certified professionals according to the vendor's recommendations.
- ☐ Selection and location of pavements incorporates Americans with Disabilities Act requirements (if applicable), site aesthetics, and uses.

### **Option 3: Cisterns or Rain Barrels**

Use of cisterns or rain barrels to comply with this requirement is subject to municipality approval. Planning and Building Permits may be required for larger systems.

Show on your site plan:

- ☐ Impervious areas tributary to each cistern or rain barrel.
- ☐ Location of each cistern or rain barrel.

Confirm the following standard specifications are met:

- ☐ Rain barrels are sited at grade on a sound and level surface at or near gutter downspouts.
- ☐ Gutters tributary to rain barrels are screened with a leaf guard or maximum 1/2-inch to 1/4-inch-minimum corrosion-resistant metallic hardware fabric.
- ☐ Water collected will be used for irrigation only.
- ☐ Openings are screened with a corrosion-resistant metallic fine mesh (1/16 inch or smaller) to prevent mosquito harborage.
- ☐ Large openings are secured to prevent entry by children.
- ☐ Rain barrels and gutters are to be cleaned annually.
- ☐ The Contra Costa Mosquito and Vector Control District (District) is informed of the installation. The District will be provided additional information and/or rights of entry if requested.

#### Option 4: Bioretention Facility or Planter Box

An above-ground planter box may be appropriate if the development site lacks level landscaped areas for dispersion and pervious pavements are not practical. Planter boxes and bioretention facilities can treat runoff from impervious surfaces 25 times their area (sizing factor of 0.04).

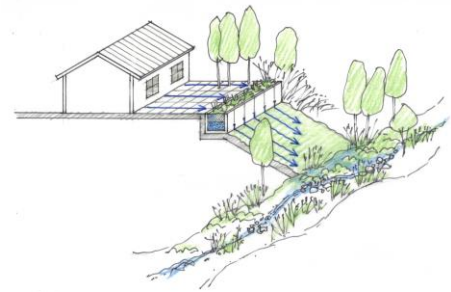
Detailed design guidance for planter boxes and bioretention areas is in the *CCCWP Stormwater C.3 Guidebook*.

Show on your site plan:

- ☐ Impervious areas tributary to the planter box.
- ☐ Location and footprint of planter box.

Confirm the following standard specifications are met:

- ☐ Reservoir depth is 4 to 6-inch minimum.
- ☐ 18-inch depth soil mix with minimum long-term infiltration rate of 5 inches per hour. See [Stormwater C.3 Guidebook - Contra Costa Clean Water Program \(ccccleanwater.org\)](http://ccccleanwater.org) for a list of soil mix suppliers.
- ☐ Surface area of soil mix is a minimum 0.04 times the tributary impervious area.
- ☐ “Class 2 perm” drainage layer 12 inches deep.
- ☐ No filter fabric.
- ☐ Perforated pipe (PVC SDR 35 or approved equivalent) underdrain with outlet located flush or nearly flush with planter bottom.
- ☐ Connection with sufficient head to storm drain or discharge point.
- ☐ Underdrain has a clean-out port consisting of a vertical, rigid, non-perforated PVC pipe, connected to the underdrain via a sweep bend, with a minimum diameter of 4 inches and a watertight cap.
- ☐ Overflow outlet connected to a downstream storm drain or approved discharge point.
- ☐ Planter is set level.
- ☐ Emergency spillage will be safely conveyed overland.
- ☐ Plantings are suitable to the climate, exposure, and a well-drained soil.
- ☐ Irrigation system with connection to water supply, on a separate zone.



Flow-through planter built into a hillside. Flows from the underdrain and overflow must be directed in accordance with local requirements.



## Useful Resources

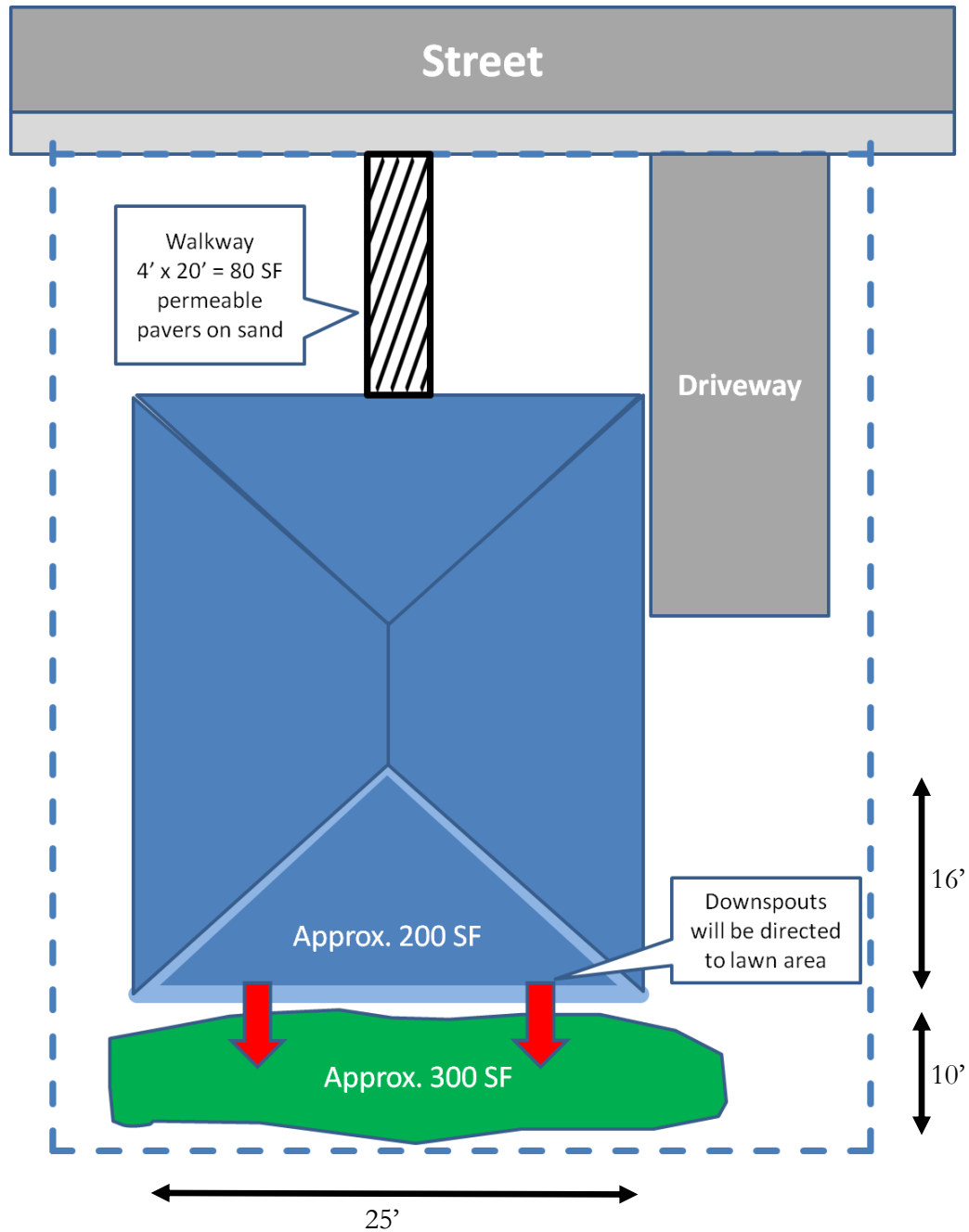
The following references may be useful for design. Designs must meet the minimum standard specifications in this supplement to the *Stormwater C.3 Guidebook*.

- *Contra Costa Clean Water Program Stormwater C.3 Guidebook*. Available at [Stormwater C.3 Guidebook - Contra Costa Clean Water Program \(cccleanwater.org\)](http://cccleanwater.org/Stormwater-C.3-Guidebook-Contra-Costa-Clean-Water-Program)
- *Start At the Source: Design Guidance Manual for Stormwater Quality*. Bay Area Stormwater Management Agencies Association, 1999. Available at [Foreword \(cccleanwater.org\)](http://cccleanwater.org/Foreword)
- *Slow It, Spread It, Sink It: A Homeowner's Guide to Turning Runoff into a Resource*. Resource Conservation District of Santa Cruz County. 2<sup>nd</sup> Ed., 2015. <https://www.rcdsantacruz.org/images/brochures/pdf/HomeDrainageGuide.v25.pdf>
- National Ready Mix Concrete Association  
<http://www.perviouspavement.org/>
- Interlocking Concrete Pavement Institute  
<http://www.icpi.org/>
- *Porous Pavements*, by Bruce K. Ferguson. 2005. ISBN 0-8493-2670-2

### Example Sketch

The example below illustrates the level of detail required.

*Not to Scale*



## **Stormwater Pollutant Sources/ Source Control Checklist**



## **APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST**

**How to use this worksheet (also see instructions on page 16 of the *Stormwater C.3 Guidebook*):**

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 Stormwater Control Plan drawings.
3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in a table in your Stormwater Control Plan. Use the format shown in Table 2-2 on page 22 of the *Guidebook*. 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.

## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative

## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

<p><input type="checkbox"/> <b>A. On-site storm drain inlets</b></p> <p>A well-executed LID design will not have any storm drain inlets except that on some hillside sites inlets may capture runoff to be conveyed to a bioretention facility or other IMP at a lower elevation.</p> <p>On previously developed sites, in areas that are not being rebuilt or retrofit with LID (see the “50% rule”), markings must be installed on existing storm drain inlets.</p>	<p><input type="checkbox"/> Locations of inlets.</p>	<p><input type="checkbox"/> Mark all inlets with the words “No Dumping! Flows to Bay” or similar.</p>	<p><input type="checkbox"/> Maintain and periodically repaint or replace inlet markings.</p> <p><input type="checkbox"/> Provide stormwater pollution prevention information to new site owners, lessees, or operators.</p> <p><input type="checkbox"/> Include the following in lease agreements: “Tenant shall not allow anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains.”</p>
<p><input type="checkbox"/> <b>B. Interior floor drains and elevator shaft sump pumps</b></p>		<p><input type="checkbox"/> State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.</p>	<p><input type="checkbox"/> Inspect and maintain drains to prevent blockages and overflow.</p>

## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
<input type="checkbox"/> <b>C.</b> Interior parking garages		<input type="checkbox"/> State that parking garage floor drains will be plumbed to the sanitary sewer.  Top floors may be drained to LID features and then to the storm drain system.	<input type="checkbox"/> Inspect and maintain drains to prevent blockages and overflow.
<input type="checkbox"/> <b>D1.</b> Need for future indoor & structural pest control		<input type="checkbox"/> Note building design features that discourage entry of pests.	<input type="checkbox"/> Provide Integrated Pest Management information to owners, lessees, and operators.



## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

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1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
<input type="checkbox"/> <b>D2. Landscape/ Outdoor Pesticide Use</b>	<input type="checkbox"/> Show locations of native trees or areas of shrubs and ground cover to be undisturbed and retained.  <input type="checkbox"/> Show self-retaining landscape areas, if any.  <input type="checkbox"/> Show stormwater treatment and hydrograph modification management IMPs. (See instructions in Chapter 3, Step 5 and guidance in Chapter 5.)	<p>State that final landscape plans will accomplish all of the following.</p> <input type="checkbox"/> Preserve existing native trees, shrubs, and ground cover to the maximum extent possible.  <input type="checkbox"/> Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution.  <input type="checkbox"/> Where landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions.  <input type="checkbox"/> Consider using pest-resistant plants, especially adjacent to hardscape.  <input type="checkbox"/> To insure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.	<input type="checkbox"/> Maintain landscaping using minimum or no pesticides.  <input type="checkbox"/> Provide IPM information to new owners, lessees and operators.
<input type="checkbox"/> <b>E. Pools, spas, ponds, decorative fountains, and other water features.</b>	<input type="checkbox"/> 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 <a href="#">Guidelines</a> .)	<p>If the local municipality 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.</p>	<input type="checkbox"/> See applicable operational BMPs in <a href="#">Fact Sheet SC-72</a> , “Fountain and Pool Maintenance,” in the CASQA Stormwater Quality Handbooks

## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
<input type="checkbox"/> <b>F. Food service</b>	<input type="checkbox"/> For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment.  <input type="checkbox"/> On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.	<input type="checkbox"/> Describe the location and features of the designated cleaning area.  <input type="checkbox"/> Describe the items to be cleaned in this facility and how it has been sized to insure that the largest items can be accommodated.	<input type="checkbox"/> See the brochure, <a href="#">“Water Pollution Prevention Tips to Protect Water Quality and Keep Your Food Service Facility Clean.”</a> Provide this brochure to new site owners, lessees, and operators.
<input type="checkbox"/> <b>G. Refuse areas</b>	<input type="checkbox"/> 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.  <input type="checkbox"/> If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run-on and show locations of berms to prevent runoff from the area.  <input type="checkbox"/> Any drains from dumpsters, compactors, and tallow bin areas shall be connected to a grease removal device before discharge to sanitary sewer.	<input type="checkbox"/> State how site refuse will be handled and provide supporting detail to what is shown on plans.  <input type="checkbox"/> State that signs will be posted on or near dumpsters with the words “Do not dump hazardous materials here” or similar.	<input type="checkbox"/> State how the following will be implemented: Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post “no hazardous materials” signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on-site. See <a href="#">Fact Sheet SC-34</a> , “Waste Handling and Disposal” in the CASQA Stormwater Quality Handbooks

## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
<input type="checkbox"/> <b>H. Industrial processes.</b>	<input type="checkbox"/> Show process area.	<input type="checkbox"/> 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.”	<input type="checkbox"/> See Fact Sheet SC-10, “ <a href="#">Non-Stormwater Discharges</a> ” in the CASQA Stormwater Quality Handbooks
<input type="checkbox"/> <b>I. Outdoor storage of equipment or materials.</b> (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.)	<input type="checkbox"/> Show any outdoor storage areas, including how materials will be covered. Show how areas will be graded and bermed to prevent run-on or run-off from area.  <input type="checkbox"/> Storage of non-hazardous liquids shall be covered by a roof and/or drain to the sanitary sewer system, and be contained by berms, dikes, liners, or vaults.  <input type="checkbox"/> Storage of hazardous materials and wastes must be in compliance with the local hazardous materials ordinance and a Hazardous Materials Management Plan for the site.	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 Contra Costa Hazardous Materials Programs for: <ul style="list-style-type: none"> <li>▪ Hazardous Waste Generation</li> <li>▪ Hazardous Materials Release Response and Inventory</li> <li>▪ California Accidental Release (CalARP)</li> <li>▪ Aboveground Storage Tank</li> <li>▪ Uniform Fire Code Article 80 Section 103(b) &amp; (c) 1991</li> <li>▪ Underground Storage Tank</li> </ul> <a href="http://www.cchealth.org/groups/hazmat/">www.cchealth.org/groups/hazmat/</a>	<input type="checkbox"/> See the <a href="#">Fact Sheets SC-31</a> , “Outdoor Liquid Container Storage” and <a href="#">SC-33</a> , “Outdoor Storage of Raw Materials ” in the CASQA Stormwater Quality Handbooks

## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
<input type="checkbox"/> <b>J. Vehicle and Equipment Cleaning</b>	<input type="checkbox"/> 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.	<input type="checkbox"/> If a car wash area is not provided, describe measures taken to discourage on-site car washing and explain how these will be enforced.	Describe operational measures to implement the following (if applicable): <input type="checkbox"/> Washwater from vehicle and equipment washing operations shall not be discharged to the storm drain system. <input type="checkbox"/> Car dealerships and similar may rinse cars with water only. See <a href="#">Fact Sheet SC-21</a> , “Vehicle and Equipment Cleaning,” in the CASQA Stormwater Quality Handbooks

## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
<input type="checkbox"/> <b>K. Vehicle/Equipment Repair and Maintenance</b>	<input type="checkbox"/> 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.  <input type="checkbox"/> Show secondary containment for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas.  <input type="checkbox"/> Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer and an industrial waste discharge permit will be obtained.	<input type="checkbox"/> State that no vehicle repair or maintenance will be done outdoors, or else describe the required features of the outdoor work area.  <input type="checkbox"/> State that there are no floor drains or if there are floor drains, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.  <input type="checkbox"/> State that there are no tanks, containers or sinks to be used for parts cleaning or rinsing or, if there are, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.	<p>In the Stormwater Control Plan, note that all of the following restrictions apply to use the site:</p> <input type="checkbox"/> No person shall dispose of, nor permit the disposal, directly or indirectly of vehicle fluids, hazardous materials, or rinsewater from parts cleaning into storm drains.  <input type="checkbox"/> No vehicle fluid removal shall be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids shall be contained or drained from the vehicle immediately.  <input type="checkbox"/> No person shall leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment.

## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
<input type="checkbox"/> <b>L. Fuel Dispensing Areas</b>	<input type="checkbox"/> Fueling areas <sup>1</sup> 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.  <input type="checkbox"/> Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area <sup>1</sup> .] The canopy [or cover] shall not drain onto the fueling area.		<input type="checkbox"/> The property owner shall dry sweep the fueling area routinely.

<sup>1</sup> 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.

## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
<input type="checkbox"/> <b>M. Loading Docks</b>	<input type="checkbox"/> Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks shall be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts shall be positioned to direct 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.  <input type="checkbox"/> Loading dock areas draining directly to the sanitary sewer shall be equipped with a spill control valve or equivalent device, which shall be kept closed during periods of operation.  <input type="checkbox"/> Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.		<input type="checkbox"/> Move loaded and unloaded items indoors as soon as possible. <input type="checkbox"/> See <a href="#">Fact Sheet SC-30</a> , “Outdoor Loading and Unloading,” in the CASQA Stormwater Quality Handbooks
<input type="checkbox"/> <b>N. Fire Sprinkler Test Water</b>		<input type="checkbox"/> Provide a means to drain fire sprinkler test water to the sanitary sewer.	<input type="checkbox"/> See the note in <a href="#">Fact Sheet SC-41</a> , “Building and Grounds Maintenance,” in the CASQA Stormwater Quality Handbooks

## APPENDIX D — STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

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<p><b>O. Miscellaneous Drain or Wash Water or Other Sources</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Boiler drain lines</li> <li><input type="checkbox"/> Condensate drain lines</li> <li><input type="checkbox"/> Rooftop equipment</li> <li><input type="checkbox"/> Drainage sumps</li> <li><input type="checkbox"/> Roofing, gutters, and trim.</li> <li><input type="checkbox"/> Other sources</li> </ul>		<ul style="list-style-type: none"> <li><input type="checkbox"/> Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system.</li> <li><input type="checkbox"/> Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system.</li> <li><input type="checkbox"/> Rooftop equipment with potential to produce pollutants shall be roofed and/or have secondary containment.</li> <li><input type="checkbox"/> Any drainage sumps on-site shall feature a sediment sump to reduce the quantity of sediment in pumped water.</li> <li><input type="checkbox"/> Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff.</li> <li><input type="checkbox"/> Include controls for other sources as specified by local reviewer.</li> </ul>	
<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>P. Plazas, sidewalks, and parking lots.</b></li> </ul>			<ul style="list-style-type: none"> <li><input type="checkbox"/> 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.</li> </ul>



# Regulatory and Technical Background

*Some background, including updates, on selected policies and criteria in the Guidebook 8<sup>th</sup> Edition*

LAND development is a complex undertaking, and no two projects are the same. Municipal staff can and should exercise latitude and discretion, within the boundaries of permit compliance, when interpreting the C.3 requirements as they apply to a specific project. This appendix provides information and explanations of technical and regulatory issues which may help with decision-making.

## Introduction: Stormwater NPDES Permit History

In 1993, the Regional Water Board first issued a municipal stormwater NPDES permit to Contra Costa County, the 19 cities and towns within the County, and the Contra Costa Flood Control and Water Conservation District. The permit mandated a comprehensive program to prevent stormwater pollution. The comprehensive program 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.

In 2003, the Regional Water Board added Provision C.3, tightening requirements for new developments and redevelopments. The permittees began implementing the provision in 2005. The Regional

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Water Board added hydrograph modification management (flow control) requirements in 2006.

In October 2009, the Regional Water Board included Contra Costa municipalities in its first Municipal Regional Permit (MRP). The MRP applies to all municipalities in Alameda, Contra Costa, San Mateo, and Santa Clara counties, and some municipalities in Solano County, and supersedes the earlier countywide stormwater NPDES permits. The MRP mandates a Low Impact Development (LID) approach similar to that developed by the CCCWP from 2003 through 2009. The Regional Water Board amended the MRP on November 28, 2011, detailing some exceptions for when LID treatment is required. The LID requirements went into effect December 1, 2011.

The MRP was reissued on November 19, 2015 (MRP 2.0) and again on May 11, 2022 (MRP 3.0).

## Regulatory Context and Roles

MRP Provision C.3 requires municipalities to condition development approvals with incorporation of specified stormwater controls. The municipalities' annual report to the Regional Water Board includes a list of development projects approved during the year and the specific stormwater controls that were required for each project. In the annual report, the municipalities also document their program to verify stormwater treatment and flow-control facilities are being adequately maintained. **The municipalities—not the Regional Board or its staff—are charged with ensuring development projects comply with the C.3 requirements.** (Regional Water Board staff sometimes reviews stormwater controls in connection with applications for Clean Water Act Section 401 water-quality certification, which is required for projects that involve work in streams, including dredging and filling.)

Municipal staff review the project proponent's Stormwater Control Plan for compliance with the requirements of Provision C.3. At the same time, they consider how the design of LID features and facilities integrates with the site design, landscape design, and building architecture to support municipal objectives such as design quality, consistency with neighborhood character and values, and contribution to natural qualities achievable within the urban context.

As discussed in Chapter 5, municipalities are responsible for inspecting and verifying the proper operation and maintenance of stormwater treatment facilities, and some pervious pavement installations, in perpetuity. Project proponents and municipalities share the aim of designing and building facilities that are low-maintenance and long-lasting.

Municipal reviewers have latitude and discretion to reject proposed C.3 compliance designs that, while meeting the specific requirements and numeric criteria in this *Guidebook* and the NPDES permit, don't reflect best practices or local values for urban design and architectural design, or are not sustainable.

## 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 links urban land development to degradation of aquatic ecosystems in two ways.

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

Second, increased peak flows and runoff durations can cause erosion of stream banks and beds, transport of fine sediments, and disruption of aquatic habitat. Measures taken to control stream erosion, such as hardening banks with riprap or concrete, may permanently eliminate habitat. By reducing infiltration to groundwater, imperviousness may also reduce dry-weather stream flows.

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 detention and retention of runoff near the point where it is generated. Detention and retention reduce peak flows and volumes and allow pollutants to settle out or adhere to soils before they can be transported downstream.

## Low Impact Development (LID)

MRP Provision C.3.c mandates the use of LID for stormwater treatment, with narrow exceptions. Techniques for implementing LID are detailed in Chapter 3 of this *Guidebook*.

LID aims to mimic a site's pre-development hydrology by minimizing imperviousness and then by detaining, infiltrating, and filtering runoff in landscape-based features—principally bioretention facilities.

To mitigate the effects of imperviousness on a watershed scale, LID must be implemented widely and consistently throughout the watershed. Effective LID design requires that facilities be integrated into the urban landscape so that they are seen and valued by people living and working there. This helps ensure the LID facilities are preserved and maintained over the life of the development. The design procedures and requirements in Chapter 3, Low Impact Development Site Design Guide, sets out a design procedure and requirements intended to ensure LID features and facilities are integrated into the project site design and landscape design. See especially pp. 28 and 45.

Further, LID facilities must be designed and constructed to be robust, resilient, and low-maintenance. Chapter 4, Design and Construction of Bioretention Facilities and Other Integrated Management Practices, sets forth design criteria intended to achieve quality and consistency in facilities constructed throughout Contra Costa. Under MRP Provision C.3.h., Permittees bear responsibility for periodic inspection and verification of LID facilities on public and private properties. In Chapter 5, Table 5-2 on p. 107 lists key required features and design criteria and the corresponding benefit to long-term facility operation.

#### ► **CCCWP, LID, AND PROVISION C.3 COMPLIANCE**

In 1999, a manual, “Low Impact Development Design Strategies: An Integrated Design Approach,” was published by the Prince George’s County, Maryland Department of Environmental Resources. The manual describes the key goals, strategies, and practices of LID as understood today.

Also in the 1990s, CCCWP staff participated in meetings of the Bay Area Stormwater Management Agencies Association’s Development Committee. With participation by RWQCB staff, the Committee reached consensus to promote landscape-based methods of reducing runoff and treating runoff on new development sites. The Committee provided input to an RWQCB “Staff Recommendations for New and Redevelopment Controls for Stormwater Programs” (April 1994). The Committee then solicited proposals for, and directed the preparation of, a design manual, “Start at the Source” (1997). An updated and expanded version of “Start at the Source” was published in 1999. “Start at the Source” does not use the terms “Low Impact Development” or “LID,” but includes the same concepts.

Throughout the 1990s, decisions regarding whether to require implementation of runoff reduction and stormwater treatment on a new development site, and how much, were at the discretion of individual municipal governments—decisions typically following the recommendation of municipal planning staff. This level of implementation was described at the time as “Do what you can, where you can.”

In 2000, Water Board staff drafted amendments to the countywide stormwater permits for municipalities in Santa Clara County. The Water Board adopted the amendments in the Santa Clara, Alameda, San Mateo, and Contra Costa Counties during 2001-2003. The new “Provision C.3” requirements were based, in large part, on requirements adopted earlier by the Regional Water Quality Control Board for the Los Angeles Region. At the heart of those requirements were numerical criteria specifying the amount of runoff that must be treated prior to discharge—in effect, specifications for the size or capacity of treatment facilities. See “Stormwater Facility Sizing Criteria,” below.

In 2000 the State Water Resources Control Board, in a response to petition from the City of Bellflower and other parties, found that the Los Angeles RWQCB based its decision on a “maximum extent practicable” standard. The SWRCB Order WQ 2000-11 provided a basis for similar numeric standards in subsequent permits issued by the RWQCBs, including the Bay Area MRP in past and current iterations. See “Stormwater Treatment Facility Sizing Criteria” below.

In 2003, BASMAA published a companion document to “Start at the Source,” titled “Using Site Design Techniques to Meet Development Standards for Stormwater Quality.” The document shows how “self-treating areas” and “runoff reduction areas” (self-retaining areas) can be used to reduce the tributary drainage, and therefore the minimum required size, of stormwater treatment facilities for a development site. This document was among the first efforts to codify how to use LID techniques to meet permit standards for stormwater treatment.

The first edition (2005) of CCCWP’s *Stormwater C.3 Guidebook* built on an earlier work by the City of Milpitas (2003) that applied the permit numeric sizing criteria to the design of bioretention facilities and other LID facilities.

With these two elements in place—(1) codified methods for implementing runoff reduction and (2) criteria for sizing LID treatment facilities—it was possible to develop and promulgate a design methodology that uses LID to comply with the RWQCB’s permit requirements.

The methodology was incorporated into the *Stormwater C.3 Guidebook* and has been refined in subsequent editions. With the 3<sup>rd</sup> Edition (2006), CCCWP developed and released an IMP Sizing Calculator. The calculator facilitates the arithmetic required to size treatment facilities—that is, summing tributary areas and multiplying times sizing factors. More significantly, the calculator tracks tributary areas (Drainage Management Areas, or DMAs) and treatment facilities (Integrated Management Practices, or IMPs). This facilitates creating, documenting, and evaluating a land development project design that uses a full suite of LID features and facilities (self-treating areas, self-retaining areas, and a menu of IMPs) to achieve compliance. The *Guidebook*’s step-by-step procedure, combined with the calculator, facilitates a design that distributes, manages, and treats runoff throughout the site rather than one facility or a few facilities.

During 2004-2005, Contra Costa municipalities updated their stormwater ordinances to reference the “Provision C.3” requirements and to require that applications for development project approvals include “a stormwater control plan that meets the criteria in the most recent version of the Contra Costa Clean Water Program *Stormwater C.3 Guidebook*.” This launched LID as the standard acceptable means of compliance with the C.3 requirements throughout the County, although there was continued, but declining, use of non-LID site designs and facilities over the following few years.

**► LID IN THE MRP**

The Municipal Regional Stormwater Permit (MRP) consolidated and superseded the earlier countywide permits. Adopted October 14, 2009, MRP 1.0 included Provision C.3.c., which required treatment of the amount of runoff specified in the numeric criteria using “LID treatment measures.” These measures were defined as “harvesting and re-use, infiltration, evapotranspiration, and biotreatment.”

Among these four treatment measures, Provision C.3.c. in MRP 1.0 allowed the use of bioretention only if the first three measures were infeasible on the project site.

The effective date of Provision C.3.c. was set to be December 1, 2011. In the interim, the Permittees were directed to prepare the following reports:

- Feasibility/Infeasibility Criteria Report (due May 1, 2011), with “discussion of proposed feasibility and infeasibility criteria and procedures the Permittees shall employ to make a determination of when biotreatment will be allowed...”
- Status Report on Application of Feasibility/Infeasibility Criteria (due December 1, 2013)
- Model Biotreatment Soil Media Specifications (due December 1, 2010—see “Bioretention Soils,” below)
- Green Roof Minimum Specifications (due May 1, 2011)

These reports were prepared under the auspices of BASMAA. CCCWP participated actively in preparation of the reports.

The RWQCB amended MRP 1.0 on November 28, 2011, requiring full implementation of the LID requirements on private development projects immediately on December 1, 2011 (December 1, 2012 for public projects).

By this time, Contra Costa municipalities had been requiring LID for compliance with the Provision C.3.d. treatment requirements for nearly seven years. CCCWP participated actively in the preparation of the required reports, and because CCCWP negotiated permit terms that aligned with the *Stormwater C.3 Guidebook*, the mandated transition to LID required only minor changes to the *Guidebook* and to the development review practices of Contra Costa municipalities. However, it was

necessary to incorporate instructions for analyzing the feasibility of harvesting and reuse—and the feasibility of infiltration—in the 6<sup>th</sup> Edition, which was published February 15, 2012.

The Status Report on Application of Feasibility/Infeasibility Criteria (December 1, 2013) found:

- Infiltration of some runoff is feasible on most projects, but in the clay soils typical in the Bay Area, the amount of runoff that can be infiltrated is highly variable. On most sites, it is not practical or feasible to design facilities that can reliably and dependably infiltrate the amount of runoff specified in Provision C.3.d. Bioretention facilities can infiltrate between 40% and 80% of total runoff depending on rainfall patterns and facility size.
- Very few development projects create the quantity and timing of non-potable water demand required to feasibly harvest and use the amount of runoff specified in Provision C.3.d.
- Bioretention is, on balance, equal in water-quality effectiveness to harvesting/use or infiltration.

A BASMAA “White Paper” on Provision C.3 in MRP 2.0 (February 2015) proposed a “Bay Area Approach” to implementing new development requirements based on by-then-substantial experience with implementing LID. The “White Paper” recommended omitting the feasibility test and allowing bioretention as an equivalent “first tier” option for LID treatment.

To support the recommendation, BASMAA’s consultants conducted modeling of bioretention performance. The modeling, presented in the Status Report on Application of Feasibility/Infeasibility Criteria, used a bioretention facility with the underdrain discharge elevation set at the top of the gravel underdrain layer. It is assumed that underlying soils are not compacted.

Setting the underdrain discharge elevation at the top of a bioretention facility’s gravel layer, and specifying that underlying soils be uncompacted, maximizes the amount of runoff that is captured and made to infiltrate into native soils rather than being discharged through the underdrain. This, in turn, minimizes the amount of pollutants discharged from the facility, particularly for soluble pollutants.

MRP 2.0 implemented the “White Paper” recommendation but did not include any design requirement regarding the underdrain discharge elevation. Nevertheless, CCCWP Permittees have required that bioretention facilities include the “raised underdrain” design and that underlying soils be uncompacted and be loosened or ripped prior to installation of the gravel layer. See p. 56.

Where bioretention facilities are to be built close to foundations or pavement, or on steep slopes, the design of curbs, walls, footings, and other elements may need to

incorporate consideration of additional soil moisture introduced by the facilities. In many cases, an impermeable cutoff wall is constructed between the bioretention facility and an adjacent foundation or pavement section, as recommended by the project geotechnical engineer.

Flow-through planters may be used as an alternative to bioretention only on upper-story plazas, where infiltration could cause mobilization of pollutants in soil or groundwater, and other situations where infiltration is a concern, such as locations with potential geotechnical hazards that cannot be mitigated except by preventing infiltration.

## **Bioretention Soil Mix Specification and Verification**

### **► BACKGROUND**

The original C.3 requirements (for Contra Costa municipalities, these were in a 2003 permit amendment) did not require LID be used for treatment and had no specific criteria for bioretention facilities. CCCWP took the lead, regionally, to refine guidance and criteria for LID features and facilities that would treat the stormwater flows identified in the new Provision C.3.d.

CCCWP's initial design guidance for bioretention facility soils (Guidebook 2nd Ed., 2005) called for a "sandy loam with a minimum infiltration rate of 5 in./hr." In at least one significant instance, native "sandy loam" material passed initial review, was installed in a constructed facility, and then exhibited a sudden loss of infiltration capacity after three to four rain events. In the Guidebook 3rd Ed. (Oct. 2006), the specification was revised to "... 'sandy loam' soil mix with no more than 5% clay content. Mix should be 50-60% sand, 20-30% compost, and 20-30% topsoil..." This was the beginning of a move away from a performance specification and toward a design specification for bioretention soils. However, as late as 2007, CCCWP trainings included the use of a falling-head "bucket test" to measure the infiltration rate of bioretention soil delivered to the site. Staff from Contra Costa County, San Pablo, and Walnut Creek later developed a more portable version of the "bucket test" that uses a plexiglass tube.

Experience revealed the "bucket test" has poor repeatability. This could be due, in part, to variation among samples, test equipment, and test procedures. Many users found that initial test runs on a sample show an adequate infiltration rate (sometimes much faster than 5 inches per hour) which diminishes unpredictably on repeated wettings. In addition, there is no data available with which to evaluate the hypothesized correlation between the "bucket test" measurement and performance of the installed soil material.

In early 2008, CCCWP issued an RFP seeking a technical consultant to prepare specifications for "an appropriate soil mix to ensure a long-term minimum infiltration rate of 5 inches per hour while supporting plants and recommended procedures for verification at the construction site and/or in a laboratory." WRA, Inc., was selected and their consultant Megan Stromberg worked with CCCWP's Development Committee to develop detailed specifications for two soil mix options



(Mix “A” and Mix “B”). The two mixes were included in an update to the Guidebook 4th Ed. in January 2009. The specifications required submittal of grain size analyses for the sand component and quality analyses for the compost component, but purposefully omitted any requirement for infiltration testing of the final mix. In addition, the specifications explicitly allowed municipal inspectors to accept test results and certification for a “brand name” mix from a soil supplier.

The first version of the San Francisco Bay Area Municipal Regional Stormwater Permit (MRP 1.0), which took effect December 1, 2009, required the Permittees to propose, within a year, soil media specifications for bioretention soil media. Through the Bay Area Stormwater Management Agencies Association (BASMAA), the Permittees retained WRA, Inc., and Megan Stromberg assisted a regional process to develop consensus on the proposed specifications. The process included an April 2010 roundtable of soil scientists, soils engineers, consultants, municipal staff, building industry representatives, and Water Board staff. Based on the outcomes of the process, BASMAA recommended the Contra Costa specifications be used as a starting point for the required proposal. With minor changes from the Contra Costa specifications, as recommended by WRA, the proposed regional specifications were submitted to the Water Board. The specifications were incorporated into a permit amendment effective December 1, 2011. With a few minor updates, these are the same specifications that are in effect now.

#### ► SUBMITTAL AND VERIFICATION REQUIREMENTS

In addition to ensuring that bioretention facility operation is in compliance with permit requirements, inspection of the delivered bioretention soil protects the facility owner and future owners. Infiltration rates vary logarithmically, and when an installed soil fails to infiltrate runoff, it tends to fail noticeably. In a properly operating facility, any runoff ponded on the surface should infiltrate within an hour or two following the end of rainfall. In a facility that is failing, ponding on the surface of the facility may be apparent several hours or even days after a rain event. Corrective maintenance would typically require the current owner to remove and replace the plantings and soil media.

The specifications call out the information that applicants must submit to show the soil in their under-construction bioretention facilities meets the minimum performance requirements. The submittal requirements omit any infiltration test if the recommended mix is used. If an alternative mix is used, as allowed, the submittal must include: “Certification from an accredited geotechnical testing laboratory that the Bioretention soil has an infiltration rate between 5 and 12 inches per hour...” when compacted to 85-90% of maximum dry density. This is substantially different from the “bucket test.” There is no readily available means to correlate the one test to the other, or to performance of a facility after installation. Further, the need to convey a sample to an accredited geotechnical testing laboratory and await results means that it is not practical to test the material following its delivery to the

construction site. Therefore, the test results may or may not be applicable to the material that is delivered and installed.

In summary, CCCWP's early decision to rely on a design specification (that is, the physical properties of the mix components) rather than on infiltration-rate testing was based on the experience of Permittee staff overseeing the construction and operation of bioretention facilities. With BASMAA, CCCWP negotiated the current permit requirements, which do not include infiltration-rate testing if the recommended mix is used. If an alternative mix is used, infiltration testing is required, but must be done in a laboratory.

Based on this experience, this 8th Edition of the Guidebook strongly encourages use of the recommended mix and includes submittal procedures for verifying the mix prior to installation.

A sample must be submitted along with a multi-page form completed by the suppliers of the compost, the sand, and the completed mix, and by laboratories testing and certifying the sand and compost components. At the job site, at the time of delivery, the inspector should compare the sample to the delivered material. If there is indication that it might not be the same material, it should be rejected.

As discussed among municipal staff during CCCWP's annual trainings, the most effective way for inspectors to ensure the quality of the delivered material, after reviewing the laboratory test results for the sand and compost components, is to inspect it by look and feel.

A mix meeting the design specification will have a grainy, gritty texture and will not clump when dry. If formed in the hand when damp, the material may be slightly spongy but should break apart easily. Smearing or discoloration on the hand likely indicates the presence of excessive clay. Each delivery should be inspected, and each batch inspected visually for homogeneity.

Note that a slower infiltration rate is not always necessary for plant health. In some cases this misconception has led to problems in executing the mix design. What's needed for plant health is moisture retention, and the specified amount of compost is intended to provide that regardless of a high infiltration rate. Excessive water use can be avoided by selecting an appropriate plant palette and by using drip irrigation with smart controllers (if water is available at the location).

## **Limits on the Use of Infiltration Devices**

MRP Provision C.3.d.iv. restricts the design and location of "infiltration devices" that, as designed, may bypass filtration through surface soils before reaching groundwater.

Infiltration devices include:

- Dry wells

- Infiltration basins
- Infiltration trenches

Infiltration devices do not include:

- Bioretention facilities
- Self-retaining or self-treating areas
- Pervious pavements

Infiltration devices may not be used in areas of industrial or light industrial activity; areas subject to high vehicular traffic (25,000 or greater average daily traffic on main roadway or 15,000 or more average daily traffic on any intersecting roadway); automotive repair shops; car washes; fleet storage areas (bus, truck, etc.); nurseries, or other areas with pollutant sources that could pose a high threat to water quality, as determined by municipal staff.

The vertical distance from the base of any infiltration device to the seasonal high groundwater mark shall be at least 10 feet. Infiltration devices shall be located a minimum of 100 feet horizontally from any known water supply wells.

In addition, infiltration devices are not recommended where:

- The infiltration device would receive drainage from areas where chemicals are used or stored, where vehicles or equipment are washed, or where refuse or wastes are handled.
- Surface soils or groundwater are polluted.
- The facility could receive sediment-laden runoff from disturbed areas or unstable slopes.
- Increased soil moisture could affect the stability of slopes of foundations.
- Soils are insufficiently permeable to allow the device to drain within 72 hours.

## Stormwater Treatment Facility Sizing Criteria

Criteria for sizing stormwater treatment facilities are in MRP Provision C.3.d.

### ► TECHNICAL BACKGROUND

For **flow-based** facilities, the NPDES permit specifies the rational method be used to determine flow. The rational method uses the equation

$Q = CiA$ , where

$Q$  = flow

$C$  = weighted runoff factor between 0 and 1

$i$  = rainfall intensity

$A$  = area

The permit identifies three alternatives for calculating rainfall intensity:

1. the intensity-duration-frequency method, with a hydrograph corresponding to a 50-year storm,
2. the 85<sup>th</sup> percentile rainfall intensity times two, and
3. 0.2 inches per hour.

An [analysis](#) conducted for the CCCWP determined all three methods yielded similar results.

The 0.2 inches per hour criterion is the basis for a consistent countywide sizing factor for bioretention facilities when used for stormwater treatment only (i.e., not for flow control). The factor is based on a design maximum surface loading rate of 5 inches per hour (mandated by MRP Provision C.3.c.i.(2)(b)(iv)). The sizing factor is the ratio of the design intensity of rainfall on tributary impervious surfaces (0.2 inches/hour) to the design surface loading rate in the facility (5 inches/hour), or **0.04** (dimensionless).

The City of Milpitas (2003) was the first Bay Area municipality to publish guidance incorporating the 4% sizing factor for bioretention facilities, followed by the first edition (2005) of this *Guidebook*. Other countywide programs' guidance soon followed. By the time the MRP was adopted in 2009, the 4% sizing criterion for bioretention was in common use by most municipalities.

For **volume-based** treatment facilities, MRP Provision C.3.d. references two methods, the **WEF method** and the **CASQA BMP Handbook method**. Both the WEF and California BMP methods are based on continuous simulation of runoff from a hypothetical one-acre area entering a basin designed to draw down in 48 hours. The CASQA BMP Handbook method is based on continuous simulation of runoff from a hypothetical unit tributary area entering a basin designed to draw down in 24 or 48 hours. The WEF method is a simplified procedure involving a regression equation for a runoff coefficient developed using rainfall/runoff relationships for 60 urban U.S. watersheds, and regression constants for determining the design

runoff volume, for a 12-, 24-, or 48-hour drawdown time, based on analysis of long term rainfall records from seven U.S. cities, including San Francisco.<sup>1</sup>

Local rainfall data and the CASQA BMP Handbook method were formerly used for sizing detention basins in Contra Costa County. The simulation was iterated to find the unit basin size that detains about 80% of the total runoff during the simulation period. The unit basin storage size is expressed as a depth which varies from about 0.45 to 0.85 inches in Contra Costa County. The results of the method are presented in a [nomograph](#). The technical background is available in a 2005 [technical memo](#).

Since the LID requirements in the MRP 2011 amendments took effect, **detention basins may not be used to meet stormwater treatment requirements for Regulated Projects**. The WEF method and CASQA BMP Handbook method were included in the 2011 amendments and in the subsequent MRP 2.0, but are **obsolete** as design standards, but are sometimes used to calculate the volume associated with capture of 80% of annual runoff.

In the 2009 MRP, a third option for sizing stormwater treatment facilities was added to Provision C.3.d. This option states that “treatment systems that use a **combination of flow and volume capacity** shall be sized to treat at least 80 percent of the total runoff over the life of the project, using local rainfall data.”

This option can also be used to develop sizing factors for facilities with a standard cross-section (i.e., where the volume available to detain runoff is proportional to facility surface area). To calculate sizing factors, inflows, storage, infiltration to groundwater, underdrain discharge, and overflows are tracked for each time-step during a long-term simulation. The simulation is repeated, with variations in the treatment surface area, to determine the minimum area required for the facility to capture and treat 80% of the inflow during the simulation. Such an analysis was conducted for BASMAA by Dubin Environmental Consulting and is described in a Technical Report (Dubin, 2017).

#### ► APPLICABILITY OF REDUCED BIORETENTION SIZING

The criteria on p. 50 require that a minimum 4% sizing factor be used unless justification is provided and documented. Reduced sizing can only be used for road reconstruction projects that follow requirements outlined in MRP 3.0 Provision C.3.b.ii (5)(c), or that are non-regulated projects under C.3.b. For further detail on applicability of reduced bioretention sizing, visit <https://www.cccleanwater.org/development-infrastructure/green-infrastructure/resources>. In addition, all facilities must be at least as large as the minimum sized determined from the equation in the Technical Report (Dubin, 2017). The rationale for this policy follows.

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<sup>1</sup> WEF Manual of Practice No. 23/ASCE Manual and Report on Engineering Practice No. 87, “Urban Runoff Quality Management”, 1998, pages 175-178.

Generally, in projects with surface parking and/or substantial landscaping, bioretention facilities designed to the 4% sizing factor can be incorporated into the project at reasonable cost and in a way that complements other elements of the site and landscape design. Hundreds of development projects have been built to this LID standard in Contra Costa municipalities since 2005.

Use of the 4% sizing factor is practicable on most sites. Requiring that facilities be built to this minimum addresses the following uncertainties inherent in LID design and construction.

**Uncertainties in Hydrologic Analysis.** Variation in actual runoff from predicted runoff could result from any or all of the following factors:

- Geographic variability might not be fully captured by the rainfall analysis.
- Rainfall is simulated in hourly increments, but drainage management areas typically have a time of concentration less than one hour.
- Rain gauge records may not fully represent the range and timing of all runoff events, especially rare large events.
- Climate change is causing increased frequency of intense storms.
- The model is based on a 1-acre impervious tributary area. Actual tributary areas are more complex, with various slopes and surfaces, and sometimes complicated routing of runoff.

**Uncertainties in Facility Design and Construction.** The Permittees' experience is that this ideal configuration—the configuration simulated by the modeling in the Technical Report—is not always attained in built facilities. Despite best efforts to ensure project quality, the Permittees have somewhat limited authority, and limited resources, to enforce design and construction standards on private projects. Even on public projects, where the Permittee is both implementer and overseer, it is often necessary to make compromises in design and construction, because of unforeseen field conditions, or to accommodate other project purposes. Typical deviations from the ideal configuration include the following:

- Side slopes were counted when representing the facility area, but some or all of the side slope area is not actually inundated prior to overflow (i.e., is actually higher in elevation than the facility overflow).
- The facility is not built flat, reducing the amount of effective surface storage or subsurface storage.
- The overflow grate is placed too low, reducing the amount of surface storage.
- The surface reservoir is made shallow by an excess of sand/compost mix.

- The excavation for the gravel layer does not extend beneath the entire treatment area of the facility.
- The underdrain discharge elevation is lower than the top of the gravel layer.
- Subsurface utilities or footings intrude into the gravel layer.
- Soil media is not to specification, or clayey sediment drains into the facility, causing the percolation rate to be less than 5 inches per hour.

**Projects where reduced sizing may be justified.** Based on Contra Costa municipalities’ experience reviewing applications for development project approvals, in projects where structures cover all or nearly all the site square footage, designers are more likely to encounter some or all of the following constraints:

- Tributary drainage areas (Drainage Management Areas, or DMAs) are smaller and the routing of runoff from the DMAs to the facilities becomes more complex.
- There is a greater variation in the ratio between DMA area and the available area for a bioretention facility. It is more difficult to adjust DMA boundaries to distribute runoff among facilities.
- There is insufficient room for side slopes between the facilities and surrounding grade. Perimeter curbs and walls may be required, and protective fences may sometimes be installed atop the walls. High walls around facilities can yield a well-like appearance and the soil surface may be shaded. The walls may need to be buttressed or engineered to avoid tipping, sliding, or other modes of failure.
- Facilities may be located adjacent to buildings or roadways, requiring the addition of moisture barriers or beefed-up foundations.
- Potential facility locations conflict with above-ground or below-ground utilities.
- Facilities are more visible to site users and maintaining a pleasing appearance is of greater concern.

To facilitate maximum effectiveness of LID stormwater treatment in situations with these constraints, the criteria on p. 50 include a project-wide requirement that the project include no surface parking or only incidental surface parking. The criteria also require a demonstration—for each facility proposed to be smaller than the 4% criterion—that facility size has been maximized given the specific constraints.

## Flow-Control (Hydromodification Management)

MRP Provision C.3.g. specifies:

Stormwater discharges from HM projects shall not cause an increase in the erosion potential of the receiving stream over the pre-project (existing) condition. Increases in runoff flow and volume shall be managed so that post-project runoff shall not exceed pre-project rates and durations, where such increased flow and/or volume is likely to cause increased potential for erosion of creek beds and banks, silt pollutant generation, or other adverse impacts on beneficial uses due to increased erosive force.

Comparison of post-project to pre-project flows is based on continuous simulation of runoff over a period of 30 years or more, using local hourly rainfall data, and statistical analysis of the cumulative duration of flows.

As required by the 2003 amendment adding “Provision C.3” requirements to the countywide NPDES permit, the CCCWP submitted a **Hydrograph Modification Management Plan (HMP)** in July 2005. CCCWP’s HMP included design criteria for Low Impact Development **Integrated Management Practices** (IMPs). Applicants for development approvals can comply with both treatment and HM requirements by incorporating IMPs into the project drainage design. The RWQCB approved<sup>2</sup> Contra Costa’s proposed HM standard in July 2006. The HM standard was incorporated into the *Guidebook* Third Edition, which was published in October 2006. The IMPs and IMP design criteria were updated in the Fourth Edition, published in September 2008. A supplement to the Fourth Edition, adding two new IMP configurations (Cistern + Bioretention, Bioretention + Vault) was published in October 2009.

Fulfilling a requirement in the RWQCB’s 2006 Order, CCCWP implemented an IMP Model Calibration and Validation Plan during 2011-2013. The objective of that plan was to evaluate the flow-control effectiveness of the IMPs. IMPs at sites in Walnut Creek and in Pittsburg were monitored during the 2011 and 2012 water years. The results were submitted to the Water Board in a September 2013 IMP Monitoring Report. Results showed that the IMPs provide considerably greater flow-control effectiveness than predicted by the continuous simulation modeling presented in the 2005 HMP. The primary reason is that the 2005 model inputs underestimated the amount of runoff that would be infiltrated by the IMPs. Bioretention facilities built to *Guidebook* criteria controlled runoff flows between one-tenth of the 2-year pre-project peak flow (0.1Q<sub>2</sub>) and the 10-year pre-project peak flow (Q<sub>10</sub>). These are the thresholds specified in MRP 1.0, 2.0, and 3.0.

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<sup>2</sup> Order R2-2006-0050



Fulfilling a requirement in MRP 2.0, CCCWP worked closely with RWQCB staff to prepare a Hydromodification Technical Report, completed in September 2017. The report describes field work conducted on Contra Costa streams during 2017, which supplemented field work conducted in 2004-2005. The report also documents implementation of Direct Simulation of Erosion Potential a modeling methodology used in other parts of California that more precisely predicts the risk of accelerated stream erosion. The September 2017 report concluded that risk could be controlled using LID design criteria—including IMP sizing factors—similar to those in effect since 2008.

In MRP 3.0 (2022), Provision C.3.v.(2) directs CCCWP Permittees to require development projects subject to HM to use the methods and criteria in the *Guidebook*, as it may be updated. CCCWP will propose updated methods and criteria for HM in 2023 Annual Report.

**Applicability: Maps and Exemptions.** The flow-control standard applies to projects which create or replace one acre or more of impervious area and for which applications for development approvals were deemed complete after 14 October 2006. See Chapter 1, including Table 1-1.

Projects may be exempted from HM requirements if any of the following apply:

- The post-project impervious area is less than, or the same as, the pre-project impervious area.
- The project is located in a catchment that drains to pipes or hardened channels, or tidally influenced channels that extend continuously to the Bay, Delta, or a flow-controlled reservoir.
- The project is located in a catchment or subwatershed that is highly developed (that is, 70% or more impervious).

In the 2005 HMP submittal, CCCWP chose not to include an HM applicability map. Program staff and consultants, with input from Permittee staff, concluded:

- An HM Applicability Map would be difficult and expensive to prepare.
- Obtaining approval of each boundary in the map might involve needless contention with Water Board staff.
- The map would need to be updated frequently with new information about watershed conditions, or as conditions changed (for example, stream channel restoration), and there was not a clear regulatory pathway to accommodate map updates.

Instead, CCCWP adopted, and incorporated into the *Guidebook*, requirements that each applicant for approval of an HM project would need to determine if any exemptions applied, and document any claimed exemptions with evidence (for

example, show that each reach of drainage from the project site to the Bay or Delta was pipe or hardened channel).

For most projects, this is a short process, as the outcome is clear one way or the other.

The Tentative Order for MRP 2.0 (2015) unexpectedly included a requirement that Permittees without applicability maps produce maps. CCCWP elected not to contest this requirement, because some Permittees felt that having a map would streamline the review process for their applicants. The development of GIS technology since 2005 meant that maps could be prepared and updated more quickly and accurately than 10 years previous.

CCCWP prepared a draft map, with a few areas “to be determined” and submitted it to the Water Board in September 2017. Water Board staff has not yet approved the map, so exemptions must still be documented for each project. Among the issues to be resolved is agreement on a mechanism to allow map updates based on new evidence. For example, in flat areas adjoining the Bay/Delta, the distance to which tidal action on channel water elevations extends inland is not well-documented for every channel. Applicants for approval of HM projects in these flat areas will likely want to review the line on the map delineating exempt/non-exempt zones and collect detailed channel elevation data and/or evidence of tidal activity that could be used to update the map.

**Sites that Are Already Partially Developed.** At the discretion of municipal staff, on HM projects applicants may provide treatment-only controls for an impervious square footage that is less than or equal to the pre-project impervious square footage. Treatment + HM controls must be provided for the remaining impervious square footage.

The rationale for this guidance is that the combination of treatment-only and treatment + HM controls will meet the Permit requirement that runoff flow and volume be managed so that post-project runoff doesn’t exceed estimated pre-project rates and durations. The rationale is detailed in a 10 March 2009 memo, “Guidance on Flow Control for Development Projects on Sites that are Already Partially Developed,” available on the CCCWP website.

**Selection and Design of HM Controls.** The LID design procedure and criteria in Chapter 3 have been developed and refined, progressively for over a decade, to meet the needs of Contra Costa development projects. In addition to meeting the HM standard, projects designed using Chapter 3 will also meet the LID goals and principles in MRP Provision C.3.c.

Most projects use a combination of site design measures (self-treating and self-retaining areas) and bioretention facilities to meet runoff treatment and flow-control requirements. Design guidance and criteria for more complex options with smaller surface footprints—“cistern + bioretention” and “bioretention + vault”—are in Chapters 3 and 4 and may be used if space on the site is constrained.