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C.3 Stormwater Technical Guidance

May 29, 2012

A handbook for developers, builders and project applicants

Version 3.1

Protecting Alameda County Creeks, Wetlands & the Bay

Updates and Errata

The following changes were made since Version 3.0 was published in December 2011.

#1 – Deleted May 2012

Table 2-1 (Projects Excluded from Provision C.3 Requirements)

#2 – Added May 2012

A new revised Table 5-3 (Projects Excluded from Provision C.3 Requirements)

#3 – Deleted May 2012

Portions of Section 5.1 (Hydraulic Sizing Criteria)

- The entire subsection titled "Combination Flow and Volume Design Basis"
- Table 5-3 (Estimated Runoff Coefficients for Various Surfaces During Small Storms)

#4 – Added May 2012

Portions of Section 5.1 (Hydraulic Sizing Criteria)

- A new revised subsection titled "Combination Flow and Volume Design Basis"
- A new revised Table 5-3 (Estimated Runoff Coefficients for Various Surfaces During Small Storms)

#5 – Deleted May 2012

Text in Section 6.9 (Green Roofs):

- The planting media shall be a minimum of 3-inches deep and shall have sufficient depth to provide capacity within the pore space of the media to capture 80 percent of the average annual runoff.

#6 – Added May 2012

Text in Section 6.9 (Green Roofs):

- The green roof system planting media shall be sufficiently deep to provide capacity within the pore space of the media to capture 80 percent of the average annual runoff.

#7 – Deleted May 2012

Appendix C (Example Scenarios)

#8 – Added May 2012

New version of Appendix C (Example Scenarios)

#9 – Deleted May 2012

Figure J-1 (Flow chart of feasibility and infeasibility evaluation process) in Appendix J

#10 – Added May 2012

Revised Figure J-1 (Flow chart of feasibility and infeasibility evaluation process) in Appendix J

#11 – Deleted May 2012

Text in Step 3.a. of Section J.1 (General Approach) in Appendix J

- , if the applicant meets the requirement, described in Appendix K, to document that LID treatment is infeasible.

#12 – Deleted May 2012

Text in Section J.2 of Appendix J (Feasibility Evaluation: Infiltration and Rainwater Harvesting/Use)

- The entire subsection titled "Special Projects Prescreening"

#13 – Added May 2012

Text in Section J.2 of Appendix J (Feasibility Evaluation: Infiltration and Rainwater Harvesting/Use)

- A new revised subsection titled "Special Projects Prescreening"

#14 – Deleted May 2012

Worksheets in Appendix J (Feasibility Evaluation: Infiltration and Rainwater Harvesting/Use)

- Screening Worksheet
- Infiltration Feasibility Worksheet
- Rainwater Harvesting and Use Feasibility Worksheet
- Special Projects Worksheet

#15 – Deleted May 2012

Text in Section K.1 (Introduction) of Appendix K (Special Projects)

- As described in Section K.5, documentation must be provided to show why the use of LID treatment is considered infeasible.

#16 – Added May 2012

Text in Section K.1 (Introduction) of Appendix K (Special Projects)

- As described in Section K.5, documentation must be provided to discuss the feasibility and infeasibility of using 100 percent LID treatment onsite and offsite.

#17 – Added May 2012

New Section K.6 (Select Non-LID Treatment Measures Certified by a Government Agency) of Appendix K

- The new section advises that non-LID treatment measures that are allowed in Special Projects should be certified by the Washington State Department of Ecology's Technical Assessment Protocol – Ecology (TAPE) program.

Local Contacts

Please contact the local agency with any questions regarding requirements specific to the local jurisdiction, using contact information provided below.

Alameda: Public Works Department, 510.749.5840

Albany: Community Development and Environmental Resources Department 1000 San Pablo Avenue, Albany, CA 94706. 510.528.5760

Berkeley: 510.981.7451

Dublin: 925.833.6650

Emeryville: Civic Center, 1333 Park Ave, Emeryville, CA 94608
510.596.3728, www.ci.emeryville.ca.us/planning/stormwater.html

Fremont: Environmental Services Division, 39550 Liberty Street, Fremont CA 94538, 510.494.4570, www.fremont.gov/stormwaterdevelopment

Hayward: Engineering and Transportation Division, 510.583.4785

Livermore: 925.960.8100 (Inspection/reporting), 925.960-4500 (C.3 Technical Info)
Permit Center, 1052 South Livermore, Ave. Livermore, CA 94550

Newark: Michael Carmen or Soren Fajeau, City Hall – Public Works, 37101 Newark Boulevard, 1st Floor, Newark CA 94560, 510.578.4320

Oakland: Permit Center, 250 Frank H. Ogawa Plaza, 2nd Floor, Oakland, CA 94612
510.238.3911, www.oaklandnet.com

Piedmont: Public Works Counter, City Hall, 120 Vista Avenue, Piedmont, CA 94611; 510.420.3050; www.ci.piedmont.ca.us

Pleasanton: Utility Engineer, 925.931.5508

San Leandro: Engineering and Transportation Department, Civic Center- 835 East 14th Street, San Leandro, CA 94577
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Keith Cooke, 510.577.3439, kcooke@ci.san-leandro.ca.us

Union City: 34009 Alvarado-Niles Blvd., Union City, CA 94587, 510.675.5362

Unincorporated Alameda County: 510.670.5543
339 Elmhurst Street, 1st Floor, Permit Center, Hayward, CA 94544

Alameda County Flood Control and Water Conservation District: 510.670.5543
339 Elmhurst Street, 1st Floor, Permit Center, Hayward, CA 94544

Zone 7 Water Agency: 925.454.5036

Credits

The Clean Water Program extends its appreciation to all those who contributed to this document, which was developed under the guidance of the C.3 Technical Guidance Work Group and New Development Subcommittee. We appreciate the comments, suggestions, and guidance provided by the participating work group and subcommittee members listed below.

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The Clean Water Program recognizes the firms that helped prepare this document. BKF Engineers prepared the technical guidance for specific stormwater controls in Chapters 4 and 6, as well as Appendix C (Example Scenarios). Design, Community and Environment prepared Appendix B (Planting Guidance) and contributed to Section 5.7 (Selecting and Maintaining Plantings). Four Dimensions Landscape Company conducted peer review of Appendix B. Stopwaste.org staff reviewed the Bay-Friendly Landscaping and Integrated Pest Management sections of Appendix B. EOA, Inc., as the program management consultant, coordinated and compiled the information and assisted with the overall preparation of the document.

The Clean Water Program gratefully acknowledges the public agencies whose post-construction stormwater guidance documents served as inspiration and models for this document, including the Contra Costa Countywide Clean Water Program's C.3 Stormwater Guidebook, the Milpitas C.3 Stormwater Guidebook, the Santa Clara Valley Urban Runoff Pollution Prevention Program's C.3 Stormwater Handbook, the Santa Rosa Area SUSMP Guidelines, and Portland, Oregon's Stormwater Management Manual, and the San Mateo Water Pollution Prevention Program's C.3 Technical Guidance.

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Glossary of Terms

Alameda Countywide Clean Water Program	Now known as the Clean Water Program Alameda County.
Bay Area Hydrology Model (BAHM)	A computer software application to assist project applicants in sizing specialized detention facilities that will allow a project to meet the Flow Duration Control standard where required by the hydromodification management provision (Provision C.3.g) of the Municipal Regional Stormwater Permit. The BAHM is available for download at www.bayareahydrologymodel.com.
Beneficial Use	The uses of water of the state protected against degradation, such as domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation and preservation of fish and wildlife, and other aquatic resources or preserves.
Best Management Practice (BMP)	Any program, technology, process, siting criteria, operational method or measure, or engineered system, which when implemented prevents, controls, removes, or reduces pollution. Includes schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce water pollution. BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, litter or waste disposal, or drainage from raw material storage.
Bioinfiltration Area	A type of low development treatment measure designed to have a surface ponding area that allows for evapotranspiration, and to filter water through 18 inches of engineered biotreatment soil. After the water filters through the engineered soil, it encounters a 12-inch layer of rock in which an underdrain is typically installed. If the underlying soils have a saturated hydraulic conductivity rate of 1.6" per hour or greater, then the C.3.d amount of runoff is treated by evapotranspiration and infiltration. If the soils have a lower hydraulic conductivity rate, then the bioinfiltration area treats stormwater with evapotranspiration, some infiltration, and the remaining amount of the C.3.d amount of runoff is filtered and released into the underdrain. The difference between a bioinfiltration area and a bioretention area is that the bioinfiltration area is never lined with an impermeable layer; whereas, a bioretention area may be lined or unlined.

Bioretention Area	A type of low development treatment measure designed to have a surface ponding area that allows for evapotranspiration, and to filter water through 18 inches of engineered biotreatment soil. After the water filters through the engineered soil, it encounters a 12-inch layer of rock in which an underdrain is typically installed. If the underlying soils have a saturated hydraulic conductivity rate of 1.6" per hour or greater, then the C.3.d amount of runoff is treated by evapotranspiration and infiltration. If the soils have a lower hydraulic conductivity rate, or if infiltration is prohibited and the bioretention area is lined with an impermeable layer, then the bioretention area treats stormwater with evapotranspiration, some or no infiltration, and the remaining amount of the C.3.d amount of runoff is filtered and released into the underdrain. The difference between a bioinfiltration area and a bioretention area is that the bioinfiltration area is never lined with an impermeable layer; whereas, a bioretention area may be lined or unlined.
Biotreatment	A type of low impact development treatment allowed under Provision C.3.c of the MRP, if infiltration, evapotranspiration and rainwater harvesting and use are infeasible. As required by Provision C.3.c.i(2)(vi), biotreatment systems shall be designed to have a surface area no smaller than what is required to accommodate a 5 inches/hour stormwater runoff surface loading rate and shall use biotreatment soil as specified in the biotreatment soil specifications approved by the Regional Water Board, or equivalent.
Buffer Strip or Zone	Strip of erosion-resistant vegetation over which stormwater runoff is directed.
C.3	Provision of the Municipal Regional Stormwater NPDES Permit (MRP) that requires each Discharger to control the flow of stormwater and stormwater pollutants from new development and redevelopment sites over which it has jurisdiction.
C.3 Regulated Projects	Development projects as defined by Provision C.3.b.ii of the MRP. This includes public and private projects that create and/or replace 10,000 square feet or more of impervious surface, and restaurants, retail gasoline outlets, auto service facilities, and uncovered parking lots (stand-alone or part of another use) that create and/or replace 5,000 square feet or more of impervious surface. Single family homes that are not part of a larger plan of development are specifically excluded.

C.3.d Amount of Runoff	The amount of stormwater runoff from C.3 Regulated Projects that must receive stormwater treatment, as described by hydraulic sizing criteria in Provision C.3.d of the MRP.
California Association of Stormwater Quality Agencies (CASQA)	Publisher of the California Stormwater Best Management Practices Handbooks, available at www.cabmphandbooks.com. Successor to the Storm Water Quality Task Force (SWQTF).
Clean Water Act (CWA)	The Federal Water Pollution Prevention and Control Act, or Clean Water Act (33 U.S. Code 1251 *et seq.*) is intended to control or eliminate surface water pollution and establishes the National Pollutant Discharge Elimination System, which regulates surface water discharges from municipal storm drains, publicly-owned treatment works and industrial discharges.
Clean Water Program Alameda County	Formerly the Alameda Countywide Clean Water Program. The Clean Water Program is established by a memorandum of understanding among the 14 Alameda County cities, Alameda County (Unincorporated Area), the Alameda County Flood Control and Water Conservation District, and the Zone 7 Water Agency. All these agencies are listed as Co-permittees in a municipal stormwater NPDES permit adopted by the Regional Water Quality Control Board. The Clean Water Program implements common tasks and assists the member agencies to implement their local stormwater pollution prevention programs.
Complete Application	Applications that have been accepted by the Planning Department and have not received a letter within 30 calendar days stating that the application is incomplete (consistent with the Permit Streamlining Act). Where an application has not been accepted by the Planning Department and the applicant has received a letter within 30 days stating that the application is incomplete, the application will be deemed complete if the additional requested information is submitted to the satisfaction of the Planning Department.
Conditions of Approval (COAs)	Requirements the City may adopt for a project in connection with a discretionary action (e.g., adoption of an EIR or negative declaration or issuance of a use permit). COAs may include features to be incorporated into the final plans for the project and may also specify uses, activities, and operational measures that must be observed over the life of the project.
Conduit/Conveyance System/ Culvert	Channels or pipes for collecting and directing the flow of water. Conduits and conveyance systems may be open channels, covered channels or pipes. Culverts are covered channels or large diameter pipes.

Constructed Wetland	Constructed detention basins that have a permanent pool of water throughout the year and capacity for temporary additional storage of runoff that is released via an outlet structure. They differ from wet ponds in that they are typically shallower and have greater vegetation coverage.
Construction General Permit	A NPDES permit issued by the State Water Resources Control Board (SWRCB) for the discharge of stormwater associated with construction activity from soil disturbance of one (1) acre or more. The current Construction General Permit was adopted by the SWRCB on September 2, 2009, and went into effect July 1, 2010.
Design Storm	A hypothetical rainstorm defined by rainfall intensities and durations.
Detention	The temporary storage of stormwater runoff in ponds, vaults, within berms, or in depressed areas to allow treatment by sedimentation and metered discharge of runoff at reduced peak flow rates. See Infiltration and retention.
Directly-Connected Impervious Area (DCIA)	The area covered by a building, impermeable pavement, and/or other impervious surfaces, which drains directly into the storm drain without first flowing across permeable land area (e.g., turf buffers).
Directly Discharging	Outflow from a drainage conveyance system that is composed entirely or predominantly of flows from the subject property, development, subdivision, or industrial facility, and not commingled with flows from adjacent lands.
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.
Discharge	A release or flow of stormwater or other substance from a conveyance system or storage container.
Discharger	Any responsible party or site owner or operator within the MRP Permittees' jurisdiction whose site discharges stormwater runoff, or a non-stormwater discharge.
Drawdown Time	The time required for a stormwater detention or infiltration BMP to drain and return to the dry-weather condition. For detention BMPs, drawdown time is a function of basin volume and outlet orifice size. For infiltration BMPs, drawdown time is a function of basin volume and infiltration rate.
Dry Weather Flow	Flows that occur during periods without rainfall. In a natural setting, dry weather flows result from precipitation that infiltrates into the soil and slowly moves through the soil to the stream channel. Dry weather flows in storm drains may result from human activities, such as over-irrigation.

Dry Well	Structure placed in an excavation or boring, or excavation filled with open-graded rock, that is designed to collect stormwater and infiltrate into the subsurface soil.
Erosion	The diminishing or wearing away of land due to wind or water. Often the eroded debris (silt or sediment) becomes a pollutant via stormwater runoff. Erosion occurs naturally, but can be intensified by land disturbing and grading activities such as farming, development, road building, or timber harvesting.
Evapotranspiration	Evaporating water into the air directly or through plant transpiration.
Extended Detention Basin	Constructed basins with drainage outlets that are designed to detain runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow settling of sediment and pollutants.
Filter Fabric	Geotextile of relatively small mesh or pore size that is used to: (a) allow water to pass through while keeping sediment out (permeable); or (b) prevent both runoff and sediment from passing through (impermeable).
Flow-based Treatment Measures	Stormwater treatment measures that treat pollutants from a moving stream of water through filtration, infiltration, and/or biological processes.
Flow Duration	Either a) the total hours that surface flow from a watershed or drainage area occurs at a specified magnitude in response to a long-term time history of rainfall inputs, or b) the cumulative percentage of total hours that flows exceed the specified magnitude (as used in the BAHM). The overall distribution of flow durations is then expressed by a histogram or cumulative distribution curve, showing flow durations for equal subdivisions of the full range of flow magnitudes occurring over time.
Flow Duration Control	An approach to mitigating development-caused hydromodification which involves developing continuous simulation models of runoff from both pre-project and post-project site conditions, comparing flow durations for a designated range of flows, and designing specialized detention and discharge structures to reduce excess post-project flow duration for flows in the designated range (See Chapter 7).
Flow-Through Planter Box	Structure designed to treat stormwater by intercepting rainfall and slowly draining it through filter media and out of planter.
Grading	The cutting and/or filling of the land surface to a desired shape or elevation.
Green Roof/ Roof Garden	Vegetated roof systems that retain and filter stormwater prior to drainage off building rooftops.

Groundwater	Subsurface water that occurs in soils, and geologic formations that are fully saturated.
Hazardous Waste	By-products of human activities that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (flammable, corrosivity, reactivity, or toxicity), or appears on special EPA lists.
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.
Heritage Tree	An individual tree of any size or species given the 'heritage tree' designation as defined by the municipality's tree ordinance or other section of the municipal code.
High-Flow Bypass	In stormwater treatment measures, a pipe, outlet, or other structure designed to convey flood flows directly to the storm drain systems without entering the treatment measure.
Hydrodynamic Separator	A commonly used term for mechanical stormwater treatment systems that are designed as flow-through structures with a settling or separation unit to remove sediment and other pollutants that may settle to the bottom of the separation unit.
Hydrograph	Runoff flow rate plotted as a function of time.
Hydromodification	The modification of a stream's hydrograph, caused in general by increases in flows and durations that result when land is developed (e.g., made more impervious). The effects of hydromodification include, but are not limited to, increased bed and bank erosion, loss of habitat, increased sediment transport and deposition, and increased flooding.
Hydrologic Soil Group	Classification of soils by the Natural Resources Conservation Service (NCRS) into A, B, C, and D groups according to infiltration capacity.
Imperviousness	A term applied to surfaces – roads, sidewalks, rooftops, and parking lots – that prevent or inhibit rainfall from sinking into groundcover and groundwater.
Impervious surface	A surface covering or pavement of a developed parcel of land that prevents the land's natural ability to absorb and infiltrate rainfall/stormwater. Impervious surfaces include, but are not limited to, roof tops; walkways; patios; driveways; parking lots; storage areas; impervious concrete and asphalt; and any other continuous watertight pavement or covering. Landscaped soil and pervious pavement, including pavers with pervious openings and seams, underdrain with pervious soil or pervious storage material, such as a gravel layer sufficient to hold at least the

Impervious surface (continued)	Provision C.3.d volume of rainfall runoff are not impervious surfaces. Open, uncovered retention/detention facilities are not considered impervious surfaces for purposes of determining whether a project is a Regulated Project under Provisions C.3.b and C.3.g. Open, uncovered retention/detention facilities shall be considered impervious surfaces for purposes of runoff modeling and meeting the Hydromodification standard.
Indirect Infiltration	Infiltration via facilities, such as swales and bioretention areas, that are expressly designed to hold runoff and allow it to percolate into surface soils. Runoff may reach groundwater indirectly or may be underdrained through subsurface pipes.
Infiltration	Seepage of runoff through the soil to mix with groundwater. See retention.
Infiltration Devices	Infiltration facilities that are deeper that they are wide and designed to infiltrate stormwater runoff into the subsurface and, as designed, bypass the natural groundwater protection afforded by surface soil. These devices include dry wells, injection wells and infiltration trenches (includes French drains).
Infiltration Facilities	A term that refers to both infiltration devices and measures.
Infiltration Measures	Infiltration facilities that are wider than they are deep (e.g., bioinfiltration, infiltration basins and shallow wide infiltration trenches and dry wells).
Infiltration Trench	Long narrow trench filled with permeable material (e.g., gravel), designed to store runoff and infiltrate through the bottom and sides into the subsurface soil.
Inlet	An entrance into a ditch, storm sewer, or other waterway.
Integrated Management Practice (IMP)	A stormwater treatment measure that meets both stormwater treatment and hydromodification management objectives.
Integrated Pest Management (IPM)	An approach to pest control that utilizes regular monitoring to determine if and when treatments are needed and employs physical, mechanical, cultural, biological, and educational tactics to keep pest numbers low enough to prevent unacceptable damage or annoyance.
Low Impact Development	A land planning and engineering design approach with a goal of reducing stormwater runoff and mimicking a site's predevelopment hydrology by minimizing disturbed areas and impervious cover and then infiltrating, storing, detaining, evapotranspiring, and/or biotreating stormwater runoff close to its source, or onsite.

Low Impact Development (LID) Treatment	Removal of pollutants from stormwater runoff using the following types of stormwater treatment measures: rainwater harvesting and use, infiltration, evapotranspiration, or, where these are infeasible, biotreatment.
Maintenance Plan	A plan detailing operation and maintenance requirements for stormwater treatment measures and/or structural hydromodification measures incorporated into a project.
Maximum Extent Practicable (MEP)	A standard for implementation of stormwater management actions to reduce pollutants in stormwater. Clean Water Act (CWA) 402(p)(3)(B)(iii) requires that municipal stormwater permits "shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants." Also see State Board Order WQ 2000-11.
Media Filter	Two-chambered system that includes a pretreatment settling basin and a filter bed filled with sand or other absorptive filtering media.
Municipal Regional Stormwater Permit (MRP)	The Phase I municipal stormwater NPDES permit under which discharges are permitted from municipal separate storm sewer systems throughout Alameda County and other NPDES Phase I jurisdictions within the San Francisco Bay Regionl
New Development	Land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surfaces; and/or land subdivision.
Non-Stormwater Discharge	Any discharge to municipal separate storm drain that is not composed entirely of stormwater. Some types of non-stormwater discharges may be authorized by NPDES permits and others prohibited.
NPDES Permit **NPDES Permit (continued)**	An authorization, license, or equivalent control document issued by EPA or an approved State agency to implement the requirements of the National Pollutant Discharge Elimination System (NPDES) program. As part of the 1972 Clean Water Act, Congress established the NPDES permitting system to regulate the discharge of pollutants from municipal sewers and industries. The NPDES program was expanded in 1987 to incorporate permits for stormwater discharges as well. Regional Water Quality Control Boards issue stormwater NPDES Permits to local government agencies placing provisions on allowable discharges of municipal stormwater to waters of the state.
Numeric Criteria	Sizing requirements for stormwater treatment controls established in Provision C.3.d. of the MRP.

Operation and Maintenance (O&M)	Refers to requirements in the storm water NPDES permit to inspect treatment BMPs and implement preventative and corrective maintenance in perpetuity. See Chapter 8.
Operational Source Control Measure	Low technology, low cost activities, procedures, or management practices designed to prevent pollutants associated with site functions and activities from being discharged with stormwater runoff. Examples include good housekeeping practices, employee training, standard operating practices, inventory control measures, etc.
Outfall/ Outlet	The point where stormwater discharges from a pipe, channel, ditch, or other conveyance to a waterway.
Percentile Rainfall Intensity	A method of designing flow-based treatment controls that ranks long-term hourly rainfall intensities and selects the 85th percentile value, and then doubles this value.
Permeability	A property of soil that enables water or air to move through it. Usually expressed in inches/hour or inches/day.
Pervious Surface	Permeable hardscape or paved surface that allows surface runoff to infiltrate into surface soil (e.g., turf block, brick, natural stone, cobbles, gravel).
Perviousness	The permeability of a surface that can be penetrated by stormwater to infiltrate the underlying soils.
Point of Compliance	For design to meet Flow Duration Control requirements for hydromodification management, the point at which pre-project runoff is compared to post-project runoff, usually near the point where runoff leaves the project area.
Pollutant	A substance introduced into the environment that adversely affects or potentially affects the usefulness of a resource.
Post-Construction Stormwater Control	See Stormwater Control.
Potential Rainwater Capture Area	The impervious area from which rainwater may be potentially be captured, if rainwater harvesting and use were implemented for a project. If the entire site is evaluated for rainwater harvesting and use feasibility, this consists of the impervious area of the proposed project; for redevelopment projects that replace 50% or more of the existing impervious surface, it also includes the areas of existing impervious surface that are not modified by the project. If only a roof area is evaluated for rainwater harvesting and use feasibility, the potential rainwater capture area consists only of the applicable roof area.

Precipitation	Any form of rain or snow.
Provision C.3	A reference to the requirements in the MRP requiring each MRP Discharger to control the flow of stormwater and stormwater pollutants from new and redevelopment sites over which it has jurisdiction.
Rational Method	A method of calculating runoff flows based on rainfall intensity and the amount of runoff from the tributary area.
Redevelopment	Land-disturbing activity that results in the creation, addition, or replacement of exterior impervious surface area on a site on which some past development has occurred. The MRP excludes interior remodels and routine maintenance or repair, including roof or exterior surface replacement, pavement resurfacing, repaving and road pavement structural section rehabilitation within the existing footprint.
Regional Water Quality Control Board, San Francisco Bay Area Water Board (RWQCB)	One of nine California Regional Water Boards, the Regional Water Board for the San Francisco Bay Region is responsible for implementing pollution control provisions of the Clean Water Act and California Water Code within the area that drains to San Francisco Bay. Also referred to as Water Board.
Retention	The storage of stormwater to prevent it from leaving the development site; may be temporary or permanent.
Runoff	Water originating from rainfall and other sources (e.g., sprinkler irrigation) that is found in drainage facilities, creeks, streams, springs, seeps, ponds, lakes, wetlands, and shallow groundwater.
Screening Density	A threshold of density (e.g., number of units or interior floor area) per acre of impervious surface, associated with a certain potential demand for non-potable water, for C.3 regulated projects. Screening densities are used to determine the feasibility and infeasibility of rainwater harvesting and use. Screening density varies according to location (see Attachment 2 of the LID feasibility forms in Appendix J.) If the screening density is met or exceeded, the Rainwater Harvesting and Use Feasibility Worksheet must be completed for the project.
Sedimentation	The process of depositing soil particles, clays, sands, or other sediments that were picked up by runoff.
Sediments	Soil, sand and minerals washed from land into water, usually after rain.

Self-Retaining Area	A portion of a development site designed to retain the first one inch of rainfall (by ponding and infiltration and/or evapotranspiration) without producing stormwater runoff. Self-retaining areas must have at least a 2:1 ratio of contributing area to a self-retaining area and a 3" ponding depth. Self-retaining areas may include graded depressions with landscaping or pervious pavement. Areas that Contribute Runoff to Self-Retaining Areas are impervious or partially pervious areas that drain to self-retaining areas.
Self-Treating Area	A portion of a development site in which infiltration, evapotranspiration and other natural processes remove pollutants from stormwater. Self-treating areas may include conserved natural open areas, areas of landscaping, green roofs and pervious pavement. Self-treating areas treat only the rain falling on them and do not receive stormwater runoff from other areas.
Site Design Measures	Site planning techniques to conserve natural spaces and/or limit the amount of impervious surface at new development and significant redevelopment projects in order to minimize runoff and the transport of pollutants in runoff.
Source Control Measures	Land use or site planning practices, or structural or non structural measures, that aim to prevent runoff pollution by reducing the potential for contact with rainfall runoff at the source of pollution. Source control measures minimize the contact between pollutants and urban runoff.
Special Projects	Certain types of smart growth, high density and transit oriented development projects that are allowed, under Provision C.3.e.ii of the MRP, to receive LID treatment reductions. The specific development project types will be described in an amendment to the MRP, anticipated in Fall 2011.
Storm Drains	Above and belowground structures for transporting stormwater to creeks or outfalls for flood control purposes.
Storm Event	A rainfall event that produces more than 0.1 inch of precipitation and is separated from the previous storm event by at least 72 hours of dry weather.
Stormwater	Stormwater runoff, snow-melt runoff, surface runoff, and drainage, excluding infiltration and irrigation tailwater.
Stormwater Control	A design feature of a development or redevelopment project, or a routinely-conducted activity that is intended to prevent, minimize or treat pollutants in stormwater, or to reduce erosive flows during the life of the project. Storm water control is a term that collectively refers to site designs to promote water quality, source control

Stormwater Control (continued)	measures, stormwater treatment measures, and hydromodification management measures. Also referred to as "post-construction stormwater control" or "post-construction stormwater measure."
Stormwater Pollution Prevention Plan (SWPPP)	A plan providing for temporary measure to control sediment and other pollutants during construction.
Stormwater Treatment Measure	Any engineered system designed to remove pollutants from stormwater runoff by settling, filtration, biological degradation, plant uptake, media absorption/adsorption or other physical, biological, or chemical process. This includes landscape-based systems such as vegetated swales and bioretention units as well as proprietary systems. Sometimes called a treatment control, treatment control measure treatment system, or treatment control BMP.
Total Project Cost	Total project cost includes the construction (labor) and materials cost of the physical improvements proposed; however, it does not include land, transactions, financing, permitting, demolition, or off-site mitigation costs.
Treatment	Any method, technique, or process designed to remove pollutants and/or solids from polluted stormwater runoff, wastewater, or effluent.
Vector Control	Any method to limit or eradicate vectors of vector born diseases, for which the pathogen (e.g. virus or parasite) is transmitted by a vector which can be mammals, birds or arthropods, especially insects, and more specifically mosquitoes. For the purposes of this document, vector control refers to mosquito control.
Vegetated Buffer Strip	Linear strips of vegetated surfaces that are designed to treat sheet runoff flow from adjacent surfaces.
Volume-Based Stormwater Treatment Measures	Stormwater treatment measures that detain stormwater for a certain period and treat primarily through settling and infiltration.
Water Quality Inlet	Systems that contain one or more chambers that promote sedimentation of coarse materials and separation of undissolved oil and grease from stormwater. Also referred to as oil/water separators.
Water Quality Volume (WQV)	For stormwater treatment measures that depend on detention to work, the volume of water that must be detained to achieve maximum extent practicable pollutant removal. This volume of water must be detained for a specified drawdown time.
WEF Method	A method for determining the required volume of treatment BMPs, recommended by the Water Environment Federation and American Society of Civil Engineers. Described in Urban Runoff Quality Management (WEF/ASCE, 1998).

Chapter

1

Introduction / How to Use this Handbook

This Chapter describes the purpose of this handbook and gives an overview of its contents.

1.1 Purpose of this Handbook

This Alameda Countywide Clean Water Program (Clean Water Program) handbook is meant to help developers, builders, and project sponsors include post-construction stormwater controls in their projects, in order to meet local municipal requirements and State requirements in the Municipal Regional Stormwater Permit (MRP). The municipalities have to require post-construction stormwater controls as part of their obligations under Provision C.3 of the MRP. This is a National Pollutant Discharge Elimination System (NPDES) permit issued by the San Francisco Bay Regional Water Quality Control Board (Water Board), allowing municipal stormwater systems to discharge to local creeks, San Francisco Bay, and other water bodies. In case of conflicting information between this handbook and the MRP, the MRP shall prevail.

The term "***post-construction stormwater control***" refers to permanent features included in a project to reduce pollutants in stormwater and/or erosive flows during the life of the project – after construction is completed. The term "post-construction stormwater control" encompasses low-impact development (LID), which reduces water quality impacts by preserving and re-creating natural landscape features, minimizing imperviousness, and using stormwater as a resource, rather than a waste product.

"Post-construction stormwater controls" are permanent features included in a project to reduce pollutants in stormwater "and/or erosive flows after construction is completed.

Information on best management practices (BMPs) that protect stormwater during construction, is available at www.cleanwaterprogram.org (click on "Businesses," then "Construction Related Issues").

Post-construction stormwater controls are required for both private and public projects. Although this handbook is written primarily for sponsors of private development projects, its technical guidance also applies to publicly-sponsored projects. Municipalities may also find the handbook useful for training municipal staff and consulting plan checkers.

1.2 What is the Clean Water Program?

The Clean Water Program is an association of the agencies in Alameda County that manage separate storm drain systems and creek channels that discharge urban runoff to San Francisco Bay. The Clean Water Program has 17 member agencies: the 14 cities in the County, Unincorporated Alameda County, Zone 7 Water Agency, and the Alameda County Water Conservation and Flood Control Division.

The Clean Water Program's member agencies, and other agencies throughout the region, are joint permit holders of the MRP. Each member agency is individually responsible for implementing the MRP requirements, but participating in the Program helps them collaborate on Clean Water Program initiatives that benefit all members. More information on the Program is available on its website, www.cleanwaterprogram.org.

1.3 How to Use this Handbook

> Some requirements in this Clean Water Program guidance document ***may vary*** from one local jurisdiction

When using this Clean Water Program guidance document, please keep in mind that ***some requirements may vary from one local jurisdiction to the next.*** In the very early stages of project planning, contact the municipal planning staff to schedule a pre-application meeting to learn how the C.3 requirements – and other planning, zoning and building requirements – will apply to your project. Also, because regulatory requirements may change, be sure to ask the local municipal staff to provide any updates of information or requirements.

It's important to note that post-construction stormwater design requirements are complex and technical: most projects will require the assistance of a qualified civil engineer, architect, landscape architect, and/or geotechnical engineer.

To help you get started, a synopsis of the handbook's chapters and appendices is provided below:

- Chapter 2 explains how development affects stormwater quality, how post-construction stormwater measures/LID help reduce these impacts, and gives a detailed explanation of ***Provision C.3 requirements***.
- Chapter 3 gives an overview of how the post-construction stormwater requirements fit into a typical development review process, and offers ***step-by-***

step instructions on how to incorporate stormwater control/LID designs into planning permit and building permit application submittals for your project.

- Chapter 4 presents information on ***site design measures***, including guidance for self-treating and self-retaining areas, which can help reduce the size of stormwater treatment measures.
- Chapter 5 provides ***general technical guidance for stormwater treatment measures***, including hydraulic sizing criteria, the applicability of non-LID treatment measures, manufactured treatment measures, using "treatment trains," infiltration guidelines, plant selection and maintenance, mosquito control, and integrating stormwater treatment with hydromodification management.
- Chapter 6 gives technical guidance for ***specific types of stormwater treatment measures***, including bioretention areas, flow-through planters, vegetated swales, vegetated buffer strips, tree well filters, infiltration trenches, extended detention basins, pervious paving, green roofs, and media filters.
- Chapter 7 explains the requirements for ***hydromodification management measures***, which keep the flow rates and volumes of certain post-construction stormwater flows at pre-construction levels, in order to minimize development-induced erosion in creek channels.
- Chapter 8 explains the ***operation and maintenance*** requirements for stormwater treatment measures.
- Chapter 9 describes the MRP's Provision, which allows projects to contribute to off-site ***alternative compliance*** projects instead of constructing on-site stormwater treatment measures.
- Appendix A is provided for each agency to include its own ***local requirements***, such as the agency's conditions of approval, Source Control Measures List, and Impervious Surface Form.
- Appendix B includes a ***list of plants*** appropriate for use in LID treatment measures. It also offers general guidance on plant selection and maintenance.
- Appendix C presents ***example scenarios***, showing how site design, source controls and treatment measures can be incorporated into projects.
- Appendix D consists of the ***Mean Annual Precipitation Map*** for Alameda County.
- Appendix E describes manufactured stormwater treatment measures that have ***limited applicability***, including inlet filters, oil/water separators, hydrodynamic separators, and media filters.
- Appendix F presents guidelines for using stormwater controls that promote on-site ***infiltration*** of stormwater.
- Appendix G provides guidance for ***controlling mosquito production*** in stormwater treatment measures.

- Appendix H includes templates for preparing stormwater treatment measure ***maintenance plans***.
- Appendix I is the ***Hydromodification Management Susceptibility Map***.
- Appendix J includes guidance for using the ***Feasibility/Infeasibility Criteria*** to determine when the full C.3.d amount of stormwater runoff cannot be treated with rainwater harvesting and use, infiltration or evapotranspiration, in which case stormwater treatment requirements can be met with biotreatment..
- Appendix K provides guidance on using the ***Special Projects Criteria*** approved by the Regional Water Board to identify infill, high density, and transit oriented development projects that may receive LID treatment reduction credits.
- Appendix L includes regional ***Soil Specifications*** approved by the Regional Water Board for use in stormwater biotreatment measures.
- Appendix M will feature ***BMP Specifications for Small Projects***, after these specifications become available in latter half of 2012.

1.4 Precedence

In case of conflicting information between this handbook and the Municipal Regional Stormwater Permit (MRP), the MRP shall prevail.

Chapter

2

Background / Regulatory Requirements

This Chapter summarizes stormwater problems resulting from development and explains the post-construction requirements for development projects.

2.1 Stormwater Problems in Developed Areas

Throughout the country, stormwater runoff is a leading source of pollutants for water bodies that fail to meet water quality standards[1]. In the San Francisco Bay watershed, urban and agricultural runoff is generally considered to be the ***largest source of pollutants*** to aquatic systems.[2] Although stormwater runoff is part of the natural hydrologic cycle, human activities can alter the natural drainage patterns, introduce pollutants, and increase erosion, degrading the natural habitats.

2.1.1 Stormwater Runoff in a Natural Setting

The natural water cycle circulates the earth's water from sky, to land, to sea, to sky in a never-ending cycle. In a pristine setting, soil is covered with a complex matrix of mulch, roots and pores that absorb rainwater. As ***rainwater infiltrates slowly into the soil***, natural biologic processes remove impurities. Because most rainstorms are not large enough to fully saturate the soil, only a small

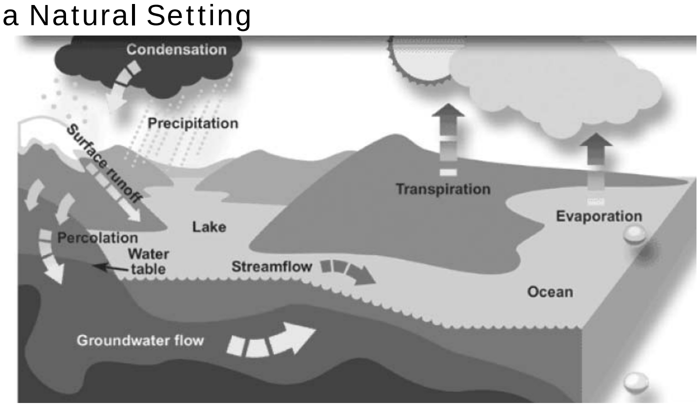

Figure 2-1: The Water Cycle (NGRDC/GDNR, 2005/06)

[1] See the USEPA's list of Stormwater Frequently Asked Questions, at http://cfpub.epa.gov/npdes/faqs.cfm?program_id=6

[2] San Francisco Bay Regional Water Quality Control Board, Basin Plan, 2004

percentage of annual rainwater flows over the surface as runoff. The natural vegetation tends to slow the runoff in a meandering fashion, allowing suspended particles and sediments to settle. In the natural condition, the hydrologic cycle creates a stable supply of groundwater, and surface waters are naturally cleansed of impurities. Sediment is carried with the flow of stormwater runoff, but in a natural setting, creeks typically find an equilibrium in which they manage normal sediment flows with no impairment of their vital functions.

2.1.2 Stormwater Runoff in Urban or Urbanizing Areas

In developed areas, impervious surfaces – such as roads, parking lots and rooftops – prevent water from infiltrating into the soil. ***Most of the rainfall remains on the surface***, where it washes debris, dirt, vehicle fluids, chemicals, and other pollutants into the local storm drain systems. Once in the storm drain, polluted runoff flows directly into creeks and other natural bodies of water. Figure 2-2 contrasts the percentage of rainfall that becomes stormwater runoff in a natural and an urban setting.

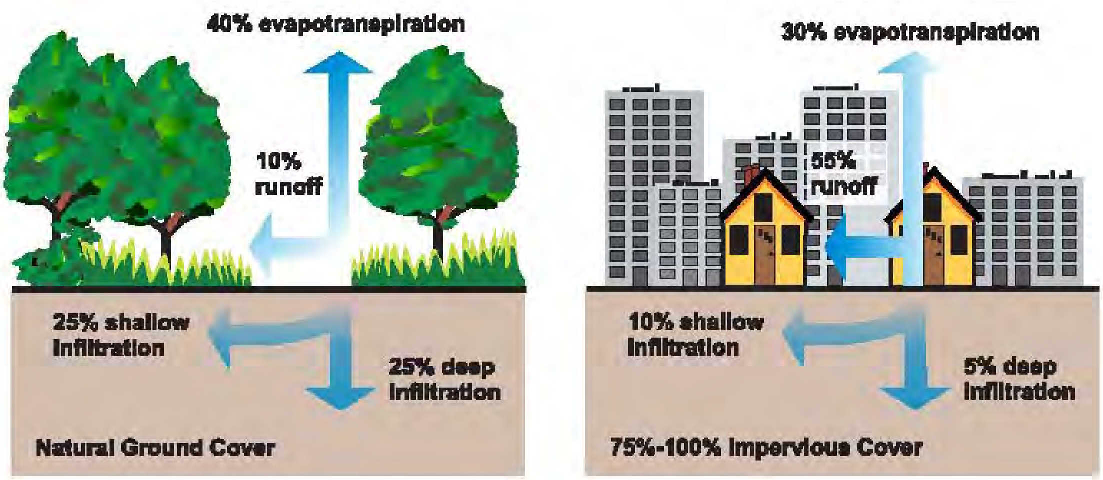

Figure 2-2: Change in volume of stormwater runoff after development. (USEPA, 2003)

Not only does urban stormwater runoff ***wash pollutants into local waterways***, but it can also cause natural creek channels to erode. When impervious surfaces are built, rainwater runs off at ***faster rates and in larger volumes*** than in the natural condition. Natural creek channels must suddenly handle much greater volumes of water traveling at much faster rates, greatly increasing the duration of erosive forces on their bed and banks. In response to these changes, creek channels enlarge by eroding and may also become less stable. This effect is called hydrograph modification or hydromodification. Figures 2-3 and 2-4 contrast creek channels in the natural condition and creek channels subject to hydromodification.

2.2 Post-Construction Stormwater Controls

Various permanent control measures have been developed in order to ***reduce the long-term impacts*** of development on stormwater quality and creek channels. These permanent control measures are often called post-construction stormwater controls/low impact development (LID), or post construction best management practices (BMPs) to distinguish them from the temporary construction BMPs that are used to control sedimentation and erosion while a project is being constructed. LID reduces water quality impacts by preserving and re-creating natural landscape features, minimizing imperviousness, and then infiltrating, storing, detaining, evapotranspiring (evaporating stormwater into the air directly or through plant transpiration), and/or biotreating stormwater runoff close to its source, or onsite.

Figure 2-3: Creek with Natural Banks

Figure 2-4: Creek Subject to Hydromodification

Post-construction stormwater control measures can be divided into four categories: site design measures, source control measures, stormwater treatment measures, and hydromodification management measures. Each of these categories is described below.

2.2.1 Site Design Measures

Site design measures are ***site planning technique***s that help reduce stormwater pollutants and increases in the peak runoff flow and duration, by protecting existing natural resources and reducing impervious surfaces of development projects. Some examples of site design measures include:

- Minimize land disturbance and preserve high-quality open space;
- Minimize impervious surfaces by using narrow streets, driveways and sidewalks;
- Minimize impervious surfaces that are directly connected to the storm drain system (unless the connection includes a stormwater treatment measure). One example of "disconnecting" impervious surfaces is to direct roof downspouts to splash blocks or "bubble-ups" in landscaped areas;
- Cluster structures and paved surfaces; and
- Use landscaping as a drainage feature.

2.2.2 Source Control Measures

Source control measures consist of either structural project features or operational "good housekeeping" practices that ***prevent pollutant discharge and runoff*** at the source, and keeping pollutants from coming into contact with stormwater. Examples of structural source controls include:

- Roofed trash enclosures,
- Berms that control runon to or runoff from a potential pollutant source, and
- Indoor mat/equipment washracks that are connected to the sanitary sewer. (Note that any sanitary sewer connections must be approved by the local permitting authority.)

Examples of operational source controls include:

- Street sweeping and
- Regular inspection and cleaning of storm drain inlets.

2.2.3 Stormwater Treatment Measures

Stormwater treatment measures are engineered systems that are designed to ***remove pollutants from stormwater*** using natural processes such as filtration, infiltration, flotation and sedimentation. Stormwater treatment measures must be sized to comply with one of the hydraulic design criteria listed in the municipal stormwater permit's Provision C.3.d, which are described in Section 5.1 of this guidance document. Chapter 6 provides technical guidance specific to the following treatment measures:

- Bioretention areas,
- Flow-through planter boxes,
- Tree well filters (effective December 1, 2011, high flow rate tree well filters are allowed only in Special Projects - see Appendix K),
- Vegetated buffer strips,
- Infiltration trenches,
- Extended detention basins,
- Pervious paving,
- Turf block and permeable joint pavers,
- Green roofs,
- Rainwater harvesting and use, and
- Media filters (effective December 1, 2011, media filters are allowed only in Special Projects - see Appendix K).

Effective ***December 1, 2011***, the Municipal Regional Stormwater Permit (MRP) requires stormwater treatment requirements to be met by using evapotranspiration, infiltration, rainwater harvesting and reuse. Where this is not feasible, biotreatment is allowed. Appendix J provides guidance for making this feasibility determination. Media filters and high flow rate tree well filters are allowed only in Special Projects. See Section 2.3.2 for more information on stormwater treatment requirements, and Appendix K for more information on Special Projects.

2.2.4 Hydromodification Management Measures

Hydromodification management (HM) measures include site design and source control measures that promote infiltration or otherwise ***minimize the change in the rate and flow of runoff***, when compared to the pre-development condition. HM measures also include constructed facilities (such as basins, ponds, or vaults) that manage the flow rates of stormwater leaving a site, and under some conditions can also include re-engineering of at-risk channels downstream from the site. In some cases a single stormwater treatment measure may be used to meet both the treatment and HM objectives for a project. A dual-use measure of this type is sometimes called an "integrated management practice," or IMP.

2.3 Municipal Stormwater Permit Requirements

The development or redevelopment of property represents an opportunity to incorporate post-construction controls that can reduce water quality impacts over the life of the project. Since the first countywide municipal stormwater permit was adopted in 1991, the Clean Water Program municipal agencies have required new development and redevelopment projects to incorporate post-construction stormwater site design, source control, and treatment measures in their projects to the maximum extent practicable (MEP). To meet the MEP standard, municipalities must employ stormwater control measures that are technically feasible (that is, are likely to be effective) and are not cost prohibitive.

The Municipal Regional Stormwater Permit (MRP), adopted by the Water Board in October 2009, includes more prescriptive requirements for incorporating post-construction stormwater control/LID measures into new development and redevelopment projects than those included in the last countywide permit's update in 2003. These requirements are known as Provision C.3, and the text of Provision C.3 and the entire MRP can be found at http://www.waterboards.ca.gov/sanfranciscobay/board_decisions/adopted_orders/2009/R2-2009-0074.pdf.

2.3.1 Do the C.3 Requirements Affect My Project?

Provision C.3.c establishes thresholds at which new development and redevelopment projects must comply with Provision C.3, although it also states that "all projects regardless of size should consider incorporating appropriate source control and site design measures that minimize stormwater pollutant discharges to the maximum extent practicable [MEP]…". Regardless of a project's need to comply with Provision C.3, municipalities apply the MEP standard, including standard ***stormwater conditions of approval*** for projects that receive development permits. These conditions of approval require appropriate site design, source control measures, and, in some cases, treatment measures.

> Regardless of a project's need to comply with Provision C.3, municipalities apply standard ***stormwater conditions of approval*** to projects that receive development permits.

PROVISION C.3 THRESHOLDS

The thresholds for determining whether Provision C.3 applies to a project are based on the amount of impervious surface that is created and/or replaced by a project, as described below.

- Since August 15, 2006, private or public projects that create and/or replace ***10,000 square feet or more*** of impervious surface must comply with Provision C.3.
- Effective ***December 1, 2011***, the threshold for requiring stormwater treatment is reduced from 10,000 to ***5,000 square feet, or more,*** of impervious surface for the following project categories: uncovered parking areas (stand-alone or part of another use), restaurants, auto service facilities[1] and retail gasoline outlets.

"DEEMED COMPLETE" EXCLUSIONS

- Development applications "deemed complete" for review by the planning department before December 1, 2009 and "diligently pursued[2]" by the project applicant will not be affected by the requirements that are effective December 1, 2011.
- Development applications that were "deemed complete" for review, by the planning department, after December 1, 2009, but receive final discretionary approval before ***December 1, 2011*** are not affected by the requirements that are effective December 1, 2011.

CALCULATING IMPERVIOUS SURFACE

An "impervious surface" is any material that prevents or substantially ***reduces infiltration of water into the soil.*** This includes building roofs, driveways, patios, parking lots, impervious decking, streets, sidewalks, and any other continuous watertight pavement or covering. Impervious surface is calculated in terms of square feet or, for larger sites, in acres. When calculating the area of building roofs, be sure to include not only the footprint of the main building or structure, but also any garages, carports, sheds, or other miscellaneous structures. Landscaped soil and pervious pavement, as long as areas of pervious pavement are underlain with pervious soil or pervious storage material, such as a gravel layer sufficient to hold at least the Provision C.3.d volume of rainfall runoff are not impervious surfaces. Open, uncovered retention/detention facilities are not considered impervious surfaces for purposes of determining whether a project is a Regulated Project under Provisions C.3.b and C.3.g. Open, uncovered retention/detention facilities shall be considered impervious surfaces for purposes of runoff modeling and meeting the Hydromodification standard. The municipalities use an "Impervious Surface Form" to help project applicants with these calculations. ***Contact your local jurisdiction*** to obtain its impervious surface form.

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[1] Auto service facilities include the specific Standard Industrial Classification Codes, as follows:
5013: Wholesale distribution of motor vehicle supplies, accessories, tools, equipment, and parts.
5014: Wholesale distribution of tires and tubes for passenger and commercial vehicles.
7532: Repair of automotive tops, bodies, and interiors, or automotive painting and refinishing.
7533: Installation, repair, or sale and installation of automotive exhaust systems.
7534: Repairing and retreading automotive tires.
7536: Installation, repair, or sales and installation of automotive glass.
7537: Installation, repair, or sales and installation of automotive transmissions.

[2] Diligent pursuance may be demonstrated by the project applicant's submittal of supplemental information to the original application, plans, or other documents required for any necessary approvals of the project.

EXCLUSIONS FROM PROVISION C.3

Provision C.3.c of the municipal stormwater permit excludes specific types of projects from Provision C.3 requirements, even if they meet the threshold requirements described above. The list of excluded project types is shown in Table 2-1, below.

Table 2-1
Projects Excluded from Provision C.3 Numerically Sized Treatment Requirements

	Excluded Projects
Commercial, industrial, residential, or other development	Detached single-family home projects that are not part of a larger plan of development[4].
Road projects	▪ Roadway reconstruction that does not add one or more new lanes of travel or new roadway; ▪ Widening of roadways that does not add one or more new lanes of travel; ▪ Impervious trails with a width of 10 feet or less and located more than 50 feet from top of creek banks. ▪ Sidewalk projects in the public right of way that are not built as part of new streets or roads; ▪ Bicycle lane projects in the public right of way that are not built as part of new streets or roads.[5] ▪ Sidewalks built as part of new streets or roads that are constructed to drain to adjacent vegetated areas; ▪ Bicycle lanes built as part of new streets or roads that are not hydraulically connected to the new streets or roads, and that are constructed to direct stormwater runoff to adjacent vegetated areas; ▪ Impervious trails built to direct stormwater runoff to adjacent vegetated areas or other non-erodible pervious areas, preferably away from creeks or toward the outboard side of levees; ▪ Sidewalks, bicycle lanes or trails built with permeable surfaces; ▪ Caltrans highway projects and associated facilities.
Redevelopment projects (including pavement resurfacing)	Interior remodels and routine maintenance or repair, such as roof or exterior wall surface replacement; or pavement resurfacing within the existing footprint.
Source: San Francisco Bay Regional Water Quality Control Board, October 2009	

[4] Effective December 1, 2012, detached single-family home projects that are not part of a larger plan of development and that create and/or replace 2,500 square feet or more of impervious surface are required to implement site design measures specified in Provision C.3.i.

[5] If an existing road is widened to add a traffic lane in addition to a new bicycle lane, and the bike lane is not hydraulically separated from the road, treatment of runoff from the bike lane would be required.

2.3.2 What is Required by Provision C.3?

Except for the excluded projects listed in Table 2-1, projects that create and/or replace ***10,000 square feet or more*** of impervious surface must incorporate the stormwater controls listed below. Effective ***December 1, 2011,*** projects that consist of restaurants, auto service facilities, retail gasoline outlets, and surface parking areas (stand-alone or part of another use) that create and/or replace 5,000 square feet or more of impervious surface must also implement the stormwater controls listed below.

- Site design measures,
- Source control measures, and
- Low impact development (LID) treatment measures that are hydraulically sized as specified by the MRP. LID treatment is ***evapotranspiration, infiltration, and/or rainwater harvesting and reuse***, unless this is infeasible (Appendix J provide guidance for making feasibility determinations). Where this is infeasible, biotreatment is allowed. In some limited cases, LID treatment reduction is allowed for certain smart growth, high density or transit-oriented development Special Projects, described below.

Biotreatment systems are landscape-based treatment measures that filter water through soils that are engineered to have a long-term infiltration rate of 5 to 10 inches per hour, in accordance with the soil specifications approved by the Regional Water Board in Appendix L. Biotreatment systems must have a surface area no smaller than what is required to accommodate a 5 inches per hour stormwater runoff surface loading rate. Biotreatment systems include an underdrain in a rock layer below the engineered soil, and are used in locations where it is infeasible to infiltrate the full amount of runoff specified in Provision C.3.d. Except in locations where infiltration is precluded, the underdrain should be in the upper portion of the rock layer, in order to maximize infiltration.

LID treatment requirements are reduced for certain smart growth, high density, or transit-oriented development ***Special Projects***. LID treatment reductions are provided in terms of a percentage of the total C.3.d amount of runoff that requires treatment. The percentage that is not treated with LID must be treated with either a high flow rate tree well filter, or a high flow rate media filter. The criteria and procedures for identifying Special Projects and calculating the percentage of LID treatment reduction are provided in Appendix K.

"DEEMED COMPLETE" EXCLUSIONS

- Development applications "deemed complete" for review by the planning department before December 1, 2009 and "diligently pursued[2]" by the project applicant will not be affected by the requirements that are effective December 1, 2011.
- Development applications that were "deemed complete" for review, by the planning department, after December 1, 2009, but receive final discretionary approval before ***December 1, 2011*** are not affected by the requirements that are effective December 1, 2011.

[2] Diligent pursuance may be demonstrated by the project applicant's submittal of supplemental information to the original application, plans, or other documents required for any necessary approvals of the project.

HYDROMODIFICATION MANAGEMENT REQUIREMENTS

Projects that create and/or replace ***one acre or more*** of impervious surface and increase impervious surface area over the pre-project condition need to incorporate hydromodification management measures, if the project is located in an area susceptible to hydromodification.

REDEVELOPMENT PROJECTS

If your project is located on a previously developed site and will result in the ***replacement of impervious surface***, then it is considered a redevelopment project and the following special provisions apply to it:

- ***"50 Percent Rule:"*** Projects that replace 50 percent or less of existing impervious surface need to treat stormwater runoff only from the portion of the site that is redeveloped. Projects that replace more than 50 percent of the existing impervious surface are required to treat runoff from the entire site.
- A project that does not increase impervious surface over the pre-project condition is not a hydromodification management (HM) project.

ROAD PROJECTS

If your roadway project (includes sidewalks and bicycle lanes built as part of new streets or roads) creates 10,000 square feet or more of newly constructed, contiguous impervious surface, the project is subject to the requirements of Provision C.3. Impervious trails 10 feet wide or more that are constructed within 50 feet of the top of a creekbank are also considered roadway projects. If the roadway project widens existing roads with additional traffic lanes, the ***"50 Percent Rule"*** for stormwater treatment (see above) applies. Road projects excluded from Provision C.3 are listed in Table 2-1.

ALTERNATIVE COMPLIANCE

The municipal stormwater permit allows projects to use "alternative compliance," to meet stormwater treatment requirements offsite. See Chapter 9 for more information.

HOW DO PROJECTS MEET THE C.3 REQUIREMENTS?

Your permit application submittals must include detailed information showing how the Provision C.3 stormwater requirements will be met. Chapter 3 provides step-by-step instructions for incorporating C.3 stormwater submittals into your permit application.

2.3.3 Upcoming C.3 Requirements - Effective December 1, 2012

Upcoming stormwater requirements for development projects are described below. The schedule of implementation is shown in Figure 2-5.

Beginning ***December 1, 2012***, all projects which create and/or replace 2,500 sq. ft. to 10,000 sq. ft., including detached single-family residences that are not part of a larger plan of development, must implement one or more of the following:

- Direct roof runoff into cisterns or rain barrels for reuse.
- Direct roof runoff onto vegetated areas.
- Direct runoff from sidewalks, walkways, and/or patios onto vegetated areas.
- Direct runoff from driveways and/or uncovered parking lots onto vegetated areas.

- Construct sidewalks, walkways, and/or patios with permeable surfaces.
- Construct bike lanes, driveways, and/or uncovered parking lots with permeable surfaces.

The Clean Water Program is currently participating in regional collaboration to prepare standard specifications for stormwater controls for projects that create and/or replace 2,500 to 10,000 square feet of impervious surface, and individual single family homes that create and/or replace 2,500 square feet or more of impervious surface. These projects will need to implement at least one of the specified stormwater controls beginning December 1, 2012, as required by MRP Provision C.3.i.

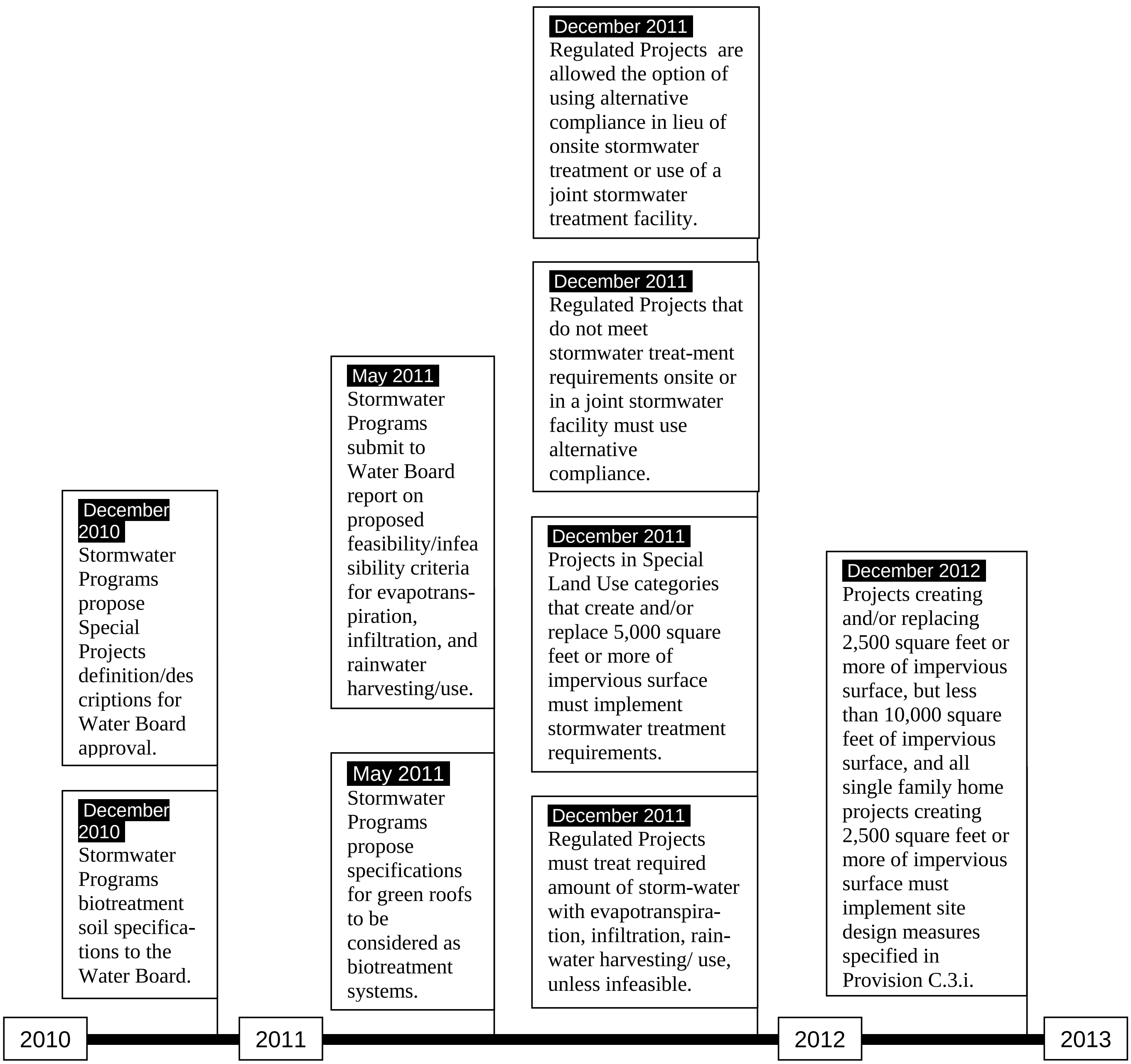

Figure 2-5: Timeline for Implementing New Provision C.3 Requirements

Chapter

3

Preparing Permit Application Submittals

This Chapter outlines the development review process and gives step-by-step instructions for preparing C.3 stormwater submittals for planning and building permit applications.

3.1 The Development Review Process

The municipalities have integrated their review of post-construction stormwater controls into the development review process. If the C.3 requirements apply to your project, your planning permit application submittal must show how you have incorporated the required post-construction stormwater controls. Section 3.2 gives step-by-step instructions on how to do this, beginning at the earliest phases of project planning. Some smaller projects may not require planning permits; see Section 3.4 for ***simple instructions for small sites***.

Preparing the preliminary design of stormwater controls simultaneously with the ***preliminary site plan*** and the landscaping plan is advised to achieve the following benefits:

- Maximize the stormwater benefits of project landscaping.
- Reduce overall project costs.
- Improve site aesthetics and produce a better quality project
- Speed project review times.
- Avoid unnecessary redesign.

> Preparing the preliminary design of stormwater controls simultaneously with the ***preliminary site plan*** and the landscaping plan can help reduce overall project costs.

After the municipality issues your planning permit, you will need to incorporate the required stormwater information into your building permit application submittal. Section 3.3 gives step-by-step instructions for preparing this submittal. A simplified diagram of a sample development review process is shown in Figure 3-1. Please note that the actual development review process in any of the municipalities may differ from the example.

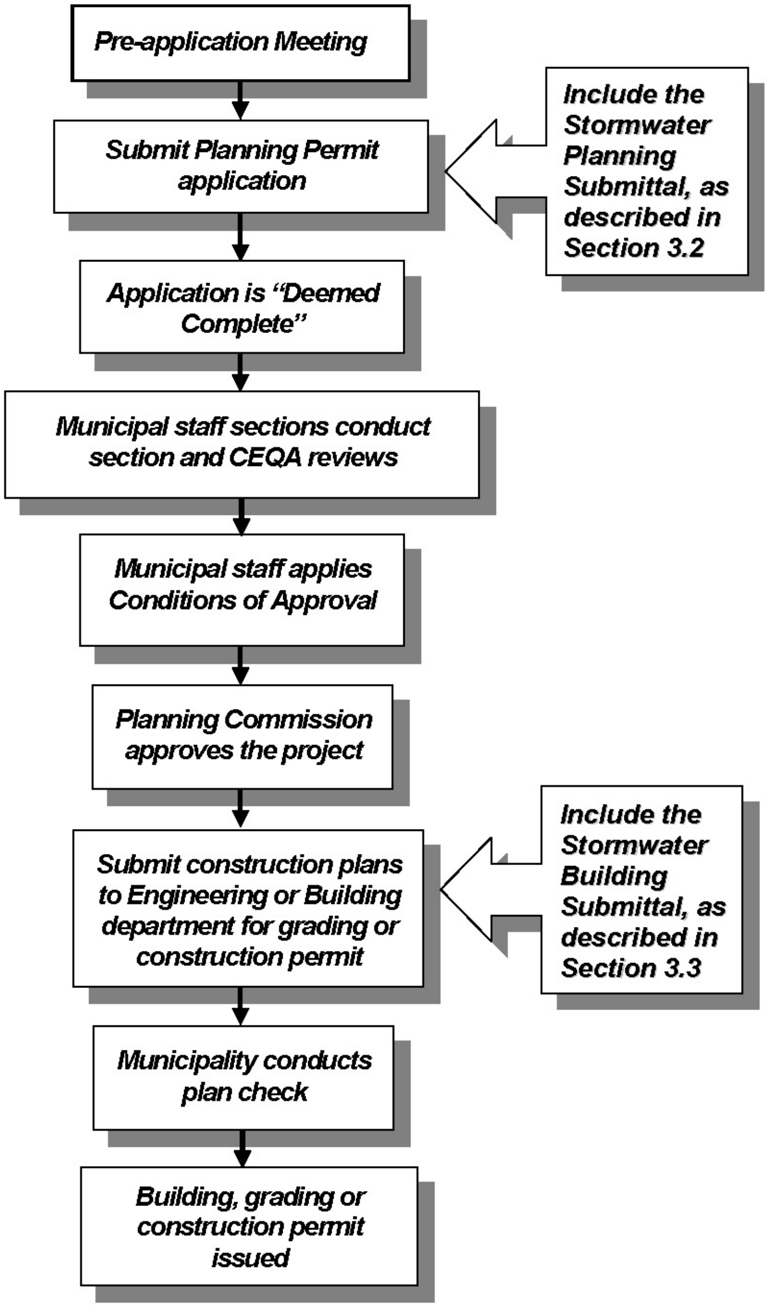

Figure 3-1: Sample Development Review Process

Although the development review process may vary from one municipality to the next, Figure 3-1 highlights the steps in the development review process at which municipalities typically require submittals showing how your project incorporates post-construction stormwater controls. These submittals are incorporated into your planning permit and building permit applications. Remember that the C.3 submittals show how the project will incorporate post-construction stormwater controls, to reduce pollutant loading and prevent increases in creek channel erosion during ***long-term project operations***. The municipality will require you to prepare separate documents to show how sedimentation and erosion will be controlled ***during construction***. Sections 3.2 and 3.3 present step-by-step instructions for preparing C.3 stormwater submittals for planning and building permit applications.

3.2 How to Prepare Planning Permit Submittals

A Planning Permit Submittal Checklist is provided below to help identify the C.3 stormwater-related items that you will need to submit with your planning permit application, but it's important to contact the planning staff of your local jurisdiction to discuss the specific requirements that may apply to your project. After you have a complete list of submittal requirements, you can use the Step-by-Step instructions in this section to prepare your submittal. Applicants with smaller projects are encouraged to read Section 3.4, "***Simple Instructions for Small Sites***," before using the Step-by-Step instructions.

> C.3 submittals show how the project will reduce pollutant loading and prevent increases in creek channel erosion during ***long-term project operations***. You will need to prepare separate documents to show how sedimentation and erosion will be controlled during construction.

3.2.1 The Planning Permit Submittal Checklist

Table 3-1 presents a checklist of C.3 post-construction stormwater information that is typically submitted with planning permit applications. Please note that if runoff from your site discharges directly to a creek or wetland without flowing through a municipality-owned storm drain, you may need to submit additional information. Municipal staff may use this checklist to determine whether your submittal is complete, or some jurisdictions may use a modified checklist. The items included in this checklist are important to demonstrate that your project will:

- Incorporate ***site design measures*** to reduce impervious surfaces, promote infiltration and reduce water quality impacts;
- *Apply* ***source control measures*** to keep pollutants out of stormwater runoff;
- Use *stormwater* ***treatment measures*** to remove pollutants from stormwater; and
- Where applicable, manage ***hydromodification*** *(erosion-inducing flows)* by reducing the rate and amount of runoff.

Table 3-1
Planning Permit Submittal Checklist

Required?[1] Yes	No	Information on Project Drawings	Corresponding Planning Step (Section 3.2)
❑	❑	Existing natural hydrologic features (depressions, watercourses, relatively undisturbed areas) and significant natural resources.	Step 1
❑	❑	Depth to groundwater and soil saturated hydraulic conductivity or soil types.	Step 1
❑	❑	Existing and proposed site drainage network and connections to drainage offsite.	Step 1
❑	❑	For more complex drainage networks, show separate drainage management areas in the existing and proposed site drainage network.	Step 1
❑	❑	Existing condition, including pervious and impervious areas, for each drainage management area.	Step 1
❑	❑	Proposed pervious surfaces, including sensitive natural areas to be preserved and protected from development (for each drainage management area).	Steps 2 and 3
❑	❑	Proposed impervious surfaces, e.g., roof, plaza, sidewalk, street, parking lot (for each drainage management area).	Step 4
❑	❑	Proposed site design measures to minimize impervious surfaces and promote infiltration[2], which will affect the size of treatment measures.	Step 4
❑	❑	Proposed locations and approximate sizes of stormwater treatment measures and (if 1 acre or more of impervious surface is created) hydromodification management measures. Elevations should show sufficient hydraulic head for the treatment measures to work.[2]	Steps 5 - 9
❑	❑	Conceptual planting palette for stormwater treatment measures.[2]	Step 10
❑	❑	Pollutant source areas – including loading docks; food service areas; refuse areas; outdoor processes and storage; vehicle cleaning, repair or maintenance; fuel dispensing; equipment washing; etc. – and corresponding source controls from the local source control list.	Step 12
		Written Information on Municipal Forms or in Report Format	
❑	❑	Completed Impervious Surface Form (obtain from local agency).	Step 4
❑	❑	Completed Infiltration and Harvesting Use Feasibility Screening Worksheet, and, if applicable, the completed Rainwater Harvesting Feasibility Worksheet and/or Infiltration Feasibility Worksheet (obtain from local agency).	Steps 5 and 6
❑	❑	Preliminary calculations for each treatment and hydromodification management measure.	Step 9
❑	❑	Preliminary maintenance plan for stormwater treatment measures.	Step 11
❑	❑	List of source control measures included in the project.	Step 12

[1] Every item is not necessarily required for every project. Municipal staff may check the boxes in the "Required" column to indicate which items will be required for your project.

[2] Site design and treatment measures that promote stormwater infiltration should be consistent with recommendations of the project geotechnical engineer based on the soils boring data, drainage pattern and the current requirements for stormwater controls.

3.2.2 Planning Permit Submittals: Step-by-Step

Step-by-step instructions are offered below to help incorporate post-construction stormwater controls into your project from the very beginning of permit planning. The step-by-step instructions are intended to help you ***prepare the materials*** you will need to submit along with the planning permit application.

PLANNING PERMIT SUBMITTAL

Step 1: Collect Needed Information

Collecting the appropriate information is essential to selecting and siting post-construction stormwater measures. A list of the most ***commonly needed information*** is provided below, but municipal staff may request additional information as well.

- Existing natural features, especially ***hydrologic features*** including creeks, wetlands, watercourses, seeps, springs, ponds, lakes, areas of 100-year floodplain, and any contiguous natural areas. This information may be obtained by site inspections, a topographic survey of the site, and existing maps such as US Geologic Survey (USGS) quadrangle maps, Federal Emergency Management Agency (FEMA) floodplain maps, and US Fish and Wildlife Service (USFWS) wetland inventory maps.
- Existing site ***topography***, including the general direction of surface drainage, local high or low points or depressions, any steep slopes, outcrops, or other significant geologic features. This may be obtained from topographic maps and site inspections.
- ***Existing site drainage.*** For undeveloped sites, this would be identified based on the topographic information described above. For previously developed sites, information on drainage and storm drain connections may be obtained from municipal storm drain maps, plans for previous development, and site inspections.
- ***Soil types*** (including hydrologic soil groups) and ***depth to groundwater.*** If a soils report is not required for the project, planning-level information may be obtained from the Natural Resources Conservation Service (NRCS) Soils Survey. This information is used in determining the feasibility of onsite infiltration of stormwater.
- ***Existing impervious areas.*** Measuring the area of existing impervious surface is necessary to calculate the amount of impervious surface that will be replaced. The Clean Water Program's NPDES stormwater permit requires that redevelopment projects that replace 50 percent or more of impervious surface treat the stormwater runoff from the entire site, not just the redeveloped area. If less than 50 percent of existing impervious surface is replaced, and the existing development was not subject to stormwater treatment measures, then only the affected portion must be included in treatment measure design.
- ***Zoning*** information, including but not limited to requirements for setbacks and open space.

Review the information collected in Step 1. Identify the principal constraints on site design and stormwater treatment measure selection, as well as opportunities to reduce imperviousness and incorporate stormwater controls into the site and landscape

> ***Constraints*** may include impermeable soils, high groundwater, steep slopes, geotechnical instability, high-intensity land use, or heavy vehicle traffic. ***Opportunities*** may include existing natural areas, low areas, oddly configured parcels, or landscape amenities.

design. For example, ***constraints*** might include impermeable soils, high groundwater, steep slopes, geotechnical instability, high-intensity land use, heavy vehicular traffic, or safety concerns. ***Opportunities*** might include existing natural areas, low areas, oddly configured of otherwise unbuildable parcels, landscape amenities including open space and buffers (which can double as locations for stormwater treatment measures) and differences in elevation (which can provide hydraulic head for treatment measures). Prepare a table or brief written summary of constraints and opportunities can prove helpful in selecting and siting stormwater controls.

PLANNING PERMIT SUBMITTAL
Step 2: Minimize Site Disturbance and Protect Sensitive Areas

Design the site layout to minimize changes to the natural topography. Using the information collected in Step 1, identify any existing sensitive natural resources on the site that will be protected and preserved from development. These may include the following types of areas:

- Development should be set back from ***creeks and riparian habitat*** as required by the local jurisdiction. If your project involves impacts to creeks and riparian habitat, contact the Water Board staff regarding permit and mitigation requirements.
- If the project includes ***wetlands*** subject to Section 404 of the federal Clean Water Act, or habitat for ***special-status species*** protected by federal or State laws, these areas should be indicated, and evidence should be provided to demonstrate compliance with the applicable laws.
- The project will need to comply with any local tree preservation ordinances and other policies protecting ***heritage or significant trees***. Mature trees offer substantial stormwater benefits, and their preservation is recommended, where feasible, even if it is not required by law.
- The project needs to comply with any local restrictions on development of ***steep slopes*** and soils that are susceptible to ***erosion***. Even where not required by law, the avoidance of such areas is advisable in order to reduce stormwater impacts.

PLANNING PERMIT SUBMITTAL
Step 3: Incorporate Site Design Measures

Design the project to minimize the overall coverage of impervious paving and roofs, with a special focus on reducing the amount of impervious area that is directly connected to the storm drain system. Using site design measures to reduce impervious surfaces on your site can ***reduce the size of stormwater treatment measures*** that you will need to install. But remember: even vegetated areas will generate some runoff. If runoff from landscaped areas flows to a stormwater treatment measure, that treatment measure will need to be sized to handle these relatively small amounts of runoff, as well as runoff from impervious surfaces. The use of self-treating areas (described below) can reduce the size of treatment measures even further.

> Using site design measures to reduce impervious surfaces on your site can ***reduce the size*** of stormwater treatment measures that you will need to install.

Some examples of site design measures are shown in Figures 3-2 and 3-3. You can find other photographs of site design measures in the Clean Water Program's Guidebook of Post-Construction BMP Examples, at www.cleanwaterprogram.org (click on "Businesses", then "Development Related Issues"). More information on site design measures is provided in Chapter 4. A range of site design examples are described in the following list:

- Use ***alternative site layout techniques*** to reduce the total amount of impervious area. This may include designing compact, multi-story structures or clustering buildings. Some cities may allow narrow streets and (in very low-density neighborhoods) sidewalks on only one side of the street.
- ***Minimize surface parking*** areas, in terms of the number and size of parking spaces.

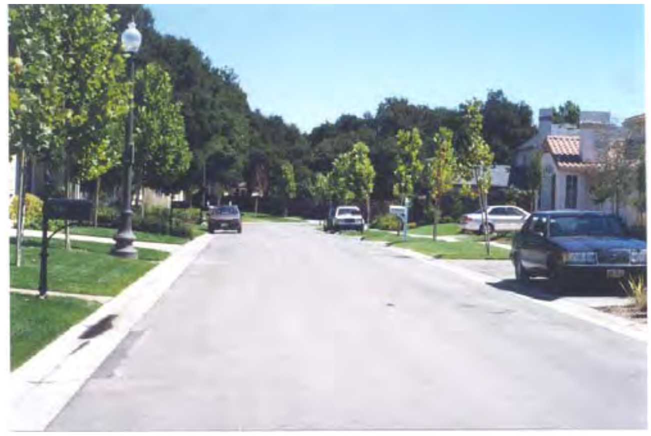

Figure 3-2: Example of a narrow street with parking pull-outs

- Use ***rainwater as a resource.*** Capturing and retaining roof runoff in cisterns can be a practical way to reduce the amount of runoff from the site and store rainwater for use in on-site irrigation. Stormwater storage provided by cisterns may be used to reduce the amount of stormwater that must be treated and, where applicable, retained on-site to meet hydromodification management requirements.
- Use ***drainage as a design element.*** Vegetated swales, depressed landscape areas, vegetated buffers, and bioretention areas can serve as visual amenities and focal points in the landscape design of your site.

Figure 3-3: Pleasanton Sports Park includes this turf block fire access road.

- ***Maximize choices for mobility.*** Motor vehicles are a major source of pollutants in stormwater runoff. Projects should promote, or at least accommodate, modes of transportation other than the automobile.
- Include alternative, pervious surfaces. ***Green roofs*** can partially or fully replace traditional roofing materials. ***Pervious surfaces*** such as crushed aggregate, turf block, unit pavers, or pervious paving – for sidewalks, parking lots, and low-volume residential areas. Green roofs and areas of pervious paving may be designed to function as self-treating areas (see next bullet).
- Identify ***self-treating areas.*** Some portions of your site may provide "self-treatment" if properly designed and drained. Such areas may include conserved natural spaces, large

landscaped areas (such as parks and lawns), green roofs and areas of pervious paving. These areas are considered "self-treating" because infiltration and natural processes that occur in these areas remove pollutants from stormwater. As long as the self-treating areas do ***not receive runoff from impervious areas*** on the site, your drainage design may direct the runoff from self-treating areas directly to the storm drain system or other receiving water. More information on self-treating areas is given in Chapter 4.

- Direct ***runoff to depressed landscaped areas.*** You may be able to design an area within your site to function as a "self-retaining area," in which the amount of stormwater runoff that is required to be treated is infiltrated or retained in depressed landscaped areas. A 2:1 ratio of impervious area to the receiving pervious area may be acceptable, where soils permit. Much higher ratios are possible if the runoff is directed to a bioretention area or other landscape-based treatment measures. See Section 4.

PLANNING PERMIT SUBMITTAL

Step 4: Measure Pervious and Impervious Surfaces

Stormwater treatment is required for projects that create and/or replace ***10,000 square feet*** or more of impervious surface – with some exceptions that are listed in Chapter 2. Effective December 1, 2011, the threshold for requiring stormwater treatment is reduced from 10,000 to ***5,000 square feet,*** or more, of impervious surface for the following project categories: uncovered parking areas (stand-alone or part of another use), restaurants, auto service facilities[1], and retail gasoline outlets. The 5,000 square foot threshold will not apply if a) the project was deemed complete on or before December 1, 2009, and the applicant has diligently pursued[2] the project; b) the project is deemed complete after December 1, 2011, but receives final discretionary approval before December 1, 2011; and/or c) it is a public project for which funding has been committed and construction is scheduled to begin by December 2, 2012.

Hydromodification management (HM) is required for projects that create and/or replace one acre or more of impervious surface AND are located in susceptible areas as identified in the Hydromodification Management Susceptibility Map (see Appendix I). Section 7.1 describes this map, and Section 7.2 lists exceptions to the requirements.

The ***Impervious Surface Form*** that is provided by the local jurisdiction must be completed as part of the planning permit application submittal. This form is used to calculate the amount of impervious surface that will be created and/or replaced, and determine whether treatment and/or HM measures are required. Impervious surfaces are those areas in which

[1] Auto service facilities include the specific Standard Industrial Classification Codes, as follows:
5013: Wholesale distribution of motor vehicle supplies, accessories, tools, equipment, and parts.
5014: Wholesale distribution of tires and tubes for passenger and commercial vehicles.
7532: Repair of automotive tops, bodies, and interiors, or automotive painting and refinishing.
7533: Installation, repair, or sale and installation of automotive exhaust systems.
7534: Repairing and retreading automotive tires.
7536: Installation, repair, or sales and installation of automotive glass.
7537: Installation, repair, or sales and installation of automotive transmissions.
7538: General automotive repair.
7539: Specialized automotive repair such as fuel service, brake relining, front-end and wheel alignment, and radiator repair.

[2] Diligent pursuance may be demonstrated by the project applicant's submittal of supplemental information to the original application, plans, or other documents required for any necessary approvals of the project by the reviewing jurisdiction.

development prevents water from infiltrating into the ground and results in runoff. Impervious surfaces include but are not limited to:

- Footprints of all buildings and structures, including garages, carports, sheds, etc.;
- Driveways, patios, parking lots, decking;
- Streets and sidewalks.

Areas of pervious paving that are underlain with pervious soil or pervious storage material, such as a gravel layer sufficient to hold at least the Provision C.3.d volume of rainfall runoff are not considered impervious surfaces, and are excluded from the calculation of impervious surfaces.

Projects that do not meet the size thresholds for impervious surface need to include stormwater treatment measures (Steps 5, 6, and 7) to the maximum extent practicable – and the Provision C.3 numeric sizing criteria may not apply. Check with the local jurisdiction to determine whether Steps 5 through 7 will apply to your project.

PLANNING PERMIT SUBMITTAL

Step 5 : Determine if Special Projects LID treatment reduction credits apply

LID treatment reduction credits can be applied to smart growth, high density or transit oriented development projects that meet specific criteria for the Special Projects included in Appendix K. Contact municipal staff to determine whether your project meets the criteria to be considered a Special Project.

PLANNING PERMIT SUBMITTAL

Step 6: Determine if New Low Impact Development (LID) Requirements Apply

Stormwater treatment requirements must be met using evapotranspiration, infiltration, and/or rainwater harvesting and reuse. Where this is infeasible, biotreatment measures may be used. Refer to Appendix J for the feasibility worksheets and guidance based on regional criteria and procedures in order to determine feasibility at a site.

PLANNING PERMIT SUBMITTAL

Step 7: Select Treatment/HM Measures

There are many different types of treatment measures, each with particular advantages and disadvantages, and new innovative solutions continue to be developed. ***Chapter 6*** provides technical guidance for specific types of stormwater treatment measures that are commonly used in Alameda County. While other treatment measures may be approved, it may be possible to expedite the review of your project by closely following the guidance provided in Chapter 6.

Selecting the appropriate treatment measure(s) for a specific site is a matter of professional judgment. Some general factors to consider are offered below:

- Effective ***December 1, 2011***, vault-based systems are allowed only in a limited number of locations and types of development.
- Is ***Hydromodification management*** (HM) required? If your project needs to meet both treatment and HM requirements, it is recommended, to the extent feasible, that stormwater control measures be designed to meet both treatment and HM needs.

- ***Soil suitability.*** Soils are classified into four hydrologic soil groups – A, B, C, and D – with the soils in each group having similar runoff potential under similar storm and cover conditions. Group A soils generally have the lowest runoff potential, and group D have the greatest.[3] Treatment measures that rely primarily on ***infiltration***, such as *infiltration trenches*, are unsuitable for use in group D soils (clay loam, sandy clay and clay) and have the potential to fail in group C (silt loam) soils. Bioretention areas installed in group C and D soils typically require subdrains.
- ***Site slope.*** LID treatment measures need to be carefully selected and designed for use on steep slopes, because infiltration of stormwater runoff can cause geotechnical instability. Depending on site conditions, it may be possible to design ***bioretention areas*** using check dams for projects on sites with some slope constraints.
- ***Considerations for larger sites.*** For larger sites that can be divided into separate drainage areas, a variety of smaller stormwater treatment measures may be dispersed throughout the site. It may also be possible to route the stormwater runoff from an individual drainage area to a cistern for non-potable use, such as irrigation or flushing toilets (see Section 4.4, ***Rainwater Harvesting and Use***).
- Consider ***maintenance requirements.*** The amount of maintenance that a stormwater treatment measure will require should be considered when selecting treatment measures. As described in Section 3.3, you will need to prepare and submit a ***maintenance plan*** for stormwater treatment measures with the building permit application. Section 8.2 provides information regarding the maintenance requirements for various treatment measures.

> The ***mosquito control guidance*** (Appendix G) needs to be implemented for all stormwater treatment measures, with special consideration given to treatment measures that are designed to include standing water.

- ***Avoid mosquito problems.*** The mosquito control guidance provided in ***Appendix G*** needs to be implemented for all stormwater treatment measures, with special consideration given to treatment measures that are designed to include standing water.
- Potential for ***groundwater contamination.*** Before selecting an infiltration device, such as an infiltration trench, infiltration basin, or French drain, review the infiltration considerations presented in ***Appendix F*** to protect groundwater from contamination by pollutants in stormwater runoff.

PLANNING PERMIT SUBMITTAL

Step 8: Locate Treatment/HM Measures on the Site

Review the existing and proposed site drainage network and connections to drainage offsite, which were collected in Step 1. Selecting appropriate locations for treatment and HM measures involves a number of important factors, including the following:

- ***Design for gravity flow.*** If at all possible, treatment/HM measures should be designed so that drainage into and out of the treatment measure is by gravity flow. This promotes effective, low-maintenance operation and helps avoid mosquito problems. Pumped

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[3] Details of this soil classification can be found in the National Soil Survey Handbook, Part 618.35 (USDA, 2006), http://soils.usda.gov/technical/handbook.

systems can be feasible, but they are more expensive, require more maintenance, and can introduce sources of underground standing water that attract mosquito breeding.

- Determine ***final ownership and maintenance responsibility.*** Treatment measures should be available for ready access by maintenance workers, municipal inspectors, and staff from the Alameda County Mosquito Abatement District or the Alameda County Vector Control District. If the property will be subdivided, be sure to locate shared treatment measures in a common, accessible area – not on a private residential lot.
- Incorporate ***treatment measures in the landscape design.*** Almost every project includes landscaped areas. Most zoning districts require a certain amount of open space, and some require landscaped setbacks or buffers. It may be possible to locate some or all of your projects' treatment/HM measures within required landscape areas.
- ***Plan for maintenance.*** Stormwater treatment measures will need to be accessible to the largest piece of equipment that will be needed for maintenance. For example, bioretention areas and vegetated swales need access for the types of machinery used for landscape maintenance. Large extended detention basins need to have a perimeter access road accessible by heavy vehicles for sediment removal and controlling emergent vegetation. Underground treatment measures and media filters may require special equipment for periodic clean out and media replacement.

Figure 3-4: This sports field in Dublin also functions as a stomwater detention area.

PLANNING PERMIT SUBMITTAL

Step 9: Preliminary Design of Treatment/HM Measures

Perform preliminary design of the stormwater treatment measures you have selected using the hydraulic sizing criteria in Section 5.1 and the technical guidance for specific types of treatment measures in Chapter 6. The technical guidance in this handbook is compatible with the ***Bay Area Hydrology Model*** (BAHM), a tool for sizing HM measures, developed by the Clean Water Program in cooperation with the Santa Clara Valley Urban Runoff Pollution Prevention Program and the San Mateo Countywide Stormwater Pollution Prevention Program. The BAHM may be downloaded at www.bayareahydrologymodel.com. See Chapter 7 for more information on the BAHM and the design of HM measures.

Detailed construction drawings are typically not required for planning permit submittals, but drawings or sketches need to be included to illustrate the proposed design and sizing information based on runoff calculations.

> Selecting plants that can survive long periods with little or no rainfall will ***help reduce irrigation requirements.***

PLANNING PERMIT SUBMITTAL

Step 10: Consider Planting Palettes for Treatment Measures

The selection of appropriate plant materials is an important part of designing a successful landscape-based stormwater treatment measure. Plants need to be hardy, low-maintenance, tolerant of saturated soils, and selecting plants that can survive long periods with little or no rainfall will ***help reduce irrigation requirements***, although irrigation systems are typically required for landscape-based stormwater treatment measures. At the planning permit phase of the project a detailed planting plan is typically not required, but many municipalities require a conceptual planting palette. Appendix B provides guidance regarding the selection of plant materials for landscape-based treatment measures.

PLANNING PERMIT SUBMITTAL

Step 11: Prepare a Preliminary Maintenance Plan (if required)

A stormwater treatment measure maintenance plan describes how stormwater treatment measures will be maintained during the years and decades ***after construction is completed.*** In some cases a municipality may require the submittal of a preliminary maintenance plan as part of the planning permit submittal. Otherwise, a maintenance plan is required only as part of the building permit submittal. ***Check with your local jurisdiction*** regarding the requirements for your project.

A preliminary maintenance plan identifies the ***proposed maintenance activities***, and the intervals at which they will be conducted, for each stormwater treatment measure included in the project. As part of the building permit submittal, applicants will also need to provide additional information that will be included in a maintenance agreement between the local municipality and the property owner. Chapter 8 provides more information about stormwater treatment measure operation and maintenance. Maintenance plan templates for various types of stormwater treatment measures are included in Appendix H.

PLANNING PERMIT SUBMITTAL

Step 12: Use Applicable Source Control Measures

> Source control measures are land use or site planning practices, or operational activities, that aim to prevent runoff pollution by reducing the potential for contact with rainfall runoff at the source of pollution.

Pollutants are generated by many common activities that will occur after construction is completed. Each local jurisdiction has specific pollutant source control requirements for projects that include landscaping, swimming pools, vehicle washing areas, trash/recycling areas, and other sources of pollutants. These requirements are identified in the agency's ***Local Source Control Measures List.*** Be sure to obtain the current list from your local jurisdiction. The lists are typically divided in two parts: Part I - Structural Source Controls and Part II – Operational Source Controls. These two types of source controls are described as follows:

- ***Structural Source Controls*** - Structural source controls are permanent features that are designed and constructed as part of a project, such as sanitary sewer connections for restaurant wash areas that are large enough to wash the largest piece of equipment.
- ***Operational Source Controls*** – Operational source controls are "good housekeeping" activities that must be conducted routinely during the operations phase of the project – such as street sweeping and cleaning storm drain inlets.

Projects must incorporate the applicable source controls for any project activity that is included in the local source control lists. The following methods may be used to accomplish this.

- ***Review*** structural source controls in Part I of the local list and compare this list to your site plan. Identify any areas on the site that require structural source controls. Remember that some activities may not have been sited yet. For example, the Model List includes a requirement for enclosing and roofing refuse storage areas. If a designer was unaware of this requirement, it may not be shown on the project plans. .
- ***Incorporate*** all the required structural source controls on your project drawings.
- ***If required by the municipality,*** prepare and submit a table, listing in three columns the potential sources of pollutants, the permanent source control measures, and any operational source control measures from Part II of the local list that apply to the project. Table 3-2 is an example Table of Source Controls.

Table 3-2: Example Table of Stormwater Source Controls

Potential Source of Pollutants	Structural Source Controls	Operational Source Controls
On-site storm drains	On-site storm drains shall be marked with the words “No Dumping! Flows to Bay” (or applicable water body) applied with thermoplastic.	All on-site storm drain inlets shall be cleaned at least once a year immediately prior to the rainy season.
Refuse areas	New or redevelopment projects, such as food service facilities, recycling facilities or similar facilities, shall provide a roofed and enclosed area for dumpsters and recycling containers. The area shall be designed to prevent water run-on to the area and runoff from the area and to contain litter and trash, so that it is not dispersed by the wind or runoff during waste removal.	None

NOTE: This table is included as an example only and is not intended for use in an actual submittal.

PLANNING PERMIT SUBMITTAL

Step 13: Coordinate with Other Project Requirements

When submitting the C.3 stormwater drawings with the planning permit submittal, the stormwater site design, source control, treatment and HM measures may be shown on a separate stormwater plan, or combined with the site plan, landscaping plan, or drainage plan – depending on the complexity of the project. Whether plans are combined or separate, there are a number of issues that must be carefully coordinated with other aspects of the project design. Some typical coordination considerations are listed below.

- ***Balance of Cut and Fill.*** When calculating the overall project balance of cut and fill, be sure to include the excavation of stormwater treatment measures (including the need to replace existing clay soils with group A or B soils).
- ***Soil Compaction during Construction.*** Compaction from construction traffic can severely restrict the infiltration capacity of soils at your site. In the construction staging plan, protect and limit operation in those portions of the site that will accommodate self-treating areas or stormwater treatment measures that rely on infiltration.
- ***Building Drainage.*** Building codes require that drainage from roofs and other impervious areas be directed away from the building. The codes also specify minimum sizes and slopes for roof leaders and drain piping. Any stormwater measure located in or on the building, or that may affect building foundations, must be designed to meet the

minimum building code requirements. Stormwater treatment measures are also required to meet the requirements for detention or flow described in Section 5.1.

- ***Control of Elevations.*** Getting runoff to flow from impervious surfaces to landscaped surfaces may require greater attention to detailed slopes and elevations in grading and landscaping plans. For example:
  - ***Provide Adequate Change in Elevation*** between the pavement and vegetated areas. The landscaped area needs to be low enough so that runoff will flow into it even after the turf or other vegetation has grown up. If adequate reveal is not provided, runoff will tend to pond on the edge of the paved surface.
  - ***Provide for Differential Settlement.*** While the soil in landscaped-based stormwater treatment measures and self-treating areas must be left loose and uncompacted, concrete structures (such as inlets and outlets) must be supported on a firm foundation. If not, they may settle more than the surrounding ground, creating depressions that can hold standing water and contribute to mosquito breeding.
  - ***Prevent Erosion.*** Erosion may occur at points where the stormwater runoff flows from impervious areas into landscape-based treatment measures. Include in the project plans any proposed erosion controls, such as cobbles or splash blocks.
- ***Drainage Plans.*** The local building or engineering department may require a drainage plan, which typically focuses on preventing street flooding during a 10-year storm and demonstrating that flooding from 100-year storms can be managed. To meet the drainage plan requirements it may be necessary to include ***high flow bypasses*** in the design of stormwater treatment measures, in order to route ***flood flows*** directly to the storm drain system. Check with your local jurisdiction regarding the need to prepare a drainage plan, and whether it is required only as part of the building permit submittal, or if a preliminary drainage plan is needed with the planning permit submittal.
- ***Signage for Traffic and Parking.*** If your project includes depressed landscaped areas next to parking lots, driveways or roadways, it may be necessary to include bollards, striping or signs to guide traffic, especially if curbs are flush with the pavement. Traffic striping may not be practical for permeable pavements such as crushed aggregate and unit pavers. In these areas signs and bollards may be needed to help direct traffic.

Figure 3-5: Drain rock is used to prevent erosion of this vegetated swale at Zone 7 Water Agency's office building.

PLANNING PERMIT SUBMITTAL

Step 14: Submit Planning Permit Application

Assemble all the items listed in Table 3-1 that municipal staff indicates are required for your project, and include them as attachments to the planning permit application for your project.

3.3 Building Permit Submittals

> If your project ***does not require a planning permit***, submit items from both Tables 3-1 and 3-3 with the building permit application.

Except fo r pro jects on small si tes, the prin cipal di fferences bet ween planning permit submittals and building permit submittals are:

- ***Construction level detail*** is needed, rather than preliminary plans;
- ***Highlight and explain changes***, if plans differ from the planning permit submittal;
- I nclude ***detailed maintenance plans*** and documentation for maintenance agreement.

Table 3-3 provides a list of materials that may be required at this stage in the project, followed by brief step-by-step instructions.

Table 3-3: Building Permit Submittal Checklist

Required? Yes	No	Information on Project Drawings	Corresponds to Building Step (Sect. 3.3)
❑	❑	Sensitive natural areas to be preserved and protected from development. – highlighting any changes since the planning permit submittal.	Step 1
❑	❑	Proposed impervious surfaces, e.g., roof, sidewalk, street, parking lot (for each drainage area) – highlight any changes since the planning permit submittal.	Step 1
❑	❑	Site design measures to minimize impervious surfaces and promote infiltration – construction level detail.	Step 1
❑	❑	Construction level detail of stormwater treatment measures and (if 1 acre or more of impervious surface is created) hydromodification management measures.	Step 1
❑	❑	Pollutant source areas and corresponding structural source controls from local source control list – construction level detail.	Step 1
❑	❑	Landscaping plan for stormwater treatment measures–construction level detail.	Step 1
❑	❑	Letter- or legal-sized conceptual or site plan showing locations of storm-water treatment measures, for inclusion in the Maintenance Agreement.	Step 2
		Written Information on Municipal Forms or in Report Format	
❑	❑	Completed Impervious Surface Form, showing any changes since planning permit submittal.	Step 1
❑	❑	Detailed hydraulic sizing calculations for each treatment and/or hydromodification management measure.	Step 1
❑	❑	List of source control measures included in the project, showing any changes since planning permit submittal.	Step 1
❑	❑	Detailed maintenance plan for stormwater treatment measures, including inspection checklists, as appropriate.	Step 2
❑	❑	A standard treatment measure O&M report form, to be attached to the Maintenance Agreement	Step 2

BUILDING PERMIT SUBMITTAL

Step 1: Update Project Documentation

Information regarding the design of stormwater measures that was submitted with the planning permit application must be updated, as necessary, for submittal with the building permit application. Specific requirements may vary in the various jurisdictions, but this is anticipated to include the following:

- Incorporate all ***stormwater-related conditions of approval*** that were applied during planning permit review.
- Highlight and explain any ***other stormwater-related changes*** that have been made since the planning review. This may include, but is not limited to, changes in the boundaries of sensitive areas to be protected, changes in the amount of impervious surface to be created/replaced, changes in the stormwater pollutant source areas, changes in the location or design of stormwater measures, etc.
- Prepare ***construction level detail*** for all stormwater measures included in the project.
- Prepare detailed ***hydraulic sizing calculations*** for stormwater treatment and HM measures, using the hydraulic sizing guidance provided in Section 5.1.
- Prepare construction-level ***planting plans*** for landscape-based stormwater treatment measures.

NOTE: Some ***smaller projects*** may not require a planning permit. If this is true for your project, your building permit application submittal will need to include items listed in both Table 3-1 and Table 3-3. Ask the building department staff to help you identify the specific items needed for your submittal.

BUILDING PERMIT SUBMITTAL

Step 2: Prepare Maintenance Documentation

Property owners are responsible for assuring the long-term operation and maintenance of a project's stormwater treatment measures, unless the applicable municipality approves other specific arrangements. Details may vary from one jurisdiction to another, but ***maintenance agreements*** generally require the property owner to assure that all stormwater treatment measures receive proper maintenance in accordance with an approved maintenance plan; that municipal, Water Board, Mosquito Abatement District, and Vector Control District staff be granted access, as needed, to ensure proper maintenance and operation; and if the property owner fails to maintain the treatment measure, municipal staff be allowed to enter the property, perform necessary emergency repairs, and charge the property owner for the necessary emergency repairs. Project applicants are typically required to provide the following documentation to support the maintenance agreement:

- A ***conceptual plan or site plan*** that is legible on letter- or legal-sized paper (8.5-by-11 inches or 8.5-by-14 inches) and shows the locations of the stormwater treatment measures that will be subject to the agreement. ***Some municipalities have specific requirements*** for these plans, such as requiring a conceptual plan that includes only the stormwater treatment measures. If more than one stormwater treatment measure is used, the treatment measures should be numbered for ease of identification (for example, Swale 1, Swale 2, etc.)

- A ***maintenance plan*** that includes specific long-term maintenance tasks and a schedule. Section 8.2 provides guidance for preparing a maintenance plan, and Appendix H features maintenance plan templates to use when preparing a maintenance plan. If a preliminary maintenance plan was submitted with the planning permit application, this plan should be updated to respond to municipal staff comments and include a sufficient level of detail for implementation.
- A Standard Treatment Measure Operation and Maintenance ***Inspection Report Form***, which some municipalities require the property owner to complete and submit to the municipality each year. The purpose the annual report is to help the municipality verify that appropriate O&M is occurring. A template for preparing this report form is included in Appendix H.

BUILDING PERMIT SUBMITTAL

Step 3: Submit Building Application

Assemble all the items listed in Table 3-3 that municipal staff has indicated are required for your project, and include them as attachments to your building permit application.

3.4 Simple Instructions for Small Sites

Some developers of smaller projects may be less familiar with requirements to incorporate stormwater treatment measures. If you are a qualified engineer, architect or landscape architect, you may be able to prepare the entire C.3 submittal yourself. If not, you will probably need to hire a ***qualified civil engineer, architect or landscape architect*** to prepare the submittal – or at least some of the more technical aspects of the submittal. Some tips for smaller projects are provided below:

- ***Review submittal checklists with municipal staff.*** If your project does not require a planning permit, you will need to include in your building permit application submittal some of the items that are listed in Table 3-1 (Planning Permit Submittal Checklist) and some from Table 3-3 (Building Permit Checklist). But remember, not every item in the checklists is required for every project. Make an appointment with a member of the building department staff to sit down and go through the checklists with you, to give you a ***reduced list*** of the items you will need for your small site. And make sure to get the list in writing, so you can refer to it, if necessary, in future conversations with municipal staff. If your project requires a planning permit, use this same strategy to get a list of required items from the planning staff.
- ***Maximize the use of site design measures.*** The less impervious surface area on the site, the smaller your stormwater treatment measures will need to be. Chapter 4 lists strategies for reducing impervious surfaces, and it offers guidance for using self-treating areas (for example, landscaping, areas paved with turf block, or green roofs) to further

reduce the size of treatment measures. Beginning ***December 1, 2012***, projects that create and/or replace at least 2,500 but less than 10,000 square feet of impervious surface will be required to incorporate site design measures, using specifications that will be included in Appendix M.

- ***Use LID treatment measures.*** Even on small sites, LID treatment measures are required, except for projects that may receive LID treatment reduction credits as a Special Project (described in Appendix K). Chapter 6 includes technical guidance for some treatment measures, such as bioretention areas and flow-through planters, which are well suited for small sites in ***densely developed areas***. Where on-site conditions, such as proximity to buildings, high groundwater or contaminated soils prohibit infiltration, flow-through planters may be a good option.

- ***Consider using simplified sizing methods.*** The technical guidance in Chapter 6 includes simplified sizing methods for several types of stormwater treatment measures, including vegetated swales, flow-through planters, and bioretention areas. The technical guidance for each of these treatment measures highlights the easy-to-follow calculations for sizing the treatment measures. Please note, however, that there is a trade-off for simplicity. The simplified sizing calculations may result in treatment measures that are conservatively large. If space is at a premium, it may be cost-effective to hire a civil engineer with experience sizing stormwater treatment measures and use the more detailed sizing calculations, in order to potentially reduce the amount of land needed for stormwater treatment.

Figure 3-6: Flow-through planters are incorporated into the landscaping in a dense, urban setting in Emeryville.

- ***Use the planting guidance.*** Appendix B provides guidance for selecting appropriate plantings for landscape-based stormwater treatment measures. Municipal staff will check to confirm that the plants included in your design meet the criteria set forth in this guidance.

Chapter

4

Site Design Measures

This Chapter explains how site design measures can reduce the size of your project's stormwater treatment measures.

Site design measures for water quality protection are low impact development (LID) techniques employed in the design of a project site in order to reduce the project's impact on water quality and beneficial uses. Site design measures are not treatment measures. Including site design measures in a project does not meet the C.3 requirements for stormwater treatment, but it can help reduce the size of treatment measures (see Section 4.1). Site design measures can be grouped into two categories:

- Site design measures that ***preserve sensitive areas*** and high quality open space, and
- Site design measures that ***reduce impervious surfaces*** in a project.

This chapter emphasizes site design measures that reduce impervious surfaces, which can reduce the amount of stormwater runoff that will require treatment. This translates into smaller facilities to meet stormwater treatment requirements than would have been needed without the site design measures. Site design measures are also important in minimizing the size of any required hydromodification management measures for the site. A wide variety of site design measures can be incorporated in your project, including:

- Design ***self-treating*** areas and ***self-retaining*** areas.
- ***Reduce the size of impervious features*** in the project.
- Use cisterns or rain barrels to ***store rainwater*** onsite.
- Preserve and plant trees.

Site design measures used to reduce the size of stormwater treatment measures ***must not be removed*** from the project without a corresponding resizing of the stormwater treatment measures.

Where landscaped areas are designed to have a stormwater drainage function, they need to be carefully integrated with other landscaping features on the site early in project design. This may require coordinating separate designs prepared by different professionals.

Remember that any site design measures (including self-treating areas) used to reduce the size of stormwater treatment measures ***must not be removed*** from the project without a corresponding resizing of the stormwater treatment measures. For this reason, your municipality may require you to include site design measures in the maintenance agreement or maintenance plan for stormwater treatment measures, or otherwise record them with the deed. Depending on the municipality, site design measures may be subject to periodic operation and maintenance inspections. Check with the municipal staff regarding the local requirements.

4.1 Using Self-Treating Areas

Some portions of your site may provide "self-treatment" if properly designed and drained. Such areas may include conserved natural spaces, landscaped areas (such as parks and lawns), green roofs, and areas paved with turf block. Areas of pervious pavement – such as porous concrete, porous asphalt, or unit block pavers – may function as self-treating areas if they are designed to store and infiltrate the rainfall runoff volume described in Provision C.3.d of the MRP. These areas are considered "self-treating" because infiltration and ***natural processes that occur in these areas remove pollutants*** from storm water. Technical guidance for green roofs, pervious pavement, turf block, and permeable joint pavers is provided in Chapter 6.

> If self-treating areas do not receive runoff from impervious areas, runoff from self-treating areas may discharge ***directly*** to the storm drain.

As long as the self-treating areas are not used to receive runoff from other impervious areas on the site, your drainage design may route the runoff from self-treating areas ***directly to the storm drain*** system or other receiving water. Thus, the stormwater from the self-treating areas is kept separate from the runoff from paved and roofed areas of the site, which requires treatment.

Even vegetated areas will generate some runoff. ***If runoff from a self-treating area comingles with the C.3.d amount of runoff from impervious surfaces***, then your stormwater treatment measure must be hydraulically sized to treat runoff from both the self-treating area and the impervious areas. This does not apply to the high flows of stormwater that are in excess of the C.3.d amount of runoff, because stormwater treatment measures are not designed to treat these high flows. If your project requires hydromodification management, then the runoff from self-treating areas will need to be included in the sizing calculations for HM treatment measures.

Figure 4-1 compares the size of the stormwater treatment measure that would be required to treat the runoff from a site, depending on whether or not the runoff from a self-treating area discharges directly to the storm drain system or other receiving water. In the first (upper) sequence, runoff from the self-treating area is directed to the stormwater treatment measure. In the second (lower) sequence, runoff from the self-treating area bypasses the treatment measure and flows directly to the storm drain system or other receiving water, resulting in a smaller volume of stormwater that will require treatment. This results in a ***smaller stormwater treatment measure***.

Figure 4-2 compares the conventional drainage approach to the self-treating area approach. The conventional approach combines stormwater runoff from landscaped areas with the runoff from impervious surfaces. Assuming the parking lot storm drain leads to a treatment measure, in the conventional approach, the treatment measure will need to be sized to treat runoff from the entire site. The ***self-treating area approach*** routes runoff from the landscaped areas directly to the storm drain system. In this approach, the treatment measure is sized to treat only the runoff from impervious areas.

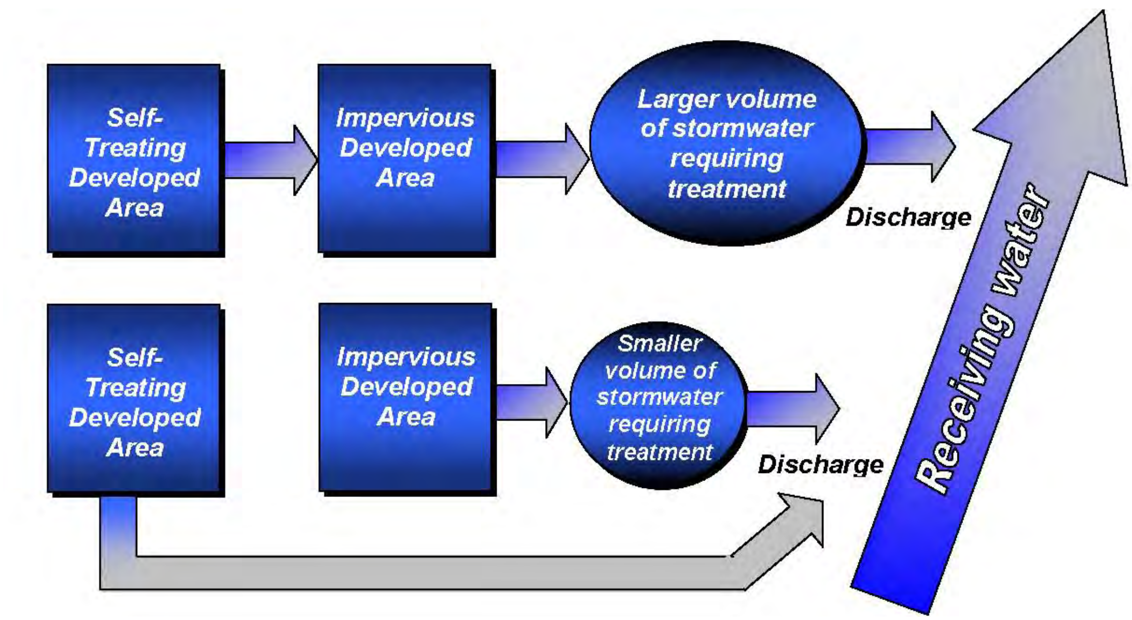

Figure 4-1: Self-Treating Area Usage (Source, BASMAA, 2003)

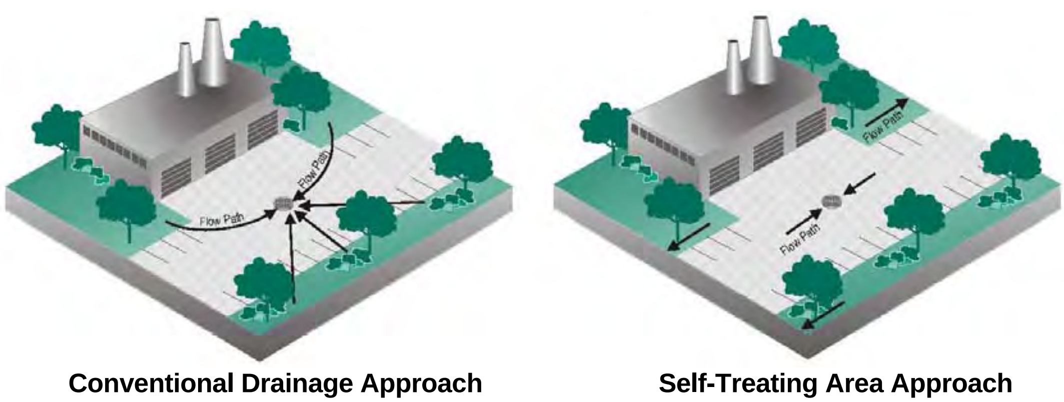

Figure 4-2: Commercial/Industrial Site Compared to Same Site with Self-Treating Areas (Source, BASMAA 2003)

Figure 4-3 shows an example site in which the runoff from impervious areas must flow to the stormwater treatment measure before discharging to the storm drain, while runoff from the self-treating area may discharge directly to the storm drain. This is allowable because the self-treating area does not accept runoff from the impervious portions of the site.

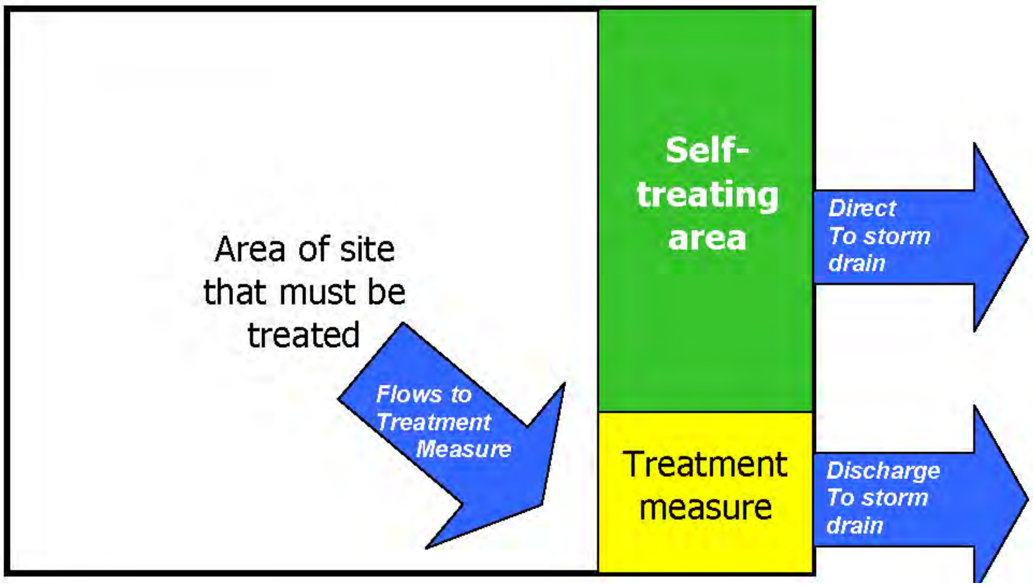

Figure 4-3: Schematic Drainage Plan for Site with a Self-Treating Area

4.2 Self-Retaining Areas

In "self-retaining areas" or "zero discharge areas," a portion of the amount of stormwater runoff that is required to be treated is infiltrated or retained in depressed landscaped areas. If it is possible to create a self-retaining area on your site, you can design smaller stormwater treatment measures (as illustrated in Figures 4-4 and 4-5). ***Drainage from roofs and paving is directed to the self-retaining area***, where it can pond and infiltrate into the soil. Self-retaining areas may be created by designing concave landscaped areas at a lower elevation than surrounding paved areas, such as walkways, driveways, sidewalks and plazas. The following design considerations apply to self-retaining areas:

- Self-retaining areas are designed as concave landscaped areas that are bermed or ditched to retain the first one-inch of rainfall without producing any runoff. Modeling conducted for the Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report (Feasibility Report), prepared by BASMAA, demonstrated that a ponding depth of 3 inches is sufficient to meet the C.3 stormwater treatment objective.
- Runoff may enter the self-retaining area as sheet flow, or it may be piped from a roof or paved area. The elevation difference between the self-retaining area and adjacent areas should be sufficient to allow build-up of turf or mulch within the self-retaining area.

- A 2:1 ratio of impervious area to the receiving pervious area is acceptable. Modeling conducted for the Feasibility Report confirmed that a 2:1 ratio is sufficient to achieve the C.3.d stormwater treatment objective, even for soils with very low hydraulic conductivity.
- Drainage from self-retaining areas (for amounts of runoff greater than the first one-inch) must flow to off-site streets or storm drains without flowing onto paved areas within the site.
- If overflow drains or inlets to the storm drain system are installed within the self-retaining area, set them at an elevation of at least 3 inches above the low point to allow ponding. The overflow drain or storm drain inlet elevation should be high enough to allow ponding throughout the entire surface of the self-retaining area.
- Any pavement within the self-retaining area cannot exceed 5 percent of the total self-retaining area.
- Slopes may not exceed 4 percent.
- The municipality may require amended soils, vegetation and irrigation to maintain soil stability and permeability.
- Self-retaining areas shall be protected from construction traffic and compaction.

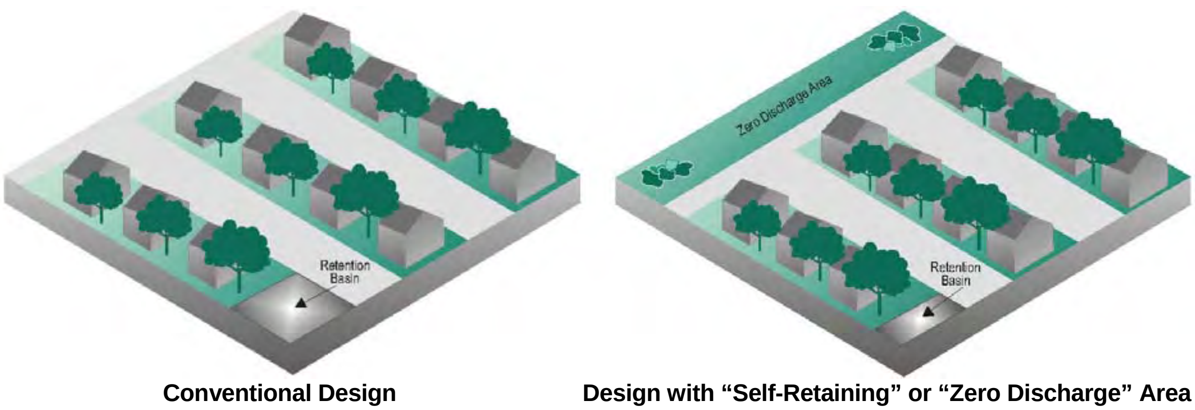

Figure 4-4: Allowing some runoff from impervious surfaces to be retained and infiltrate in a "self-retaining" or "zero discharge" area can reduce the size of the required stormwater treatment measure. (Source: BASMAA 2003)

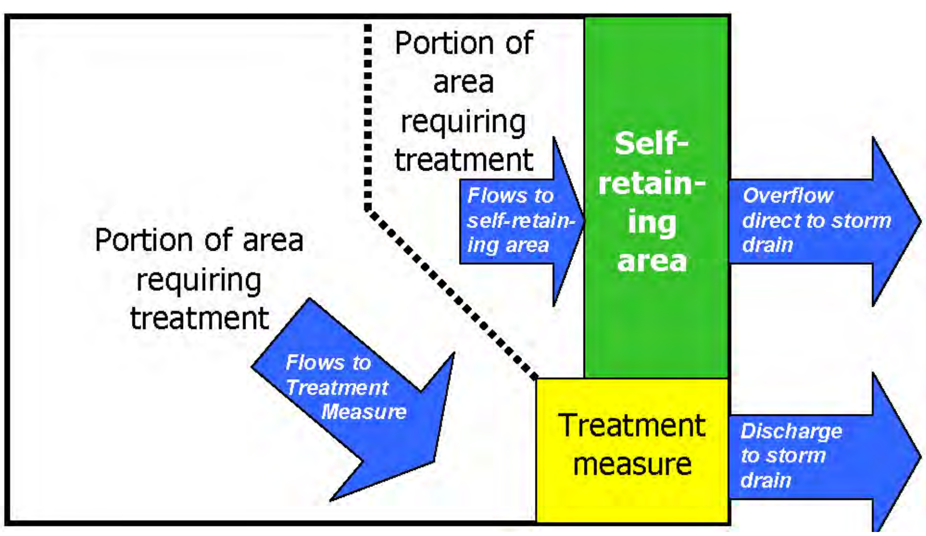

Figure 4-5: Schematic Drainage Plan for Site with a Self-Retaining Area

If you are considering using a self-retaining area in a project that must meet hydromodification management (HM) requirements, use the Bay Area Hydrology Model to identify the appropriate sizing of the self-retaining area to meet the HM objective of matching post-project stormwater flows and durations to pre-project patterns for smaller, frequent storms (ranging from 2- to 10-year storm events). See Chapter 7.

4.3 Reducing the Size of Impervious Areas

A variety of project features can be designed so that they result in a smaller "footprint" of impervious surface. These techniques generally need to be incorporated very early in the project design. A number of techniques for reducing impervious surfaces are described below.

Alternative Site Layout Techniques

Check with your local jurisdiction regarding its policies regarding the following site design measures:

- Use ***pervious pavement*** – such as porous concrete, porous asphalt, or unit block pavers – which are not considered "impervious" if designed to store and infiltrate the rainfall runoff volume described in Provision C.3.d of the MRP. See section 6.9 for pervious paving technical guidance.
- Reduce building footprints by using compact, ***multi-story structures,*** as allowed by local zoning regulations.
- ***Cluster buildings*** to reduce the length of streets and driveways, minimize land disturbance, and protect natural areas.
- *Design* ***narrow streets*** and driveways, as allowed by the local jurisdiction.
- *Use* ***sidewalks on only one side*** of the street may be appropriate in areas with little pedestrian and vehicular traffic, as allowed by the local jurisdiction.

Minimize Surface Parking Areas

A variety of techniques can be used to minimize surface parking areas, in terms of the number and size of parking spaces, as allowed by the local jurisdiction. These solutions focus on either reducing the demand for parking, maximizing the efficiency of parking utilization, or implementing design solutions to reduce the amount of impervious surface per parking space.

- Reduce parking demand by ***separating the cost of parking*** from the cost of housing or leasable space. This allows the buyer or tenant to choose how much parking they actually need and are willing to pay for.
- Maximize efficiency of parking utilization with ***shared parking*** that serves different land uses that have different times of peak demand. For example, an office use with demand peaks during the day can share parking with restaurants, where demand is greatest during the evening, and to some extent residential uses, where demand peaks are in the evenings, nights and on weekends.
- ***Structured parking*** can be an efficient way to reduce the amount of impervious surface needed for parking. Structured parking can be integrated with usable space in buildings

that also house office or residential space, or include ground-floor retail lining the street. Shared parking strategies can work very well with structured parking.

- ***Parking lifts*** are another way to reduce the amount of impervious surface needed for parking. A parking lift stacks two to three cars using a mechanical lift for each surface space. They can be operated manually by residents or employees, or by a valet or parking attendant. With proper training for residents, employers, or parking attendants, this strategy can be a practical way to double or triple the parking capacity given a set amount of land.
- Another way to maximize the efficient use of parking area is ***valet parking***, where attendants park cars much closer and tighter than individual drivers would in the same amount of parking space.

Figure 4-6: Parking Lifts in Parking Garage, Berkeley

4.4 Rainwater Harvesting and Use

Technical guidance for rainwater harvesting and use is provided in Section 6.10 of Chapter 6. A rainwater harvesting system is considered a stormwater treatment measure if it is designed to capture and use the full amount of rainwater runoff that is required to be treated per Provision C.3.d of the MRP. A rainwater harvesting system is considered a site design measure if it is designed to capture and use less than the C.3.d amount of runoff. If your project will include a rainwater harvesting system as a site design measure, follow the guidance in Section 6.10, with the exception of meeting the C.3.d stormwater treatment sizing criteria.

4.5 Tree Preservation and Planting and Interceptor Tree Credits

Trees perform a variety of functions that reduce runoff volumes and improve water quality. Leaf canopies intercept and hold rainwater on the leaf surface, preventing it from reaching the ground and becoming runoff. Root systems create voids in the soil that facilitate infiltration. Trees also absorb and transpire large quantities of groundwater, making the soil less saturated, which allows more stormwater to infiltrate. Through the absorption process, trees remove pollutants from stormwater and stabilize them. Finally, tree canopies shade and cool paved areas.

Consistent with the Feasibility Report submitted to the Water Board by BASMAA on April 29, 2011, a project may earn stormwater treatment credits by planting new trees and preserving existing trees at the project site. To be eligible for these credits, the trees need to meet the minimum requirements listed in Section 4.5.1. The system of interceptor tree credits is described in Table 4-1, and guidance for planting and protection during construction is provided in Section 4.5.2. Additional information about planting trees in dense, urban settings is provided in Section 4.5.3.

Table 4-1
Stormwater Treatment Credits for Interceptor Trees

	New Evergreen Trees	New Deciduous Trees	Existing Trees
Credits for new and existing trees that meet interceptor tree minimum requirements	200 square feet	100 square feet	Square footage under the tree canopy for: ▪ Trees with an average DBH* of less than 12 in. ▪ Trees with an average DBH of 12 inches or more.

Source: BASMAA Feasibility Report (which based its tree credit system on the tree credit system in the statewide Construction General Permit standards for post-construction stormwater control)

4.5.1 Minimum Requirements for Interceptor Trees

The following requirements are based on guidance in the Stormwater Quality Design Manual for the Sacramento and South Placer Regions.

PLANTING NEW INTERCEPTOR TREES

To be eligible for stormwater interceptor tree credits, trees planted as part of the project must meet the following minimum requirements:

- Plant tree within 25 feet of ground-level impervious surface;
- Maintain appropriate distance from infrastructure and other structures that could be damaged by roots; avoid overhead power lines, underground utilities, septic systems, sidewalks, curbs, patios, etc.
- Space trees so crowns do not overlap at 15 yrs of growth;
- Specified trees must be 15 gallon container minimum size at planting;
- Dwarf species are not acceptable; native species and trees with a large canopy at maturity are preferred.
- Clearly label on project plans the trees designated for stormwater interceptor tree credits.

PRESERVATION OF EXISTING INTERCEPTOR TREES

To be eligible for stormwater interceptor tree credits, existing trees preserved at the project site must meet the following minimum requirements:

- The tree trunk must be located within 25 feet of ground-level impervious surface that is included in the project's calculation of the amount of stormwater runoff that will require treatment.
- Dwarf species are ineligible.
- Clearly label on project plans the trees designated for stormwater interceptor tree credits.

4.5.2 Interceptor Tree Planting and Construction Guidelines

The following guidelines are based on guidance in the Stormwater Quality Design Manual for the Sacramento and South Placer Regions.

PLANTING NEW INTERCEPTOR TREES

- Drainage and soil type must support selected tree species.
- Avoid compaction of soil in planting areas.
- Avoid contamination of planting areas by construction related materials such as lime or limestone gravel.
- Install turf grass no closer than 24 inches from trunk;
- Add 4-6 inches deep of hardwood mulch, 6 inches away from trunk;
- Permanent irrigation system may be required;
- Avoid excess irrigation due to mosquito issues;
- Pruning and removal and replacement of diseased/damaged tree may be required.
- If construction is ongoing, install high-visibility protective fencing at the outer limit of the critical root zone area.

PLANTING NEW INTERCEPTOR TREES

- Plan new landscaping under existing trees to avoid grade changes and excess moisture in the trunk area, depending on the tree species. Preserve existing plants that are compatible with irrigation requirements and are consistent with the landscape design.
- Avoid grade changes greater than 6 inches within the critical root zone.
- Avoid soil compaction under trees.
- During construction minimize disruption of the root system.
- Plans and specifications shall clearly state protection procedures for interceptor trees to be preserved.
- Protect existing trees during construction through the use of high-visibility construction fencing at the outer limit of the critical root zone area. The fence must prevent equipment

traffic and storage under trees. Excavation in this area should be done by hand and roots ½-inch and larger should be preserved. Pruning of branches or roots should be done by, or under supervision of, an arborist.

- Provide irrigation of trees during and after construction.
- Install turf grass no closer than 24 inches of trunk.

4.5.3 Tree Planting in Dense, Urban Areas

> Structural soils may allow the installation of ***large shade trees*** in narrow medians where the tree otherwise may conflict with infrastructure.

When planting trees, particularly along streets where space is limited and roots may damage hard surfaces, ***consider the use of structural soils***. Structural soil is a planting medium that consists of a stone skeleton structure for strength and clay soil for water retention, which allows urban trees to grow under pavement. The structural soil system creates a load-bearing matrix with voids filled with soil and air, essential for tree health. This allows for greater tree growth, better overall heath of trees, and reduced pavement uplifting by tree roots. The voids that benefit the tree roots also provide increased stormwater storage capacity, allowing tree pits in paved areas to serve as a series of small detention basins. See www.hort.cornell.edu/uhi/outreach/csc/ for more information on structural soils. Before including structural soils in your project, please contact the municipality for information and requirements specific to the local jurisdiction.

Load-bearing modular grid products, such as the Silva Cell, have also been developed to allow the planting of trees in uncompacted native soils, fill soils, or stormwater treatment soils, extending under sidewalks and other areas of pavement. With the Silva Cell product, for example, each cell is composed of a frame (or frames) and a deck (see Figure 4-7).

The frames can be stacked one, two, or three units high before they are topped with a deck to create a maximum amount of soil volume for tree root growth and stormwater infiltration. Cells can be installed laterally as wide as necessary. Void space within the cells may accommodate the surrounding utilities.

Figure 4-7: Silva Cells, stacked three units high. (Source: Deep Root Technologies, www.deeproot.com). The use of this photograph is for general information only, and is not an endorsement of this or any other proprietary product.

Chapter

5

General Technical Guidance for Treatment Measures

The technical guidance in this Chapter applies to all types of stormwater treatment measures.

This chapter contains general technical information regarding stormwater treatment measures for all types of new development and redevelopment projects. It includes the following topics:

- Hydraulic sizing criteria,
- The applicability of non-landscape based treatment measures,
- Guidance regarding "treatment trains,"
- Infiltration guidelines,
- Using underdrains,
- Using low-flow systems,
- Selecting and maintaining plantings in landscape-based treatment measures,
- Mosquito control requirements,
- Incorporating treatment with hydromodification management measures, and
- Getting water into stormwater treatment measures.

5.1 Hydraulic Sizing Criteria

The stormwater treatment measures must be sized to treat stormwater runoff from ***relatively small sized storms*** that comprise the vast majority of storms. The intent is to treat most of the stormwater runoff while recognizing that it would be infeasible to size stormwater treatment measures to treat runoff from very large storms that occur every few years. (See Section 5.6 for more information on how stormwater treatment measures that are sized to treat runoff from small, frequent storms can be designed to also handle flows from large, infrequent storms.)

How Much of Project Site Needs Stormwater Treatment?

The Municipal Regional Stormwater Permit requires that, for all "Regulated Projects"[1] the project site must receive stormwater treatment. Municipalities may require stormwater treatment for projects that are smaller than the Regulated Project threshold, and in these cases, stormwater treatment is required to the maximum extent practicable (MEP). Exceptions to the stormwater treatment requirement for Regulated Projects are pervious areas that are "self-treating" (including areas of pervious pavement with a hydraulically-sized aggregate base layer) as described in Section 4.1, and "self-retaining areas" designed to store and infiltrate runoff from rooftops or paved areas as described in Section 4.2. Other than "self-treating areas" and "self-retaining areas," ***ALL AREAS AT A PROJECT SITE*** must receive stormwater treatment.

Flow-Based Versus Volume-Based Treatment Measures

For hydraulic sizing purposes, stormwater treatment measures can be divided generally into three groups: flow-based, volume-based, and treatment measures that use a combination of flow and volume capacity. The ***flow-based treatment measures*** remove pollutants from a moving stream of stormwater, and the treatment measures are sized based on hourly or peak flow rates. Examples of flow-based treatment measures include vegetated buffer strips and media filters. The ***volume-based treatment measures*** detain stormwater for periods of between 24 hours and 5 days, so the sizing is based on detaining a large volume of water for treatment and/or infiltration to the ground. Examples of volume-based stormwater treatment measures include extended detention basins and infiltration trenches. Flow-through planters and bioretention areas can use a ***combination of flow and volume capacity*** for stormwater treatment. Table 5-1 shows which hydraulic sizing method is appropriate for commonly used stormwater treatment measures.

Table 5-1
Flow and Volume Based Treatment Measure Designs

Type of Treatment Measure	Type of Hydraulic Sizing Criteria to Use
Tree well filter	Flow-based
Vegetated buffer strip	Flow-based
Green roof	Flow-based
Media filter	Flow-based
Bioretention area	Flow-based or Combination flow and volume
Flow-through planter box	Flow-based or Combination flow and volume
Infiltration trench	Volume-based
Extended detention basin	Volume-based
Pervious paving	Volume-based

Volume-Based Sizing Criteria

The Municipal Regional Stormwater Permit specifies two alternative methods for hydraulically sizing volume-based stormwater treatment measures. One of the permit-approved methods,

[1] "Regulated Projects" are projects that create and/or replace 10,000 square feet or more of impervious surface. Beginning December 1, 2011, this threshold is reduced to 5,000 square feet of impervious surface for surface parking areas, restaurants, auto service facilities, and gasoline outlets.

the "Urban Runoff Quality Management Approach," is based on simplified procedures that are not recommended for use when information is available from continuous hydrologic simulation of runoff using local rainfall records (see "Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual and Report on Engineering Practice No. 87.) Because the results of continuous simulation modeling based on local rainfall are available, the Clean Water Program recommends the use of the "California Stormwater BMP Handbook Approach," or "80 percent capture method," ***shown in the text box.***

Please note that the Clean Water Program's member agencies may also allow project applicants to use an even ***simpler sizing method*** for sizing flow/volume-based treatment measures such as flow-through planters and bioretention areas, which is described below, under the heading, Simplified Sizing Methods.

Volume-Based Sizing Criteria

Volume-based treatment measures shall be designed to treat stormwater runoff equal to the volume of annual runoff required to achieve ***80 percent or more capture***, determined in accordance with the methodology set forth in Appendix D of the California Stormwater Best Management Practices Handbook (2003), using local rainfall data.

The ***80 percent capture method*** should be used when sizing extended detention basins. The 80 percent runoff value is determined by the Storage, Treatment, Overflow, Runoff Model (STORM), which uses continuous simulation to convert rainfall to runoff based on local rainfall data. STORM was developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers. (See http://www.hec.usace.army.mil/publications.)

The 80 percent capture method is described in the California Stormwater Quality Association's 2003 Stormwater Best Management Practice Handbook New Development and Redevelopment available at www.cabmphandbooks.com. This method involves the following steps.

Figure 5-1: Water Quality Basin in Dublin (example of a volume-based treatment measure)

1. Determine the ***mean annual precipitation*** for the project site using the Mean Annual Precipitation Map of Alameda County (Appendix D). Use the Oakland Airport unit basin storage volume values from Table 5-2 if the project location's mean annual precipitation is 16.4 inches or greater and the San Jose values if it is less than 16.4 inches.
2. Determine the ***drainage area*** that will flow to the volume-based treatment measure. This includes all areas that will contribute runoff to the stormwater treatment measure, including

pervious areas, impervious areas, and off-site areas, regardless of whether they are directly or indirectly connected to the stormwater treatment measure. Any self-treating areas (described in Section 4.1) that discharge to the storm drain system without directing flows to the stormwater treatment measure are not included in the treatment measure drainage area.

Table 5-2
Unit Basin Storage Volumes in Inches for 80 Percent Capture Using 48-Hour Drawdowns

		Composite Runoff Coefficient for Area Tributary to the Volume-Based Treatment Measure			
Location	**Mean Annual Precipitation inches**	**0.25**	**0.50**	**0.75**	**1.00**
Oakland Airport	18.35	0.17 inches	0.34	0.50	0.67
San Jose	14.4	0.14	0.28	0.42	0.56
Source: CASQA 2003 .					

A ***runoff coefficient*** is ratio of the runoff rate to rainfall and it is dimensionless. For example, a runoff coefficient of 0.70 means that seventy percent of the rainfall that falls on this type of surface will flow off as runoff.

3. Determine the ***composite runoff coefficient*** for the area at the project location that is tributary to the volume-based treatment system. The runoff coefficients for stormwater treatment are lower than for flood control. Runoff coefficient "C" factors from BASMAA include the estimated values shown in Table 5-3 for use in sizing stormwater treatment measures. These "C" factors are only appropriate for stormwater treatment designs that are based on ***small, frequent storms.*** "C" factors such as those in the Alameda County Hydrology and Hydraulics Manual must be used for flood control sizing. The composite runoff coefficient is calculated as a weighted average. Multiply the area of each type of surface tributary to a stormwater treatment measure by the respective runoff coefficient. Add the results and divide by the total area that drains to a stormwater treatment measure.

4. Use the composite runoff coefficient to interpolate a ***unit basin storage volume value*** for composite runoff coefficients that are different from the four (0.25, 0.50. 0.75, and 1.00) listed in Table 5-2. For example using the Oakland Airport values, if the composite runoff coefficient was calculated to be 0.55, the unit basin storage volume would be 0.37 inches. The 0.55 composite runoff coefficient is one-fifth of the way between the table's 0.5 and 0.75 composite runoff coefficient values.

5. In order to account for the difference between ***mean annual precipitation of the project site*** and the two rainfall locations shown, adjust the unit basin storage volume value by multiplying the unit basin storage volume value by the following factor:

$$\frac{\text{(project location mean annual precipitation)}}{\text{(18.35 or 14.4, as appropriate)}}$$

6. Calculate the ***required capture volume*** by multiplying the drainage area from step 2 by the adjusted unit basin storage volume value. Due to the mixed units that result, such as acre-inches, it is recommended that the resulting volume be converted to cubic feet for use during design.

Table 5-3
Estimated Runoff Coefficients for Various Surfaces During Small Storms

Type of Surface	Runoff Coefficients "C" factor
Roofs	0.90
Concrete, grouted pavers	0.80
Asphalt	0.70
Cobbles	0.30
Natural stone (without grout)	0.13
Pervious concrete	0.10
Pervious asphalt	0.10
Pervious concrete Brick (without grout)	0.10
Turf block	0.10
Unit pavers on sand	0.10
Crushed aggregate	0.10
Grass	0.10
Grass over porous plastic	0.05
Gravel over porous plastic	0.05

Note: These C-factors are only appropriate for small storm treatment design and should not be used for flood control sizing. When available, locally developed small storm C-factors for various surfaces may be used.

The runoff coefficients in Table 5-3 are for use only in stormwater treatment designs based on ***small, frequent storms***. Flood control sizing must be based on coefficients such as those in the Alameda County Hydrology and Hydraulics Manual.

The other critical issue for the design of volume-based stormwater treatment measures that temporarily pond water is the ***drawdown time***. The outlet structure's orifices should be designed to draw down the stormwater flow being treated no faster than 48 hours. Forty-eight hours drawdown time is the minimum acceptable drawdown time for stormwater treatment. A longer drawdown time is acceptable, up to a maximum of 5 days. Drawdown time may not exceed five days, to avoid creating conditions for mosquito breeding.

Flow-Based Sizing Criteria

The Municipal Regional Stormwater Permit specifies three alternative methods for hydraulically sizing flow-based stormwater treatment control measures, such as vegetated swales, flow through planter boxes, and media filters. These three methods are described in Table 5-4.

The Clean Water Program recommends the use of a ***rainfall of 0.2 inches/hour*** to design flow-based treatment systems.

Table 5-4
Flow-based Sizing Criteria Included in MRP Provision C.3.d

Flow-based Sizing Criteria	Description	Practice Tips
Percentile Rainfall Intensity	Ranks the hourly depth of rainfall from storms over a long period, determines the 85th percentile hourly rainfall depth, and multiplies this value by two.	This approach requires hydrologic studies that have not been conducted in Alameda County. Results of studies in other Bay Area locations showed a rainfall intensity of about 0.2 inch/hour.
0.2 Inch-per-Hour Intensity ***(Recommended Method)***	Simplification of the Percentile Rainfall Intensity Method. In the Bay Area, calculating the percentile rainfall intensity has generally resulted in a value of about 0.2 inches/hour.	This simplified approach is most commonly used.
10% of the 50-year peak flow rate ("Factored Flood Flow Approach")	Rainfall intensity is determined using Intensity-Duration-Frequency curves published by the local flood control agency or climactic data center.	This approach may be used if the 50-year peak flow has been determined. This approach has not been used locally.

The percentile rainfall intensity method is based on ranking the hourly depth of rainfall from storms over a long period, and determining the 85th percentile hourly rainfall depth and multiplying this value by two. In the Bay Area this value is generally around 0.2 inches/hour. The permit also allows the use of 0.2 inches/hour as one of the three alternative methods regardless of the results from calculating values from local rainfall depths.

Because two of the permit allowed methods yield similar results and the third method requires data that may not be readily available, the Clean Water Program recommends the use of a ***rainfall of 0.2 inches/hour*** to design flow-based treatment systems.

The amount of flow that the stormwater treatment measure must be sized to treat is calculated using the rational method:

$$Q = CiA$$

Where

Q = flow in ft^3/second

i = rainfall intensity in inches/hour

C = composite runoff coefficient (unitless – see Table 5.3)

A = drainage area in acres

To calculate the required treatment flow, simply multiply the ***drainage area*** that contributes flow to the treatment measure by the ***composite runoff coefficient*** by 0.2 inches/hour of rainfall intensity. The drainage area and composite runoff coefficient are determined by following steps 1 through 3 described above under the Volume-Based Sizing Criteria.

Appendix C includes an example (example 1) of sizing vegetated swales and bioretention areas using this sizing method.

As with volume-based treatment measures, the Clean Water Program's member agencies may allow project applicants to use ***simplified sizing methods*** for some flow-based treatment measures. This is described below, under the heading, "Simplified Sizing Methods."

Combination Flow and Volume Design Basis

Some stormwater treatment measures, such as bioretention areas and flow-through planters, include some design elements that provide flow-based treatment and some that provide volume-based treatment. For example, flow-based treatment occurs in a biotreatment area with an underdrain as stormwater filters through the soil and flows out the underdrain. Volume-based treatment is provided when stormwater is stored in the surface ponding area and the pore spaces of the soil media. The surface ponding area may be sized so that the ponding area functions to retain water prior to it entering the soil at the minimum 5 inches per hour required by MRP Provision C.3.c(2)(b)(vi).

The "simplified approach" for sizing bioretention areas and flow-through planters, in which the surface area of the treatment measure is designed to be 4 percent of the impervious area that drains to the treatment measure, is a flow-based sizing approach. This approach tends to result in the design of a conservatively large treatment measure because it does not account for any storage provided by the surface ponding area. A volume-based sizing approach for bioretention areas, in which the surface ponding area and depth are sized to contain the entire water quality design volume, is also conservative because it does not take into account the emptying of this ponding area into the soil media during the storm event.

Figure 5-2: Bioretention area, Emeryville (example of a combination flow- and volume-based treatment measure)

Provision C.3.d of the MRP specifies that treatment measures 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 sizing criteria is best applied when using a continuous simulation hydrologic model to demonstrate that a treatment system is in compliance with C.3.d. However, when doing sizing calculations by hand, compliance with C.3.d. can be demonstrated by showing how the treatment system design meets both the flow-based and volume-based criteria.

For bioretention areas and flow-through planters, the following approach may be used to take into consideration both the flow of stormwater through the planting media and the volume of stormwater in the surface ponding area. Note that the approach assumes that all of the design rainfall becomes runoff, and thus it is appropriate for use where the drainage area to the bioretention area is mostly impervious.

1. Determine the required treatment volume using the ***80 percent capture method*** described in Section 5.1. As part of this method, you will calculate the ***unit basin storage volume*** in inches using Table 5-2 (adjusted for the mean annual precipitation of the project site) and the ***required capture volume*** in cubic feet (the unit basin storage volume multiplied by the drainage area to the treatment measure, converted to units of cubic feet). For example, say you determined the adjusted unit basin storage volume to be 0.5 inches, and the drainage area to the bioretention facility is 7,000 square feet. Then the required capture volume would be 0.5 inches × (1 foot/12 inches) × 7,000 square feet = 292 cubic feet.

2. Assume that a ***rainfall intensity of 0.2 inches/hour*** will be used as the flow based sizing criteria (as recommended by the Clean Water Program).

3. Assume that the rain event that generates the required capture volume of runoff determined in Step 1 occurs at a constant intensity of 0.2 inches/hour from the start of the storm (i.e., assume a rectangular hydrograph). Calculate the ***duration of the rain event*** by dividing the unit basin storage volume by the intensity. In other words, determine the amount of time required for the unit basin storage volume to be achieved at a rate of 0.2 inches/hour. For example, if the unit basin storage volume is 0.5 inches, the rain event duration is 0.5 inches ÷ 0.2 inches/hour = 2.5 hours.

4. Make a ***preliminary estimate of the surface area*** of the bioretention facility by multiplying the area of impervious surface to be treated by a sizing factor of 0.04. For example, a drainage area of 7,000 square feet × 0.04 = 280 square feet of bioretention treatment area.

5. Assume a bioretention area that is about 25% smaller than the bioretention area calculated in Step 4. Using the example above, 280 – (0.25 × 280) = 210 square feet. ***Calculate the volume of runoff that filters through the treatment soil*** at a rate of 5 inches per hour (the design surface loading rate for bioretention facilities), for the duration of the rain event calculated in Step 3. For example, for a bioretention treatment area of 210 square feet, with an infiltration rate of 5 inches per hour for a duration of 2.5 hours, the volume of treated runoff = 210 square feet × 5 inches/hour × (1 foot/12 inches) × 2.5 hours = 219 cubic feet.

6. Calculate the portion of the required capture volume ***remaining after treatment is accomplished by filtering*** through the treatment soil. The result is the amount that must be stored in the ponding area above the reduced bioretention area assumed in Step 5. For example, the amount remaining to be stored comparing Step 1 and Step 5 is 292 cubic feet – 219 cubic feet = 73 cubic feet. If this volume is stored over a surface area of 210 square feet, the average ponding depth would be 73 cubic feet ÷210 square feet = 0.35 feet or 4.2 inches.

7. Check to see if the ***average ponding depth is between 6 and 12 inches***, which is the recommended allowance for ponding in a bioretention facility or flow-through planter. If the ponding depth is less than 6 inches, the bioretention design can be optimized with a smaller surface area (i.e., repeat Steps 5 and 6 with a smaller area). If the ponding depth is greater than 12 inches, a larger surface area will be required. (In the above example, the optimal size of the bioretention area is 190 square feet with a ponding depth of 6 inches.)

Appendix C includes examples of sizing bioretention areas using this combination flow- and volume-based method.

Simplified Sizing Methods

Some simplified sizing methods are offered to help evaluate, during the planning phase, whether sufficient land has been allocated for stormwater treatment. If these methods are used in place of design calculations for site-specific conditions, they may result in conservatively large stormwater treatment measures.

- A ***bioretention area*** or ***flow-through planter*** requires 4 percent of the impervious area (1,750 square feet of bioretention area per impervious acre). This is a flow-based ratio, based on runoff inflow resulting from 0.2 inches of rainfall per hour, with an infiltration rate of 5 inches per hour. This 4 percent "rule of thumb" does not take into consideration the volume of water that is temporarily detained in the surface ponding area.
- An ***extended detention basin*** has a minimum drainage area of 5 acres. Allow a 1-inch diameter outlet orifice for a 5-acre drainage area. Allow a 1-acre basin, 3.5-feet deep, for a 100-acre drainage area.

5.2 Applicability of Non-Low Impact Development (LID) Treatment

Beginning December 1, 2011, the MRP places ***restrictions on the use of non-LID treatment treatment measures.*** Only Special Projects will be allowed some limited use of non-LID treatment measures for stand-alone treatment of stormwater. Specifically, Special Projects, as defined in Appendix K, are allowed to treat specified percentages of the C.3.d amount of stormwater runoff with vault-based media filters that have a high flow rate and with tree well filters that have a high flow rate. See Appendix K for additional guidance on Special Projects.

> Effective December 1, 2011, there are restrictions on the use of non-LID treatment measures.

Underground vault-based, non-LID treatment measures typically require frequent maintenance to function properly, and experience has shown that because these systems tend to be "out of sight, out of mind," they often do not receive adequate maintenance. Where underground vaults are allowed, they must be sealed to prevent mosquito access and include suitable access doors and hatches to allow for frequent inspections and maintenance. But even when maintained properly, some types of underground vault systems lack the detention time required to remove ***pollutants associated with fine particles.*** See Appendix E for more information regarding inlet filters, oil/water separators, hydrodynamic separators and media filters.

5.3 Using Treatment Trains

> ***What Is A Treatment Train?***
> A treatment train is a multiple treatment system that uses two or more stormwater treatment measures in series, for example, a settling basin/ infiltration trench combination.

Stormwater can be directed to flow through a series of different types of stormwater treatment measures that are each designed to treat different broad categories of stormwater pollutants. These groupings of stormwater treatment measures have been called "stormwater treatment trains" or a "multiple treatment system." The definition of treatment train given in Fact Sheet TC-60 of the CASQA Handbook is shown in the text box. The use of a ***series of treatment measures*** is most effective where each treatment measure optimizes the removal of a particular type of pollutant, such as coarse solids and debris, pollutants associated with fine solids, and dissolved pollutants. Stormwater treatment measures operate by using physical processes, such as sedimentation and filtration, to remove solids suspended in stormwater runoff. The removal of dissolved pollutants requires chemical adsorption or biological uptake. ***Each stormwater treatment measure in a treatment train should be sized using the Provision C.3 numeric sizing criteria.***

The ***simplest version*** of a treatment train consists of pretreatment prior to the stormwater reaching the main treatment system. For example, bioretention areas may use vegetated buffer strips to pretreat stormwater to settle out sediment before the stormwater enters the

Figure 5-3: Tule Pond, Fremont

bioretention area. This type of pretreatment helps prevent sediment from clogging the bioretention area, which maximizes its life. Another example of a coupled ***pretreatment and treatment system*** is used in extended detention basins that have a small, sediment forebay where most of the larger sediment settles and can be easily removed.

The combining of ***three or more stormwater treatment measures*** in series is often limited in practice because of the expense and additional space required. Some prototypes exist, such as the Tule Pond at Tyson Lagoon in Fremont. This stormwater treatment system was constructed in 1998 by the Alameda County Flood Control and Water Conservation District. It includes a wet pond where most of the sediment in the incoming stormwater settles. The wet pond also includes log booms to trap floating debris. From the wet pond the water flows into two other treatment ponds that are shallower in depth and where finer sediments and their associated pollutants settle and dissolved pollutants are removed by aquatic vegetation. The entire system also allows infiltration of the stormwater into the underlying soils.

5.4 Infiltration Guidelines

Infiltration is prioritized by the MRP, and it can be a very cost-effective method to manage stormwater – if the conditions on your site allow. A wide-range of site-design measures and stormwater treatment measures can be used to increase stormwater infiltration and can be categorized as follows:

- ***Site design measures*** -- such as clustering development or otherwise laying out the site to reduce impervious area, routing drainage from building roofs to landscaped areas, and using pervious pavement.
- ***Indirect infiltration*** methods, which allow stormwater runoff to percolate ***into surface soils***. Runoff may reach groundwater indirectly, or it may be underdrained into subsurface pipes. Bioretention are examples of indirect infiltration methods. Unless geotechnical considerations preclude it, all projects should maximize infiltration of stormwater runoff through methods such as raising the underdrain in unlined bioretention areas (see Section 6.1).
- ***Direct infiltration*** methods***,*** which are designed to ***bypass surface soils*** and transmit runoff directly to subsurface soils, which allows infiltration to groundwater. These types of devices must be located and designed to limit the potential for stormwater pollutants to reach groundwater. Infiltration trenches are an example of a direct infiltration method.

The local jurisdiction may require a geotechnical review for your project. When selecting site design and stormwater treatment measures that promote on-site infiltration, be sure to ***follow the geotechnical engineer's recommendations*** based on soil boring data, drainage pattern, and the current requirements for stormwater treatment. The geotechnical engineer's input will be critical to prevent infiltrating water from damaging surrounding properties, public improvements, slope banks, and even mudslides from accumulated below-ground water.

Appendix J provides instructions for determining the feasibility and infeasibility of treating the entire C.3.d amount of runoff from a project with infiltration. ***Appendix F*** provides additional information to help you determine whether your project site is suitable for using site design and/or stormwater treatment measures that increase stormwater infiltration. Appendix F also describes regulatory requirements that apply to direct infiltration methods, as well as practical tips for design and construction.

5.5 Underdrains in Biotreatment Measures

Where the existing soils have a lower infiltration rate than soils specified for a landscaped-based stormwater treatment measure, or "biotreatment measure," it may be necessary to install an underdrain to allow the treatment measure to function as designed and ***prevent the accumulation of standing water.*** Beginning December 1, 2011, the full amount of stormwater runoff specified in Provision C.3.d of the MRP will need to be infiltrated, evapotranspired, or harvested for use. Where this is infeasible, as determined using feasibility/infeasibility criteria included in Appendix J, stormwater biotreatment will be allowed. For projects subject to the requirements that go into effect on December 1, 2011, any use of underdrains will need to be consistent with the feasibility/infeasibility criteria, and/or any technical guidance for specific stormwater treatment measures in Chapter 6, which may be revised to show how underdrains may be incorporated in stormwater treatment measures that are designed to infiltrate and evapotranspire the C.3.d amount of runoff.

Underdrains are perforated to allow water to enter the pipe and flow to the storm drain system. To help prevent clogging, two rows of perforation may be used. Cleanouts should be installed to allow access to underdrains to remove clogs. ***Underdrains should NOT be wrapped in filter fabric,*** to help avoid clogging. Underdrains are typically installed in a layer of washed drain rock or Class 2 perm aggregate, beneath high-percolation stormwater biotreatment soils.

5.6 Technical Guidance for Low-Flow Systems

Although stormwater treatment measures are sized to remove pollutants from flows resulting from frequent, small storms, projects must be designed to handle flows for stormwater treatment and drainage from large infrequent flows to ***prevent flooding***. The integration of flood control and stormwater treatment may be accomplished in one of two ways, which are described below.

One option is to have the flows that are larger than those required by the hydraulic sizing criteria (given in Section 5.1) handled ***within the stormwater treatment measure.*** This includes making sure that treatment measures do not re-suspend and flush out pollutants that have been accumulating during small storms, and that stormwater treatment measures do not erode during flows that will be experienced during larger storms. Most vegetated buffer strips and extended detention basins are designed to handle flood flows, although they would not be providing much treatment during these flows. The technical guidance in Chapter 6 for treatment measures that operate in this manner includes design standards to accommodate flood flows associated with larger storms.

Bioretention areas, flow-through planter boxes, and other treatment systems that rely on filtering or infiltrating stormwater through soils must have ***overflow systems*** that allow flood flows larger than the increment of flow that can be treated to bypass the stormwater treatment measure. These systems have to include an alternative flow path for high flows, otherwise stormwater would back up and flood the project area. The technical guidance in Chapter 6 for treatment measures that operate in this manner includes design standards for high-flow bypasses.

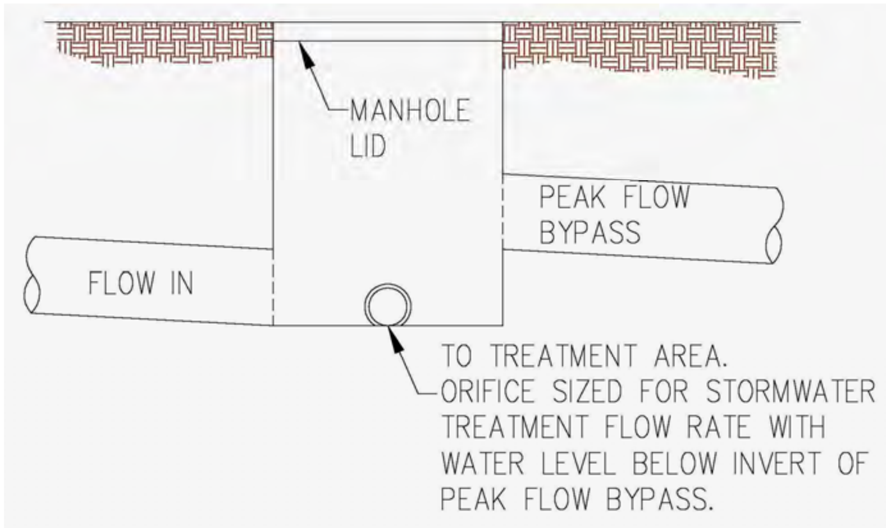

Figure 5-4: Stepped manhole design directs low-flows to treatment measure and diverts high flows to storm drain system. (BKF Engineers)

For some types of stormwater treatment measures that are designed as low-flow systems, it is often necessary to restrict stormwater flows and ***bypass the flows around the facility.*** In these instances the stormwater treatment measures are designed to treat only the water from small storm events, and may include infiltration trenches, media filters, or extended detention basins. Bypassing larger flows helps prevent hydraulic overload and resuspension of sediment, and it can protect stormwater treatment measures from erosion.

Flow splitter devices may be used to direct the initial flows of runoff, or “first flush,” into a stormwater treatment measure, and bypass excess flows from larger storm events around the facility into a bypass pipe or channel. The bypass may connect directly to the storm drain system, or to another stormwater treatment measure that designed to handle high flows. This can be accomplished using a stepped manhole (Figure 5-4) or a proprietary flow splitter. As illustrated in Figure 5-5, runoff enters the device by way of the inlet at the left side of the figure; low flows are conveyed to the stormwater treatment measure by way of the outlet pipe at the lower right. Once the treatment measure reaches its design

Figure 5-5: StormGate™ flow splitter structure. Source: Contech Construction Products Inc. Use of this illustration is for general information only and is not an endorsement of this or any other proprietary device.

capacity, water backs up in the low-flow outlet pipe and into the flow splitter. When the water level in the flow splitter reaches the bypass elevation, stormwater begins to flow out the overflow pipe, shown at the upper right of the figure, bypassing the stormwater treatment measure. The bypass generally functions by means of a weir inside the flow splitter device.

5.7 Plant Selection and Maintenance

Selecting the appropriate plants and using sustainable, horticulturally sound landscape design and maintenance practices are essential components of a successful landscape-based stormwater treatment measure.

Plant Selection Guidance

Plant selection must consider the type of development and location, uses on the site and an appropriate design aesthetic. Ideally, a Landscape Architect will be involved as an active member of the design team ***early in the site design phase*** to review proposed stormwater measures and coordinate development of an integrated solution that responds to all of the various site goals and constraints. In some cases, one professional will design a stormwater control, while another designs the rest of the landscaping. In these situations it is critical for the professionals to work together very early in the process to integrate their designs. Appendix B provides user-friendly guidance in selecting planting appropriate to the landscape-based stormwater treatment measures included in Chapter 6.

Bay Friendly Landscaping

Bay-friendly landscaping is a whole systems approach to the ***design, construction and maintenance*** of the landscape in order to support the integrity of the San Francisco Bay watershed. Project sponsors are encouraged to use landscape professionals who are familiar with and committed to implementing Bay-Friendly landscaping practices from the initial plant selection through the long-term maintenance of the site. Appendix B summarizes Bay Friendly Landscaping Practices that may be implemented to benefit water quality of the Bay and its tributaries, based on the Bay-Friendly Landscaping Guidelines prepared by Stopwaste.Org (available at www.bayfriendly.org).

Integrated Pest Management

Integrated pest management (IPM) is a holistic approach to mitigating insects, plant diseases, weeds, and other pests. Projects that require a landscaping plan as part of a development project application are encouraged to use IPM, as indicated in each agency's source control measures list. ***Avoiding pesticides and quick release synthetic fertilizers*** is particularly important when maintaining stormwater treatment measures to protect water quality.

IPM encourages the use of many strategies for first preventing, and then controlling, but not eliminating, pests. It places a priority on fostering a healthy environment in which plants have the strength to resist diseases and insect infestations, and out-compete weeds. Using IPM requires an understanding of the life cycles of pests and beneficial organisms, as well as regular monitoring of their populations. When pest problems are identified, IPM considers all viable solutions and uses a combination of strategies to control pests, rather than relying on pesticides alone. The least toxic pesticides are used only as a last resort. More information on IPM is included in Appendix B.

Wetland Regulations and Treatment Measures

The Water Board's "Policy on the Use of Constructed Wetlands for Urban Runoff Pollution Control" (Resolution No. 94-102) recognizes that stormwater treatment wetlands that are constructed and operated pursuant to Resolution 94-102 and are constructed outside a creek or other receiving water are stormwater treatment systems, and, as such, properly maintained stormwater treatment measures are not waters of the United States subject to Sections 401 and 404 of the federal Clean Water Act.

Water Efficient Landscaping Requirements

The California Water Conservation in Landscaping Act of 2006 requires municipalities to adopt, by January 1, 2010, landscape water conservation ordinances that are at least as effective in conserving water as the Model Water Efficient Landscape Ordinance prepared by the Department of Water Resources. The Model Ordinance automatically went into effect, on January 1, 2010, in municipalities that had not adopted a comparable local ordinance.

Public landscapes and private developments including developer installed single family and multi-family residential landscapes with at least 2,500 square feet of landscape area are subject to the Model Ordinance. Homeowner provided landscaping at single family and multi-family homes are subject to the Model Ordinance if the landscape area is at least 5,000 square feet. Contact the municipality to ***determine whether your project is subject to the Model Ordinance*** or other water efficient landscaping ordinance.

5.8 Mosquito Control

Some types of stormwater treatment measures are designed to include standing water, and even treatment measures that are designed to eliminate standing water between storms may have the potential to ***retain standing water*** if they are not properly designed, constructed and maintained.

Treatment measure designs and maintenance plans must include mosquito control ***design and maintenance strategies*** included in Appendix G.

To reduce the potential for stormwater treatment measures to lead to mosquito problems, the Clean Water Program developed a Vector Control Plan, which describes the need to include physical access for mosquito control staff to monitor and treat mosquitoes, and includes guidance for designing and maintaining stormwater treatment measures to control mosquitoes. The Alameda County Mosquito Abatement District (ACMAD) staff has identified a ***five-day maximum*** allowable water retention time, based on actual incubation periods of mosquito species in this area. With the exception of certain stormwater treatment measures designed to hold permanent water (e.g., CDS units and wet ponds), all treatment measures should drain completely within five days to effectively suppress vector production. *Please note that the design of stormwater treatment measures* ***does not require*** *that water be standing for five days. During five days after a rain event, standing water is allowable but not required for the stormwater treatment measure to function effectively.* Treatment measure designs and maintenance plans must include mosquito control ***design and maintenance strategies*** from the Vector Control Plan, included in Appendix G.

5.9 Incorporating Treatment and HM

In addition to requiring stormwater treatment, the MRP also requires that stormwater runoff be detained and released in a way that ***prevents increased creek channel erosion*** and siltation in susceptible areas. The amount of stormwater flow and the duration of flows that cause erosion must be limited to match what occurred prior to the proposed development or re-development. These hydromodification management (HM) requirements apply to projects that create one acre or more of impervious surface in most areas of Alameda County. The requirements do not apply to projects that drain directly to the bay or tidal channels nor to projects where stormwater flows into channel segments that have been hardened on three sides and/or are culverted continuously downstream to their outfall in a tidal area.

The HM requirements have been in effect since 2007 and are different from stormwater treatment, low impact development, and flood control requirements. To prevent hydromodification, Flow Duration Control facilities are ***designed for a range of 10 percent of the two-year up to the ten-year storm.*** This is different from the sizing criteria that are used for stormwater treatment and LID measures, and it is different from the design criteria used for flood control facilities. Depending on the project, it may be possible to meet the HM requirements and stormwater treatment requirements in one facility, as shown in Figure 5-6.
To help applicants meet the HM requirements, the Clean Water Program developed a Bay Area Hydrology Model (BAHM) with assistance from the municipal stormwater programs in Santa Clara and San Mateo Counties.

Figure 5-6: Detention pond in Pleasanton provides stormwater treatment and HM.

You can use the BAHM to ***automatically size*** *stormwater detention measures* **such as detention vaults, tanks, basins and ponds for Flow Dura**tion Control of post-project runoff (go to www.bayareahydrologymodel.org to download the BAHM). The BAHM also checks the facilities for performance as volume-based stormwater treatment measures, to meet the permit requirements for both stormwater treatment and HM. Chapter 7 gives more detail on HM requirements and the BAHM.

5.10 Getting Water into Treatment Measures

Stormwater may be routed into stormwater treatment measures using ***sheet flow or curb cuts.*** The following pages from the San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook show common curb cut types. An 18-inch width is recommended for curb cuts, to avoid clogging. To avoid erosion, cobbles or other energy dissipater is recommended. A minimum two-inch drop in grade between the impervious surface and the finish grade of the stormwater treatment facility is recommended. This drop in grade needs to take into consideration the height of any vegetation.

Figure 5-7: Cobbles are placed at the inlet to this stormwater treatment measure in Fremont, to help prevent erosion.

Standard Curb Cut: Design Guidance

- Opening should be at least 18 inches wide; for smaller facilities 12" width may be allowed subject to municipal approval.
- Curb cut can have vertical sides or have chamfered sides at 45 degrees (as shown).
- Works well with relatively shallow stormwater facilities that do not have steep side slope conditions.
- Need to slope the bottom of the concrete curb toward the stormwater facility.
- Allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.
- Provide cobbles or other energy dissipater to prevent erosion.

Figure 5-8: This standard curb cut at parking lot rain garden has 45 degree chamfered sides.

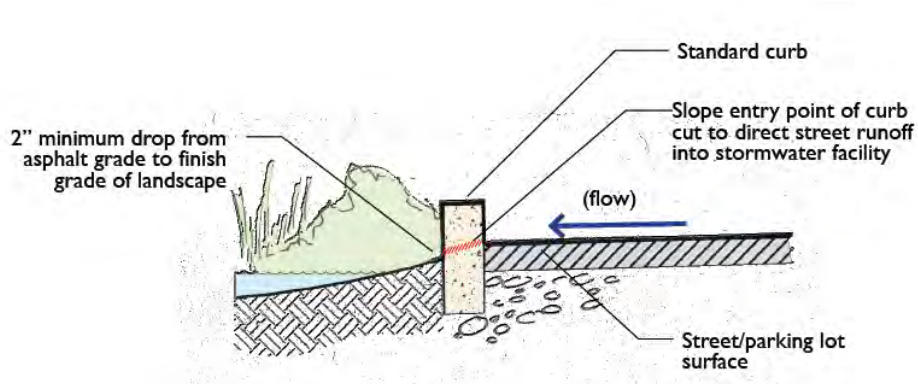

Figure 5-9: Standard curb cut: section view (Source: San Mateo Countywide Water Pollution Prevention Program [SMCWPPP] 2009)

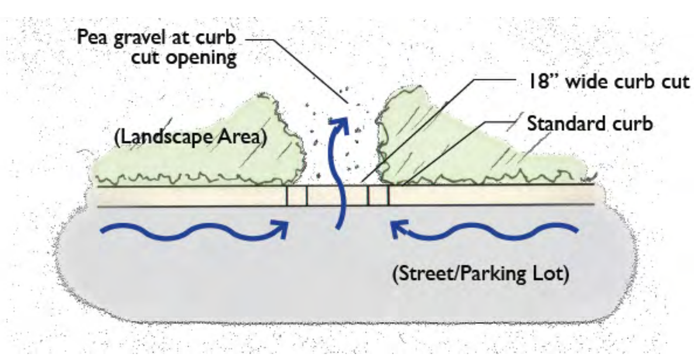

Figure 5-10: Standard curb cut: plan view (Source: SMCWPPP 2009)

Standard Curb Cut with Side Wings: Design Guidance

- Opening should be at least 18 inches wide; for smaller facilities 12" width may be allowed subject to municipal approval.
- Works well with stormwater facilities that have steeper side slope conditions.
- Need to slope the bottom of the concrete curb toward the stormwater facility.
- Allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow .
- Provide cobbles or other energy dissipater to prevent erosion.

Figure 5-11: The side wings of this standard curb cut help retain the side slope grade on each side of the curb cut opening.

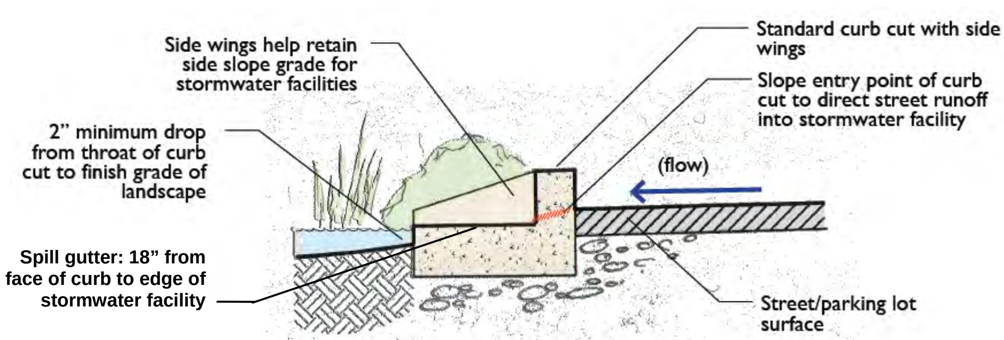

Figure 5-12: Standard curb cut with side wings: cut section view (Source: SMCWPPP 2009)

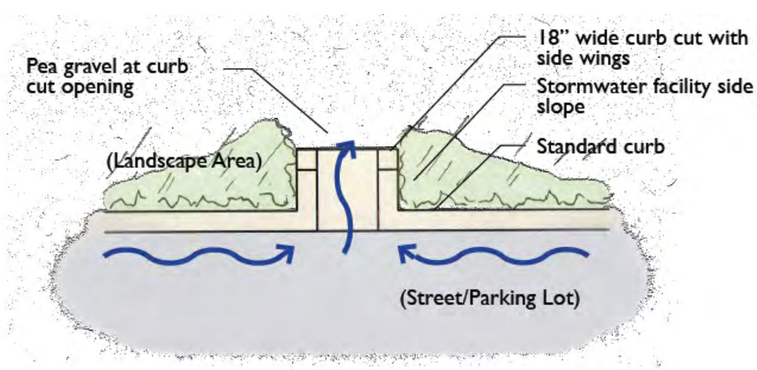

Figure 5-13: Standard curb cut with side wings: plan view (Source: SMCWPPP 2009)

Wheelstop Curbs: Design Guidance

- Wheelstops allow water to flow through frequently spaced openings.
- Wheelstops are most common in parking lot applications, but they may also be applied to certain street conditions.
- Need to provide a minimum of 6 inches of space between the wheelstop edge and edge of paving. This is to provide structural support for the wheelstop.
- Allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow .
- Provide cobbles or other energy dissipater at the wheel stop opening to prevent erosion.

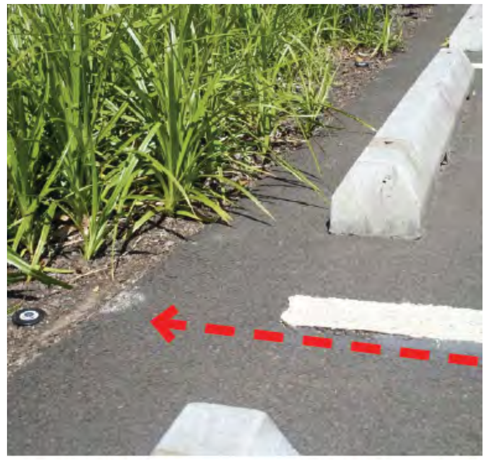

Figure 5-14: Stormwater runoff enters the stormwater facility through the 3-foot space between these wheelstops. The design could be improved by providing more of a drop in grade between the asphalt and landscape area.

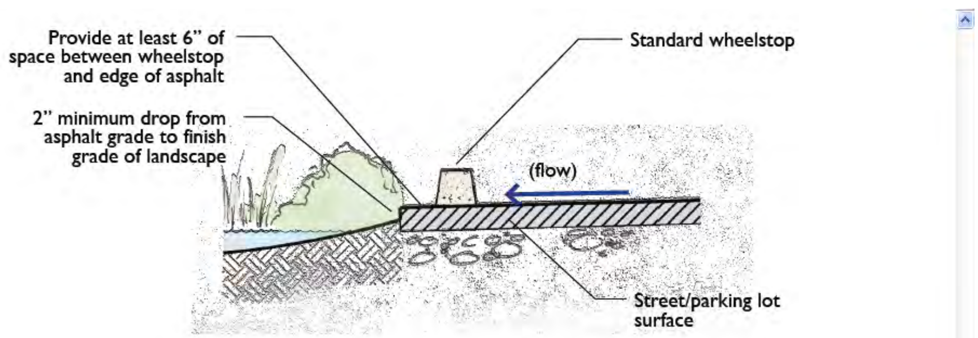

Figure 5-15: Opening between wheelstop curbs: section view (Source: SMCWPPP 2009)

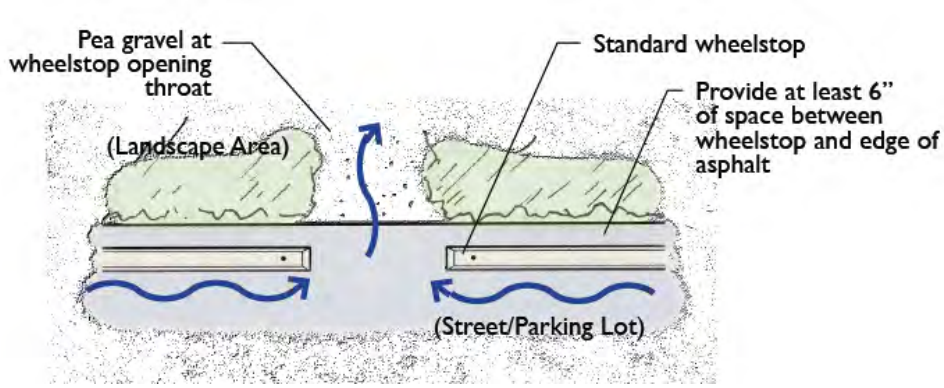

Figure 5-16: Opening between wheelstop curbs: plan view (Source: SMCWPPP 2009)

Grated Curb Cut: Design Guidance

- Grated curb cuts allow stormwater to be conveyed under a pedestrian walkway. The curb cut opening should be at least 18 inches wide; 12" may be allowed for smaller facilities subject to municipal approval.
- Grates need to be ADA compliant and have sufficient slip resistance.
- A 1-to-2 inch high asphalt or concrete berm should be placed on the downstream side of the curb cut to help direct runoff into the curb cut.
- Allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.

Figure 5-17: A grated curb cut allows stormwater to pass under a pedestrian egress zone to the stormwater facility.

- Alameda County Standard Detail 513 may also be used as another sidewalk drain option (see Figure 5-20).

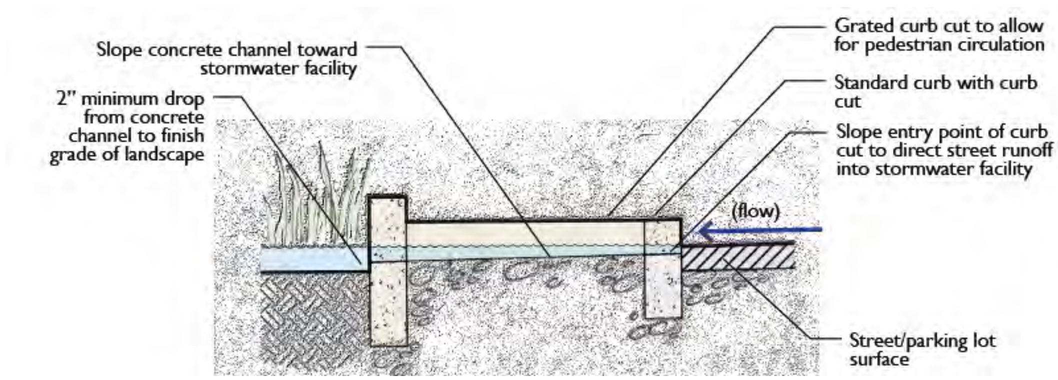

Figure 5-18: Grated curb cut: section view (Source: SMCWPPP 2009)

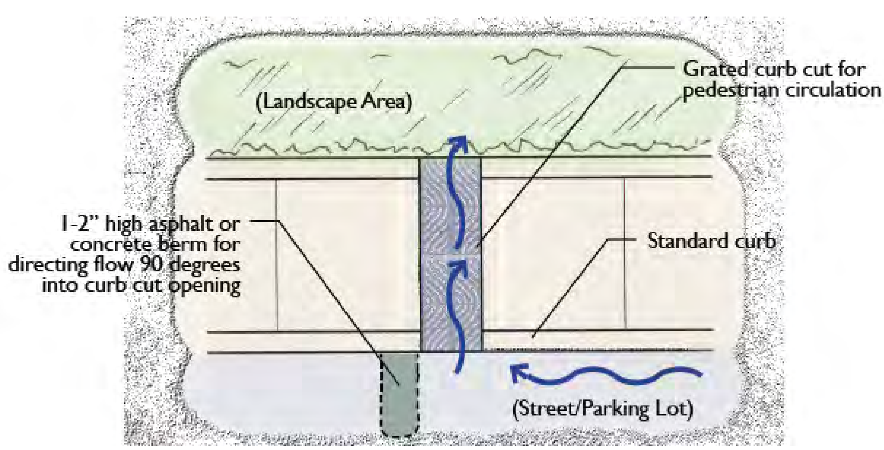

Figure 5-19: Grated curb cut: plan view (Source: SMCWPPP 2009)

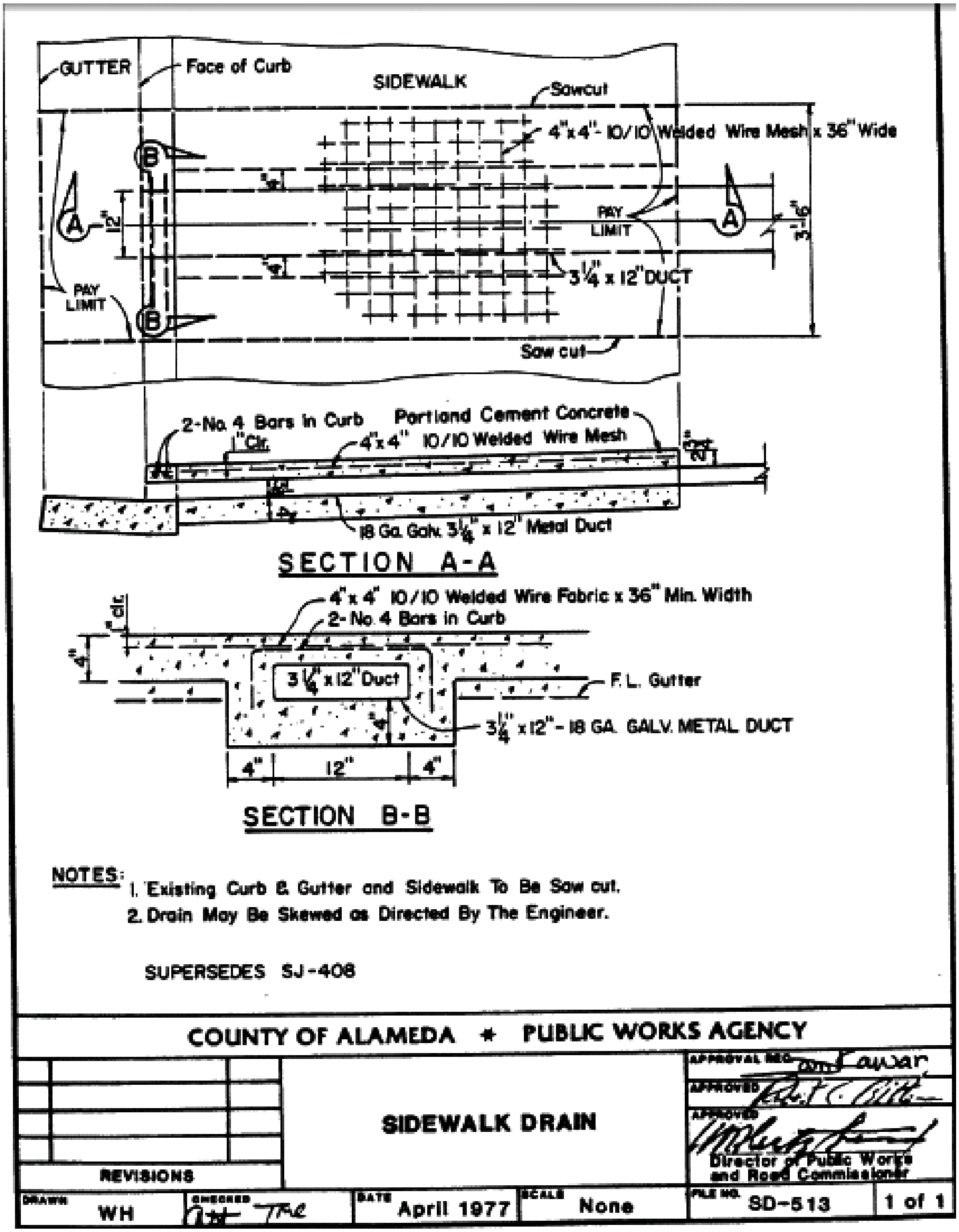

Figure 5-20: Alameda County Standard Detail 513, Sidewalk drain. This design may be used, as an alternative to plans shown in figures 5-19 and 5-20, to drain water from street gutter, across sidewalk, to stormwater treatment facility.

Chapter

6

Technical Guidance for Specific Treatment Measures

Technical guidance is provided for stormwater treatment measures commonly used in Alameda County.

Technical guidance is provided for the stormwater treatment measures listed in Table 6-1.

Table 6-1: Stormwater Measures for which Technical Guidance is Provided

Treatment Measures	Section
Bioretention[1] area/Rain garden	6.1
Flow-through planter	6.2
Tree well filter	6.3
Vegetated buffer strip	6.4
Infiltration trench	6.5
Extended detention basin	6.6
Pervious paving	6.7
Turf block and permeable joint unit pavers	6.8
Green roof	6.9
Rainwater harvesting and use	6.10
Media filter	6.11

Guidance in this chapter is intended to assist you in preparing project permit application submittals. Municipalities will require permit applications to include more specific drawings to address project site conditions, materials, plumbing connections, etc. This technical guidance was prepared using best engineering judgment and based on a review of various regional documents. Input from Water Board staff was incorporated where available. The Clean Water Program looks forward to working with Water Board staff to continue to improve this guidance.

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[1] A bioretention area that is unlined and has a raised underdrain in the underlying rock layer to promote infiltration, as shown in Section 6.1, may also be called a "bioinfiltration area".

6.1 Bioretention Area

Figure 6-1: Bioretention area, Fremont

Best uses

- Any type of development
- Drainage area up to 2 acres
- Landscape design element

Advantages

- Detains low flows
- Landscape feature
- Low maintenance
- Reliable once established

Limitations

- Not appropriate where soil is unstable
- Requires irrigation
- Susceptible to clogging – especially if installed prior to construction site soil stabilization.

Bioretention[1] areas, or "rain gardens," function as soil and plant-based filtration devices that remove pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a ponding area, organic layer or mulch layer, planting soil, and plants. Bioretention areas are designed to distribute stormwater runoff evenly along a ponding area. Percolation of stored water in the bioretention area's engineered planting soil with a high rate of infiltration will enter an underlying rock layer, from which water will either percolate into the underlying soil or enter the underdrain, so that the bioretention area empties over two days. Unless the geotechnical engineer identifies conditions, such as steep slope or a high groundwater table, that would make infiltration unsafe, bioretention areas should be designed to maximize infiltration by raising the underdrain toward the top of the rock layer. Bioretention areas can be any shape, including a linear treatment measure. The guidelines listed below apply to bioretention areas.

Design and Sizing Guidelines

DRAINAGE AREA AND SETBACK REQUIREMENTS

- Set back from structures 10' or as required by structural or geotechnical engineer, or local jurisdiction.
- Area draining to the bioretention area does not exceed 2 acres.
- Area draining to the bioretention area shall not contain a significant source of soil erosion, such as high velocity flows along slopes not stabilized with vegetation or hardscape.

[1] A bioretention area that is unlined and has a raised underdrain in the underlying rock layer to promote infiltration may also be called a "bioinfiltration area".

- Areas immediately adjacent to bioretention area shall have slopes more than 0.5% for pavement and more than 1% for vegetated areas.
- Bioretention areas, including linear treatment measures, shall not be constructed in slopes greater than 4%, unless constructed as a series of bioretention cells. Separate bioretention cells by check dams up to 24 inches high and at least 25 feet apart. The slope within cells shall not exceed 4%. Bioretention cells are not recommended if overall slope exceeds 8%.
- If treatment measure is designed to infiltrate stormwater to underlying soils, a 50-foot setback is needed from septic system leach field.

TREATMENT DIMENSIONS AND SIZING

- Bioretention area may be sized to 4% of the impervious surface area on the project site. The area of impervious surface multiplied by 0.04 sizing factor will equal the footprint of the bioretention area. Alternatively, bioretention sizing may be calculated using the flow-based treatment standard, or the combination flow- and volume-based treatment standard described in Section 5.1 based on the flow entering the basin at the treatment flow rate over the initial hours of the storm until the treatment volume is attained.
- The bioretention area shall be sized to either:
  - Percolate the design treatment flow using a rate of 5 inches per hour. No additional allowance is provided for storage or for infiltration rates exceeding 5 inches/ hour; or,
  - Store the 24-hour treatment volume based on inflow at the water treatment rate for the initial hours of the storm and outflow by infiltration.
- Where there is a positive surface overflow, bioretention areas shall have freeboard of at least 0.2 feet to the lowest structural member versus the 100-year storm water level in the bioretention area, unless local jurisdiction has other requirements.
- Where the bioretention area is in a sump that depends on outflow through a catch basin, the bioretention area shall have a freeboard of at least 0.5 feet to the lowest building finished floor elevation (including garage and excluding crawl space) for conditions with the outlet 50 percent clogged, unless local jurisdiction has other requirements. Where the freeboard cannot be provided, emergency pump may be allowed on a case-by-case basis.
- Minimum 2 inches between the crest of the emergency outfall riser and higher elevation (top of planting mounds) of the treatment surface area.
- The elevation of the surface area may vary as needed to distribute stormwater flows throughout the surface area.
- Side slopes do not exceed 3:1; downstream slope for overflow shall not exceed 3:1.
- Surface ponding depths should vary, with a maximum 12-inch depth. If ponding depths exceed 6 inches, landscape architect shall approve planting palette for desired depth.
- The inlet to the overflow catch basin shall be at least 6 inches above the low point of the bioretention planting area.

INLETS TO TREATMENT MEASURE

Flow may enter the treatment measure (see example drawings in Section 5.10):

  - As overland flow from landscaping (no special requirements)
  - As overland flow from pavement (cutoff wall required)
  - Through a curb opening (minimum 18 inches)
  - Through a curb drain
  - With drop structure through a stepped manhole (refer to Figure 5-3 in Chapter 5)
  - Through a bubble-up manhole or storm drain emitter
  - Through roof leader or other conveyance from building roof

- Where flows enter the biotreatment measure, allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.
- Cobbles or rocks shall be installed to dissipate flow energy where runoff enters the treatment measure.

VEGETATION

- Plant species should be suitable to well-drained soil and occasional inundation. See planting guidance in Appendix B.
- Shrubs and small trees shall be placed to anchor the bioretention area cover.
- Tree planting shall be as required by the municipality. If larger trees are selected, plant them at the periphery of bioretention area.
- Underdrain trench shall be offset at edge of tree planting zone, as needed, to maximize distance between tree roots and underdrain. No trees shall be planted within 20 feet of overflow inlet. Underdrain shall be solid pipe 10 feet upstream and downstream of any tree.
- Use integrated pest management (IPM) principles in the landscape design to help avoid or minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Drought tolerant plants are preferred. Provide sufficient irrigation to maintain plant life.
- Trees and vegetation do not block inflow, create traffic or safety issues, or obstruct utilities.

SOIL CONSIDERATIONS SPECIFIC TO BIORETENTION AREAS

- Planting soil shall have a minimum percolation rate of 5 inches per hour and a maximum percolation rate of 10 inches/hour. Soil specifications are provided in Appendix L. Check with municipality for any additional requirements.
- Bioretention areas shall have a minimum planting soil depth of 18 inches.
- Provide 3-inch layer of mulch in areas between plantings.
- An underdrain system is generally required. Depending on the infiltration rate of in situ soils, the local jurisdiction may allow installation without an underdrain on a case-by-case basis.
- Underdrain trench shall include a 12-inch thick layer of Caltrans Standard Section 68-1.025 permeable material Class 2. A minimum 4-inch diameter perforated pipe shall be placed within the backfill layer. To help prevent clogging, two rows of perforation may be used.
- If there is at least a 10-foot separation between the base of the underdrain and the groundwater table, and geotechnical conditions allow, there shall be at least 6-inch separation between the perforated pipe and the base of the trench to allow percolation.

SOIL CONSIDERATIONS FOR ALL BIOTREATMENT SYSTEMS

- Filter fabric shall not be used in or around underdrain trench.
- If there is less than 10 feet separation to the groundwater table, an impermeable fabric shall be placed at the base of the underdrain and the perforated pipe shall be placed on the impermeable fabric.
- The underdrain shall include a perforated pipe with cleanouts and connection to a storm drain or discharge point. Clean-out shall consist of a vertical, rigid, non-perforated PVC pipe, with a minimum diameter of 4 inches and a watertight cap fit flush with the ground, or as required by municipality.
- There shall be adequate fall from the underdrain to the storm drain or discharge point.

- Beginning December 1, 2011, soils in the area of inundation within the facility shall meet biotreatment soil specifications approved by the Regional Water Board (Appendix L). A minimum percolation rate of 5 inches per hour and a maximum percolation rate of 10 inches/hour are required (initial infiltration rate may exceed this to allow for tendency of infiltration rate to reduce over time).

CONSTRUCTION REQUIREMENTS FOR ALL BIOTREATMENT SYSTEMS

- When excavating, avoid spreading fines of the soils on bottom and side slopes. Remove any smeared soiled surfaces and provide a natural soil interface into which water may percolate.
- Minimize compaction of existing soils. Protect from construction traffic.
- Protect the area from construction site runoff. Runoff from unstabilized areas shall be diverted away from biotreatment facility.

MAINTENANCE CONSIDERATIONS FOR ALL TREATMENT MEASURES

- A Maintenance Agreement shall be provided.
- Maintenance Agreement shall state the parties' responsibility for maintenance and upkeep.
- Prepare a maintenance plan and submit with Maintenance Agreement. Maintenance plan templates are in Appendix H.

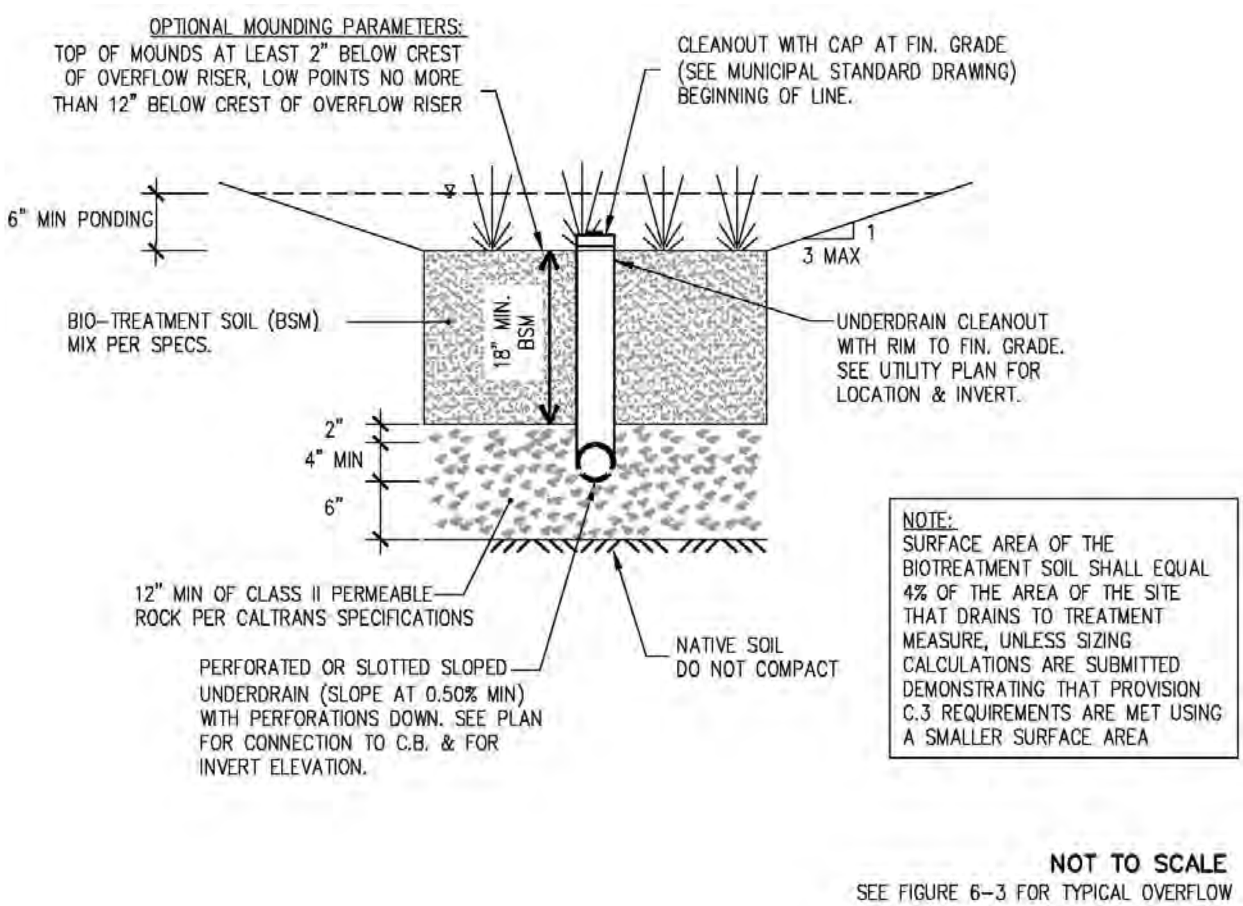


Figure 6-2: Cross Section, Bioretention Area

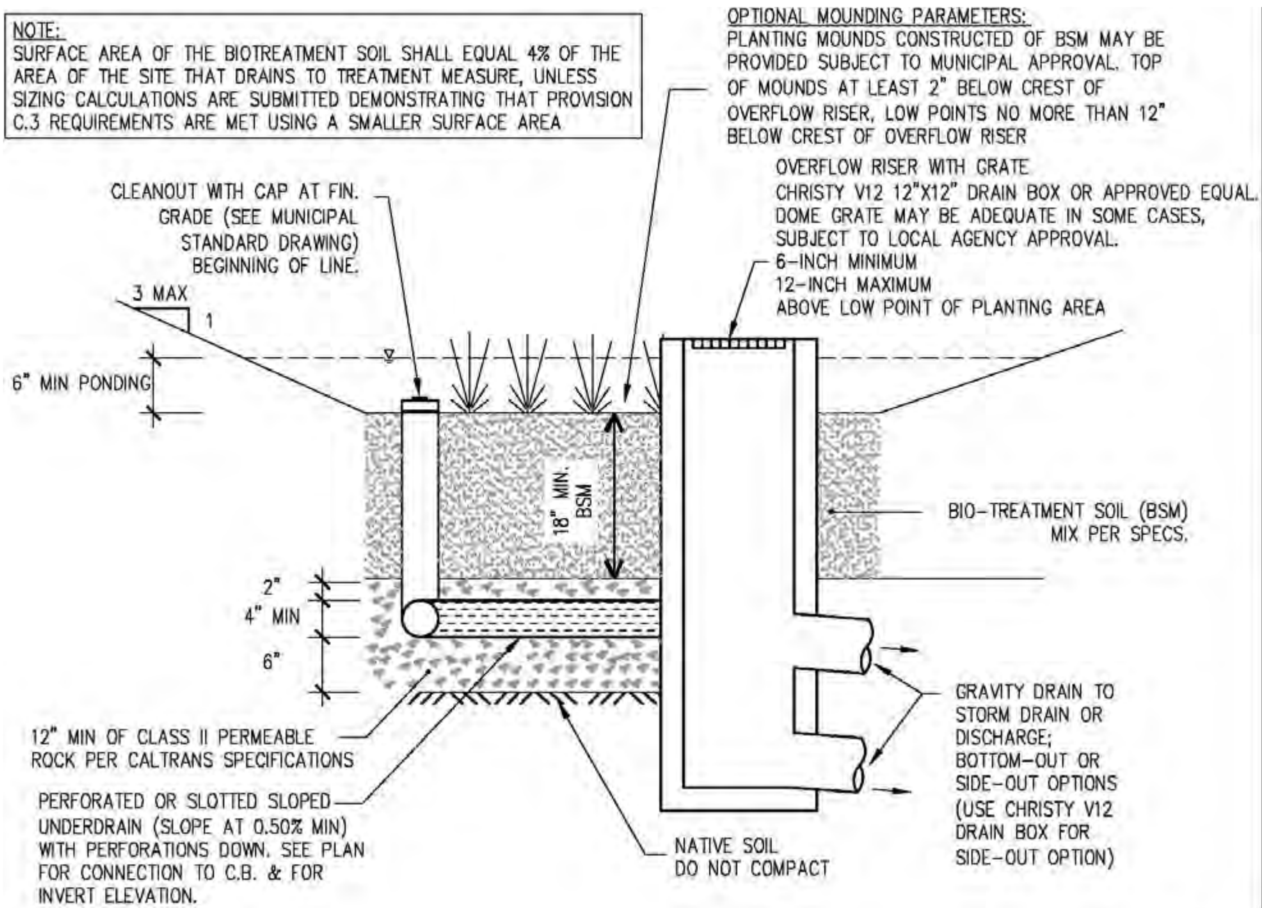


Figure 6-3: Cross Section, Bioretention Area (side view – Not to Scale)

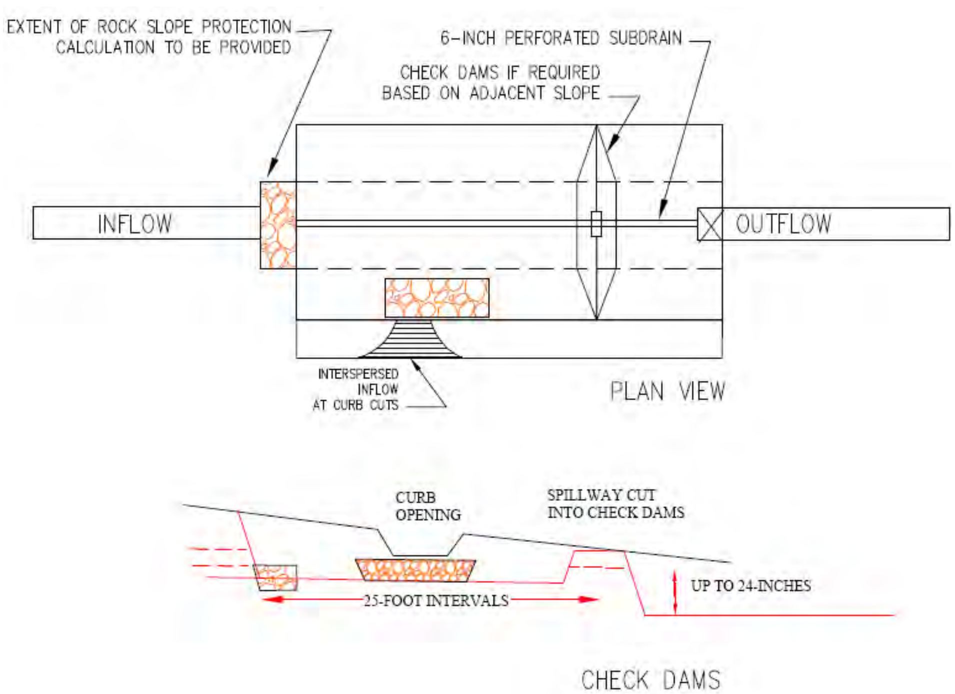


Figure 6-4: Check dam (plan view and profile) for installing a series of linear bioretention cells in sloped area

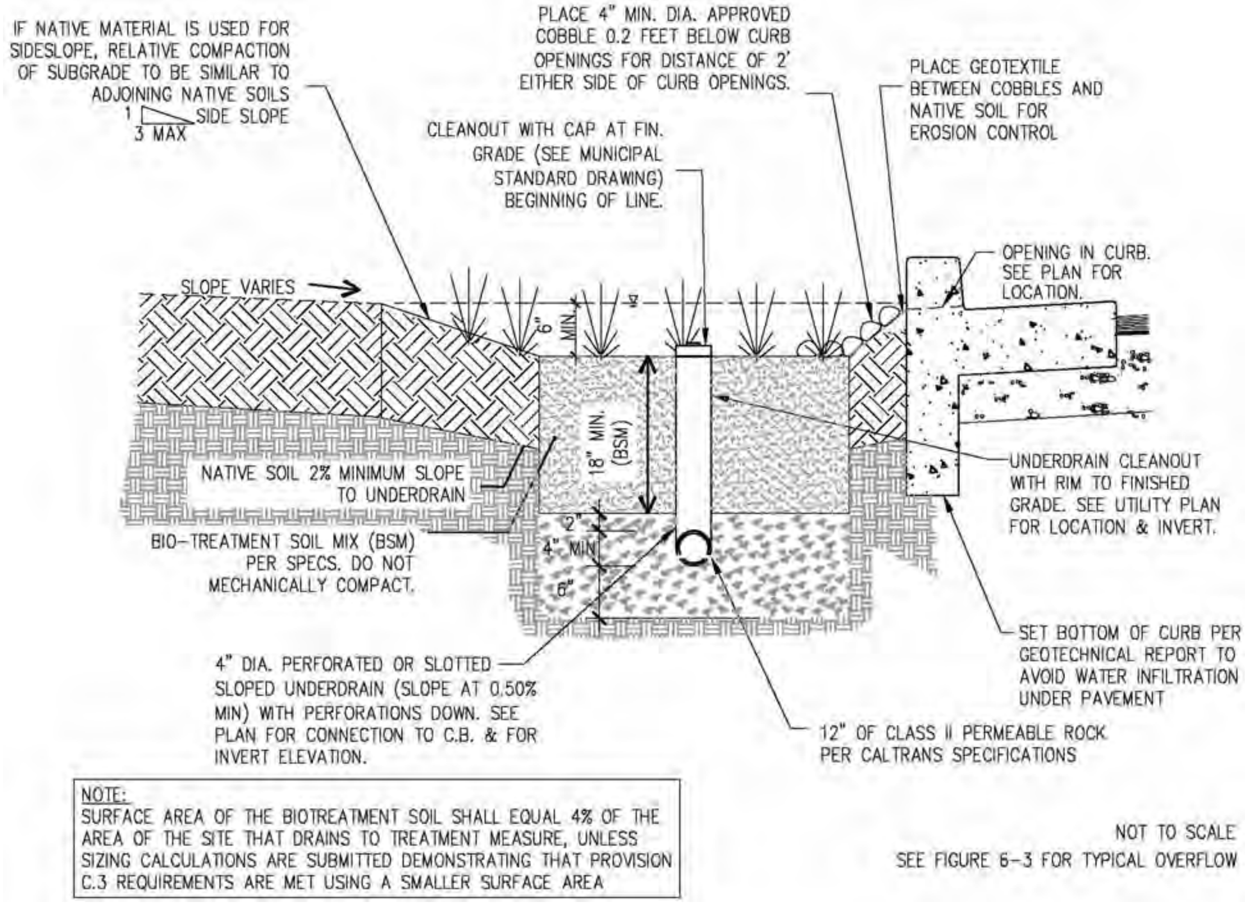


Figure 6-5: Cross-section of bioretention area showing inlet from pavement.

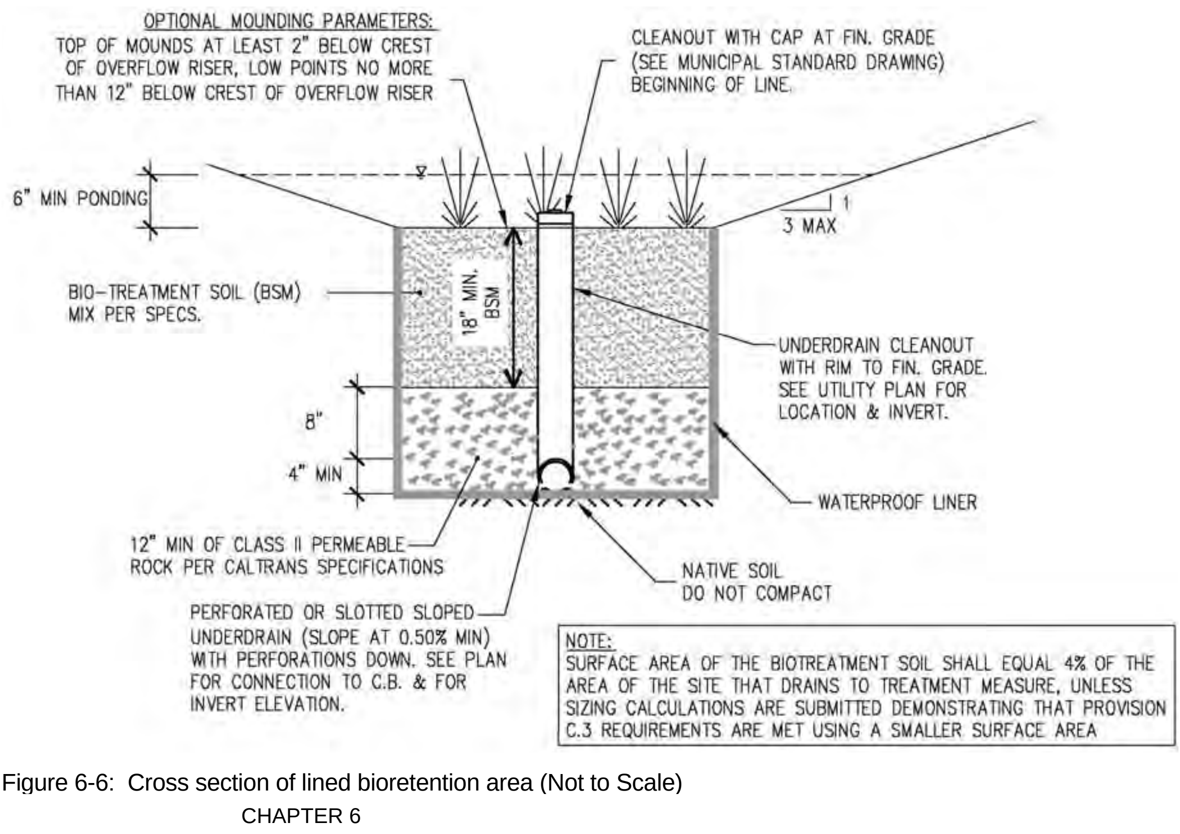


Figure 6-6: Cross section of lined bioretention area (Not to Scale)

6.2 Flow-Through Planter

Figure 6-7: At-grade flow-through planters. Source: City of Emeryville

Best uses

- Treating roof runoff
- Next to buildings
- Dense urban areas
- Locations where infiltration is not desired

Advantages

- Can be adjacent to structures
- Multi-use
- Versatile
- May be any shape
- Low maintenance

Limitations

- Requires sufficient head
- Careful selection of plants
- Requires level installation
- Susceptible to clogging

Flow-through planters are designed to treat and detain runoff without allowing seepage into the underlying soil. They can be used next to buildings and other locations where soil moisture is a potential concern. Flow-through planters typically receive runoff via downspouts leading from the roofs of adjacent buildings. However, flow-through planters can also be set level with the ground and receive sheet flow. Pollutants are removed as the runoff passes through the soil layer and is collected in an underlying layer of gravel or drain rock. A perforated pipe underdrain must be directed to a storm drain or other discharge point. An overflow inlet conveys flows that exceed the capacity of the planter.

Design and Sizing Guidelines

TREATMENT DIMENSIONS AND SIZING

- Flow-through planters may be designed with a 4% sizing factor (percentage of the surface area of planter compared to the surface area of the tributary impervious area). The area of impervious surface multiplied by 0.04 sizing factor will equal the footprint of the flow-through planter. Alternatively, calculations may be performed using either the hydraulic sizing criteria for flow-based treatment measures or the hydraulic sizing criteria for combination flow- and volume-based treatment measures, included in Section 5.1.
- Install an overflow weir adequate to meet municipal drainage requirements.
- Flow-through planters can be used adjacent to building and within set back area.
- Flow-through planters can be used above or below grade.
- Size overflow trap for building code design storm, set trap below top of planter box walls.
- Planter wall set against building should be higher to avoid overflow against building.
- Elevation of the surface area may vary as needed to distribute stormwater flows throughout the surface area.

- Minimum 2 and up to12 inches of water surface storage between the planting surface and crest of overflow weir.

VEGETATION

- Plantings should be selected for viability in a well-drained soil. See planting guidance in Appendix B.
- Use integrated pest management (IPM) principles in the landscape design to help avoid or minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Irrigation shall be provided, as needed, to maintain plant life.
- Trees and vegetation do not block inflow, create traffic or safety issues, or obstruct utilities.

INLETS TO TREATMENT MEASURE

Flow may enter the treatment measure (see example drawings in Section 5.10):

  - As overland flow from landscaping (no special requirements)
  - As overland flow from pavement (cutoff wall required)
  - Through a curb opening (minimum 18 inches)
  - Through a curb drain
  - With drop structure through a stepped manhole (refer to Figure 5-4 in Chapter 5)
  - Through a bubble-up manhole or storm drain emitter
  - Through roof leader or other conveyance from building roof
- Where flows enter the biotreatment measure, allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.
- Splash blocks, cobbles or rocks shall be installed to dissipate flow energy where runoff enters the treatment measure.
- For long linear planters, space inlets to planter at 10-foot intervals or install flow spreader.

SOIL CONSIDERATIONS SPECIFIC TO FLOW THROUGH PLANTERS

- Waterproofing shall be installed as required to protect adjacent building foundations.
- If site conditions permit infiltration to underlying soils, waterproofing is not required.
- An underdrain system is generally required for flow through planters. Depending on the infiltration rate of in situ soils, the local jurisdiction may allow installation without an underdrain on a case-by-case basis.
- Underdrain trench shall include a 12-inch thick layer of Caltrans Standard Section 68-1.025 permeable material Class 2. Minimum 4-inch diameter perforated pipe shall be placed within backfill layer. To help prevent clogging, two rows of perforation may be used.
- Planting soil shall have a minimum percolation rate of 5 inches per hour and a maximum percolation rate of 10 inches/hour. Soil specifications are provided in Appendix L. Check with municipality for any additional requirements.
- The planting soil shall be at least 18 inches thick.
- Provide 3-inch layer of mulch in areas between plantings.

SOIL CONSIDERATIONS FOR ALL BIOTREATMENT SYSTEMS

- Beginning December 1, 2011, soils in the area of inundation within the facility shall meet biotreatment soil specifications approved by the Regional Water Board (Appendix L). A minimum percolation rate of 5 inches per hour and a maximum percolation rate of 10 inches/hour are required (initial infiltration rate may exceed this to allow for tendency of infiltration rate to reduce over time).

- Filter fabric shall not be used in or around underdrain trench.
- The underdrain shall include a perforated pipe with cleanouts and connection to a storm drain or discharge point. Clean-out shall consist of a vertical, rigid, non-perforated PVC pipe, with a minimum diameter of 4 inches and a watertight cap fit flush with the ground.
- There shall be adequate fall from the underdrain to the storm drain or discharge point.

CONSTRUCTION REQUIREMENTS FOR ALL BIOTREATMENT SYSTEMS

- When excavating, avoid spreading fines of the soils on bottom and side slopes. Remove any smeared soiled surfaces and provide a natural soil interface into which water may percolate.
- Minimize compaction of existing soils. Protect from construction traffic.
- Protect the area from construction site runoff. Runoff from unstabilized areas shall be diverted away from biotreatment facility.

MAINTENANCE CONSIDERATIONS FOR ALL TREATMENT MEASURES

- A Maintenance Agreement shall be provided.
- Maintenance Agreement shall state the parties' responsibility for maintenance and upkeep.
- Prepare a maintenance plan and submit with Maintenance Agreement. Maintenance plan templates are in Appendix H.

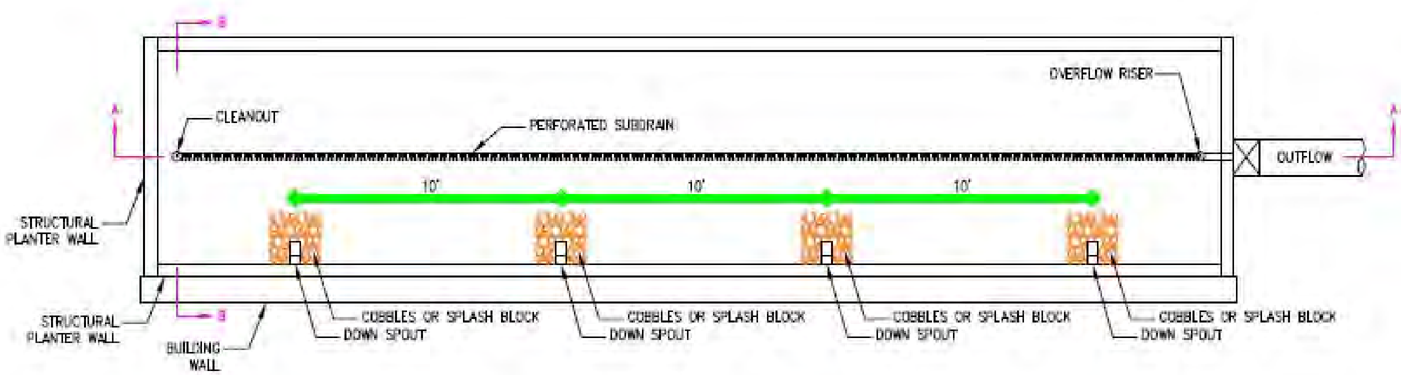


Figure 6-8: Plan view of long, linear planter, with inlets to the planter distributed along its length at 10' intervals.

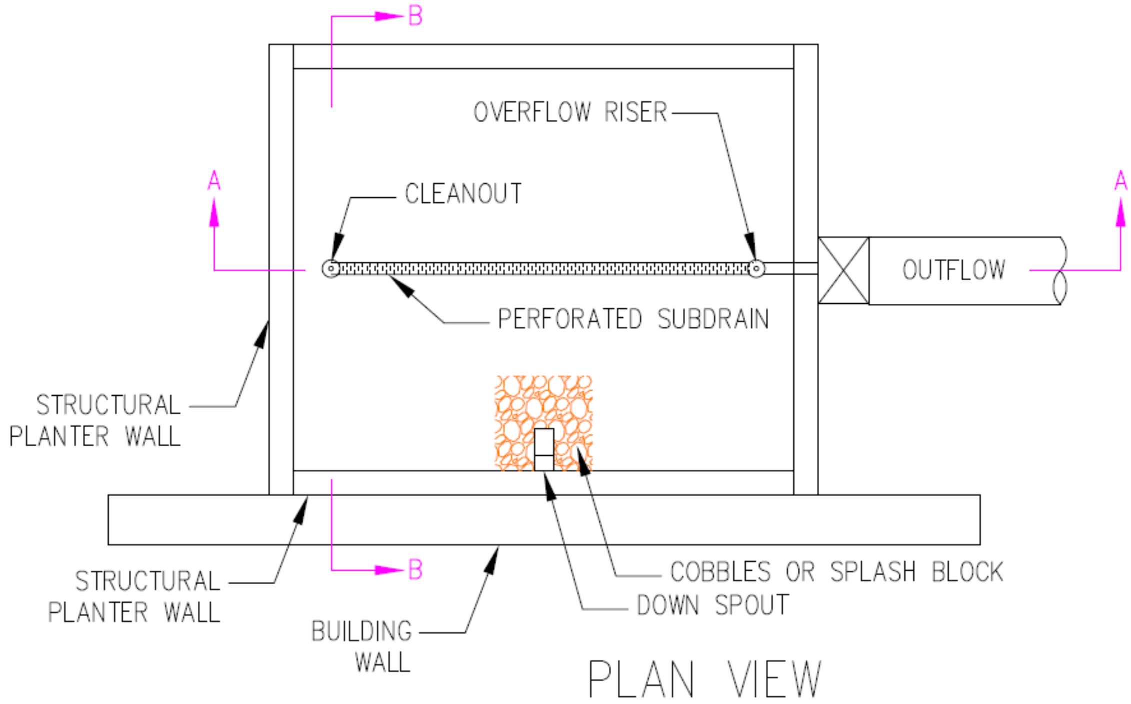


Figure 6-9: Plan view of planter designed to disperse flows adequately with only one inlet to planter

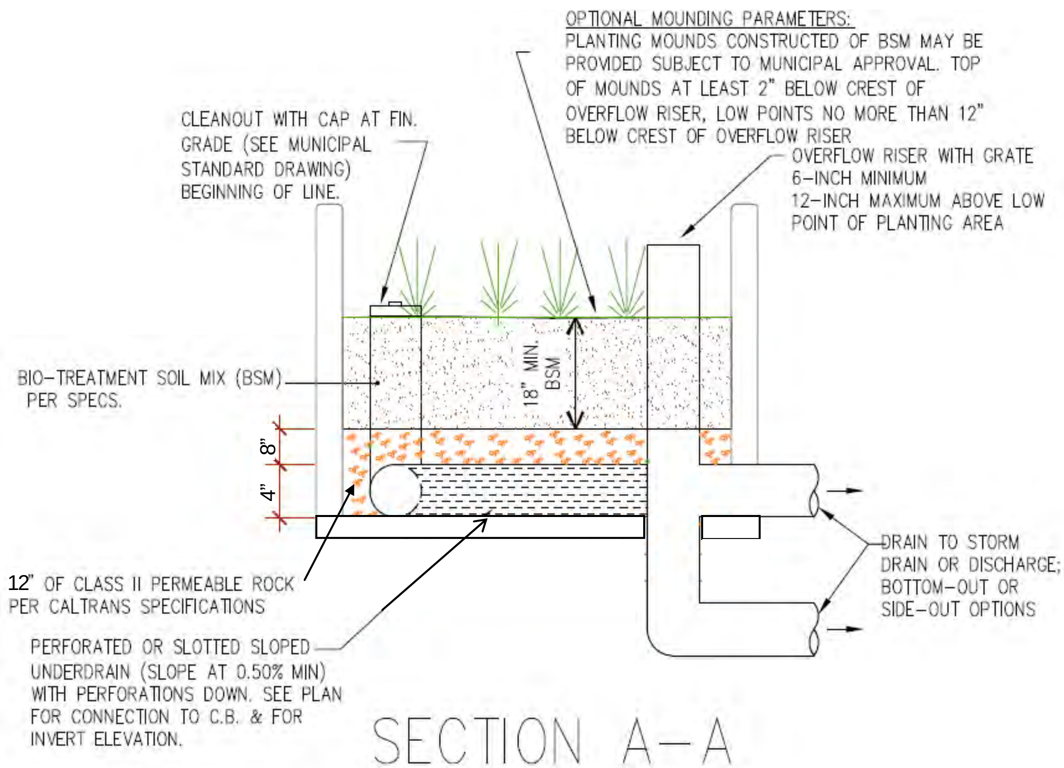


Figure 6-10: Cross section A-A of flow-through planter, shows side view of underdrain

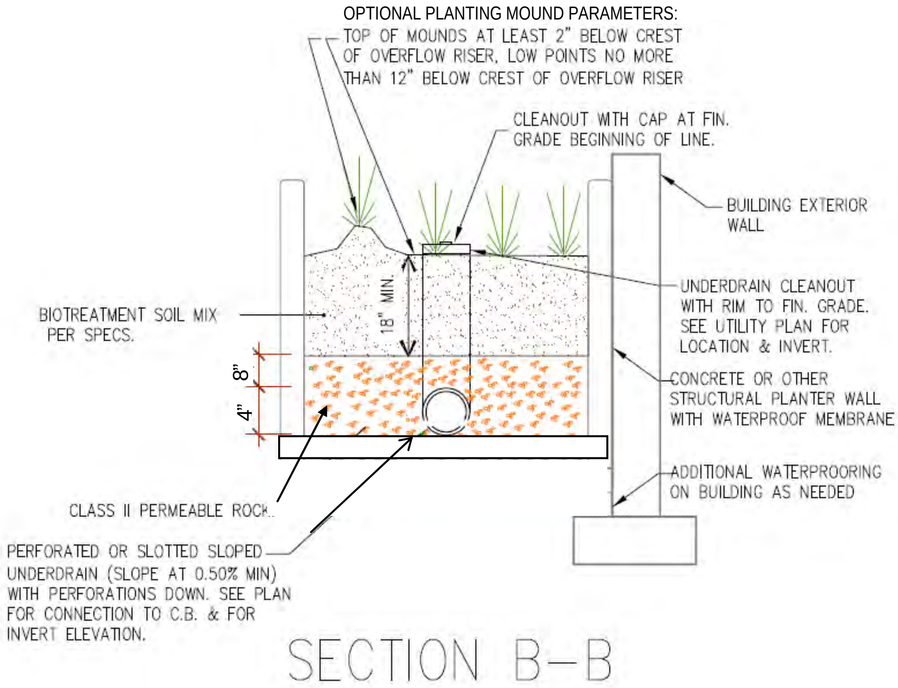


Figure 6-11: Cross section B-B of flow-through planter, shows cross section of underdrain

Figure 6-12: Half-buried, perforated flexible pipe serves as a flow spreader to distribute stormwater evenly throughout long, linear flow-through planter in Emeryville (Source: GreenGrid/ Weston Solutions).

Figure 6-13: The same planter as shown in Figure 6-12, after vegetation has matured and partially conceals the half-buried pipe from view (Source: San Francisco Estuary Partnership).

6.3 Tree Well Filter

Figure 6-14: Non-proprietary tree well filters in Fremont use bio-retention soils with an infiltration rate of 5 to 10 inches per hour. Spacing the units closely together provides a total tree well filter surface area that is 4 percent of the impervious surface area from which stormwater runoff is treated.

Best Uses

- Special Projects, per Appendix K
- Limited space
- Parallel to roadways

Advantages

- Aesthetic
- Small surface land use
- Blends with the landscape

Limitations

- Can clog without maintenance
- High installation cost
- Systems with very high infiltration rates are allowed ***only in Special Projects beginning December 2011***

Tree well filters are especially useful in settings where available space is at a premium. They can be installed in open- or closed-bottom chambers where infiltration is undesirable or not possible, such as tight clay soils, sites with high groundwater, or areas with highly contaminated runoff. Tree well filters may be installed along urban sidewalks, but they are highly adaptable and can be used in most development scenarios. In urban areas, tree filters can be used in the design of an integrated street landscape – a choice that transforms isolated street trees into stormwater filtration devices. In general, tree well filters are sized and spaced much like catch basin inlets, and design variations are abundant. The tree well filter's basic design is a vault filled with bioretention soil mix, planted with vegetation, and underlain with a subdrain. ***Beginning December 1, 2011,*** manufactured tree well filters, and other tree well filters with long-term rates of infiltration that exceed 10 inches per hour, will be allowed only in Special Projects, as described in Appendix K.

Design and Sizing Guidelines

- Flows in excess of the treatment flow rate shall bypass the tree filter to a downstream inlet structure or other appropriate outfall.
- Tree filters cannot be placed in sump condition; therefore tree filters shall have flow directed along a flow line of curb and gutter or other lateral structure. Do not direct flows directly to a tree filter.
- If a proprietary tree well filter is used, and until there are results demonstrating effectiveness in the Bay Area, the capacity of the installed manufactured tree filter unit shall be twice the capacity that is predicted to be required for the device.

- If a proprietary tree filter is used, it shall be reviewed by the manufacturer before installation.
- For proprietary tree filters, manufacturer will size the tree filter to the impervious surface of a site. The manufacturer shall certify the ratio of impervious area to treatment area for the project. For example, Filterra states that a tree filter of 6 x 6-feet can treat 0.25 acres of impervious surface.
- Proprietary tree filters are available in multi-sized pre-cast concrete drop in boxes, Sizes range from 4 x 6-feet up to 6 x 12-feet boxes.

INLETS TO TREATMENT MEASURE

Flow may enter the treatment measure (see example drawings in Section 5.10):

  - As overland flow from landscaping (no special requirements)
  - As overland flow from pavement (cutoff wall required)
  - Through a curb opening (minimum 18 inches)
  - Through a curb drain
  - With drop structure through a stepped manhole (refer to Figure 5-4 in Chapter 5)
  - Through a bubble-up manhole or storm drain emitter
  - Through roof leader or other conveyance from building roof
- Where flows enter the biotreatment measure, allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.
- Cobbles or rocks shall be installed to dissipate flow energy where runoff enters the treatment measure.

VEGETATION

- Suitable plant species are identified in Appendix B planting guidance.
- Use integrated pest management (IPM) principles in the landscape design to help avoid or minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Irrigation shall be provided, as needed, to maintain plant life.
- Trees and vegetation do not block inflow, create traffic or safety issues, or obstruct utilities.

SOIL REQUIREMENTS SPECIFIC TO TREE WELL FILTERS

- Filter media in tree well filter shall be specialized for expected site pollutant loads.
- Beginning December 1, 2011, if the long-term infiltration rate of media exceeds 10 inches per hour, use of the tree well filter will not be allowed, except for Special Projects (see Appendix K).
- An underdrain system is required for tree well filters.
- Underdrain trench shall include a 12-inch thick layer Caltrans Standard Section 68-1.025 permeable material Class 2. A minimum 4-inch diameter perforated pipe shall be placed within the backfill layer. To help prevent clogging, two rows of perforation may be used.
- If there is at least a 10-foot separation between the base of the underdrain and the groundwater table, there shall be at least 6-inch separation between the perforated pipe and the base of the trench to allow percolation.

SOIL CONSIDERATIONS FOR ALL BIOTREATMENT SYSTEMS

- If there is less than 10 feet separation to the groundwater table, an impermeable fabric shall be placed at the base of the underdrain and the perforated pipe shall be placed on the impermeable fabric.
- Filter fabric shall not be used in or around underdrain trench.
- The underdrain shall include a perforated pipe with cleanouts and connection to a storm drain or discharge point. Clean-out shall consist of a vertical, rigid, non-perforated PVC pipe, with a minimum diameter of 4 inches and a watertight cap fit flush with the ground, or as required by municipality.
- There shall be adequate fall from the underdrain to the storm drain or discharge point.
- Beginning December 1, 2011, soils in the area of inundation within the facility shall meet biotreatment soil specifications approved by the Regional Water Board (Appendix L). A minimum percolation rate of 5 inches per hour and a maximum percolation rate of 10 inches/hour are required (initial infiltration rate may exceed this to allow for tendency of infiltration rate to reduce over time).

CONSTRUCTION REQUIREMENTS FOR ALL BIOTREATMENT SYSTEMS

- When excavating, avoid spreading fines of the soils on bottom and side slopes. Remove any smeared soiled surfaces and provide a natural soil interface into which water may percolate.
- Minimize compaction of existing soils. Protect from construction traffic.
- Protect the area from construction site runoff. Runoff from unstabilized areas shall be diverted away from biotreatment facility.

MAINTENANCE CONSIDERATIONS FOR ALL TREATMENT MEASURES

- A Maintenance Agreement shall be provided.
- Maintenance Agreement shall state the parties' responsibility for maintenance and upkeep.
- Prepare a maintenance plan and submit with Maintenance Agreement. Maintenance plan templates are in Appendix H.

Figure 6-15: Non-proprietary Tree Filter with Overflow Bypass. Source: University of New Hampshire Environmental Research Group, 2006

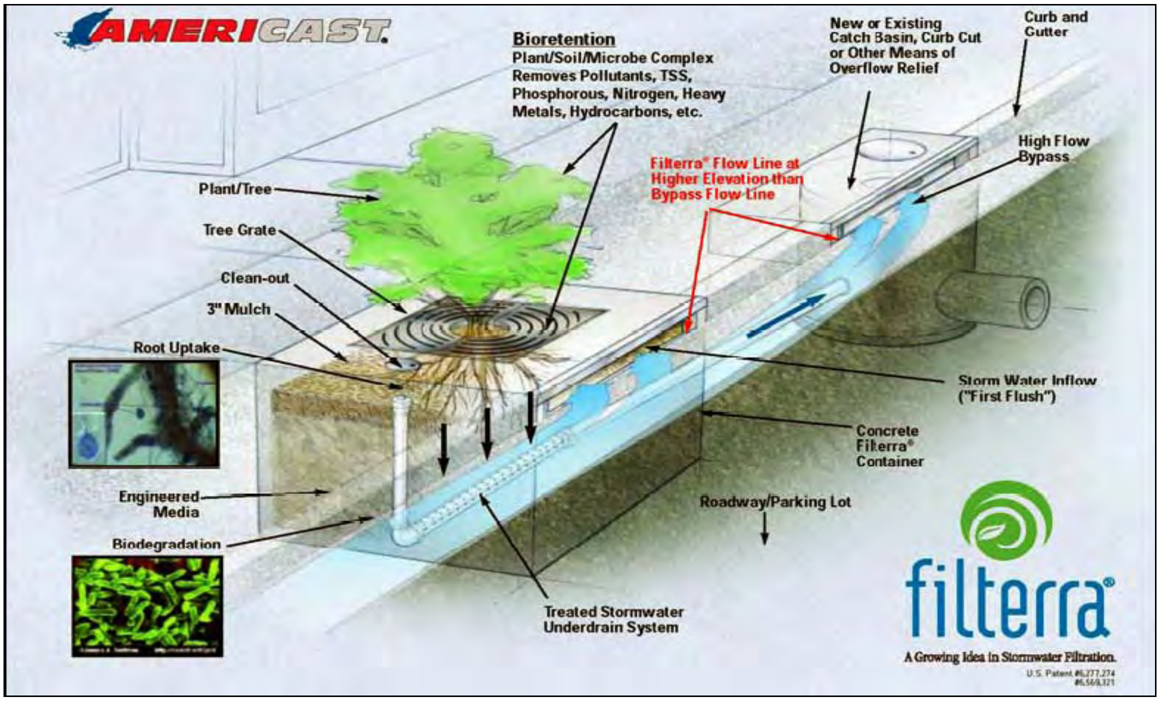


Figure 6-16: Cut-away view of proprietary tree well filter. Source: Americast, 2006. The use of this photo is for general information only, and is not an endorsement of this or any other proprietary stormwater treatment device.

6.4 Vegetated Buffer Strip

Figure 6-17: Vegetated buffer strip. Source: www.cabmphandbooks.com

Best Uses
- Roadside shoulders
- Landscape buffer

Advantages
- Minimal maintenance
- Reliable
- Aesthetic appeal
- Adjustable to suit site

Limitations
- No large drainage areas
- Thick cover necessary
- Large size requirements
- Minimal detention provided

Vegetated buffer strips (grassed buffer strips, filter strips, and grassed filters) are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. Vegetated buffer strips function by slowing runoff velocities and allowing sediment and other pollutants to settle and by providing some infiltration into underlying soils. Vegetated buffer strips were originally used as an agricultural treatment practice and have more recently evolved into an urban practice. With proper design and maintenance, vegetated buffer strips can provide relatively high pollutant removal. In addition, the public views them as landscaped amenities and not as stormwater infrastructure.

Design and Sizing Guidelines

TREATMENT DIMENSIONS AND SIZING

- Strip shall be sized as long as the site will reasonably allow. The width in the direction of flow shall be at least:
  - 5 feet where the length of flow across an impervious surface is less than 10-feet in the direction of flow.
  - At least 50 percent of the length of flow across an impervious surface where the length of flow across an impervious surface is between 10 and 30 feet in the direction of flow.
  - At least 15 feet where the length of flow across an impervious surface is between 30 feet and 60 feet in the direction of flow.
- Level spreaders shall be used if the length of flow across an impervious surface is greater than 60 feet in the direction of flow. The level spreader shall distribute flows over a length that will provide equivalent discharge per linear foot of level spreader as if the flow to the vegetated buffer strip was from a surface with 60-feet length in the direction of flow.
- Slopes should not exceed 1-foot Vertical to 4-foot Horizontal (1:4).
- Strip shall be free of gullies or rills.

VEGETATION

- Either grass or a diverse selection of other low growing, drought tolerant, native vegetation should be specified. Vegetation whose growing season corresponds to the wet season is preferred. See planting guidance in Appendix B.
- Use integrated pest management (IPM) principles in the landscape design to help avoid or minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Irrigation shall be provided, as needed, to maintain plant life.
- Trees and vegetation do not block inflow, create traffic or safety issues, or obstruct utilities.

INLETS

- Flow may enter the treatment measure (see example drawings in Section 5.10):
  - As overland flow from landscaping (no special requirements)
  - As overland flow from pavement (cutoff wall required)
  - Through a curb opening (minimum 18 inches)
  - Through a curb drain
  - With drop structure through a stepped manhole (refer to Figure 5-4 in Chapter 5)
  - Through a bubble-up manhole or storm drain emitter
  - Through roof leader or other conveyance from building roof
- Where flows enter the biotreatment measure, allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.
- If runoff is piped or channeled to the strip, a level spreader must be installed to create sheet flow.
- Flows from the buffer strip must concentrate sheet flows for discharge to storm drain system. This may be accomplished with a trench drain, vegetated conveyance swale, or other method approved by the municipality.

SOIL CONSIDERATIONS SPECIFIC TO VEGETATED BUFFER STRIPS

- Check with municipality for planting soil requirements. Until December 1, 2011, and except where other municipal requirements apply, planting soil shall have a minimum percolation rate of 2 inches per hour and a maximum percolation rate of 10 inches/hour. If native soils do not meet this percolation requirement, import soil meeting the Clean Water Program's dewatering soil specifications shall be used in the area of inundation.
- Planting soil will be to a minimum depth of at least 6 inches.
- No underdrain trench is needed where native soils are Hydrologic Soil Group A or B.
- When placed on native hydrologic soil group C and D soils, drainage must be provided to allow gravity drainage of the treatment soils. This may consist of underdrain trenches or other means to assure that the biotreatment soil is able to fully dewater after storm event.
- Underdrain trench shall include a 12-inch thick layer of Caltrans Standard Section 68-1.025 permeable material Class 2. A minimum 4-inch diameter perforated pipe shall be placed within the backfill layer. To help prevent clogging, two rows of perforation may be used.
- If there is at least a 10-foot separation between the base of the underdrain and the groundwater table, there shall be at least 6-inch separation between the perforated pipe and the base of the trench to allow percolation.
- Provide 3-inch layer of mulch in areas between plantings.

SOIL CONSIDERATIONS FOR ALL BIOTREATMENT SYSTEMS

- If there is less than 10 feet separation to the groundwater table, an impermeable fabric shall be placed at the base of the underdrain and the perforated pipe shall be placed on the impermeable fabric.
- No filter fabric shall be used in or around underdrain trench.
- The underdrain shall include a perforated pipe with cleanouts and connection to a storm drain or discharge point. Clean-out shall consist of a vertical, rigid, non-perforated PVC pipe, with a minimum diameter of 4 inches and a watertight cap fit flush with the ground.
- There shall be adequate fall from the underdrain to the storm drain or discharge point.
- Beginning December 1, 2011, soils in the area of inundation within the facility shall meet biotreatment soil specifications approved by the Regional Water Board (Appendix L). The minimum percolation rate for the biotreatment soil is 5 inches per hour. The long-term desired maximum infiltration rate is 10 inches per hour, although initial infiltration rate may exceed this to allow for tendency of infiltration rate to reduce over time.

CONSTRUCTION REQUIREMENTS FOR ALL BIOTREATMENT SYSTEMS

- When excavating, avoid spreading fines of the soils on bottom and side slopes. Remove any smeared soiled surfaces and provide a natural soil interface into which water may percolate.
- Minimize compaction of existing soils. Protect from construction traffic.
- Protect the area from construction site runoff. Runoff from unstabilized areas shall be diverted away from biotreatment facility.

MAINTENANCE CONSIDERATIONS FOR ALL TREATMENT MEASURES

- A Maintenance Agreement shall be provided.
- Maintenance Agreement shall state the parties' responsibility for maintenance and upkeep.
- Prepare a maintenance plan and submit with Maintenance Agreement. Maintenance plan templates are in Appendix H.

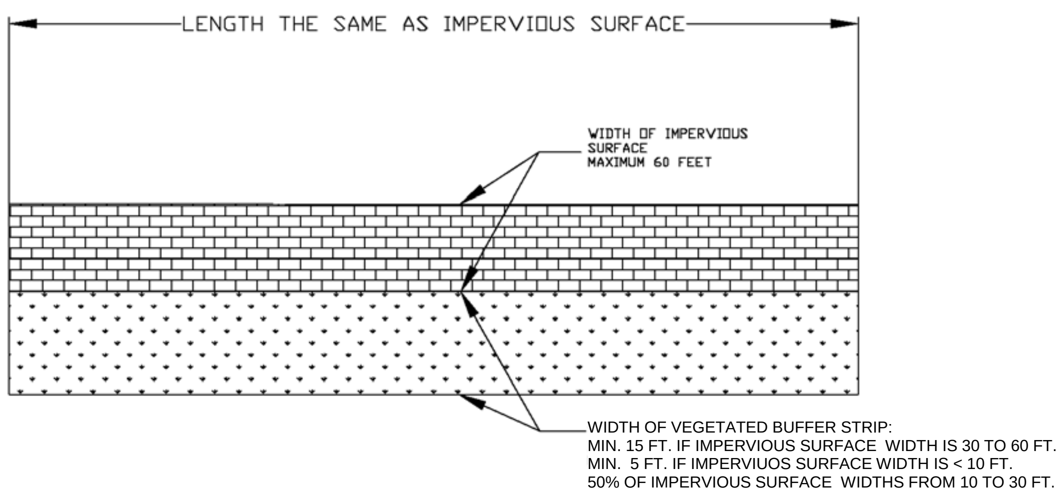
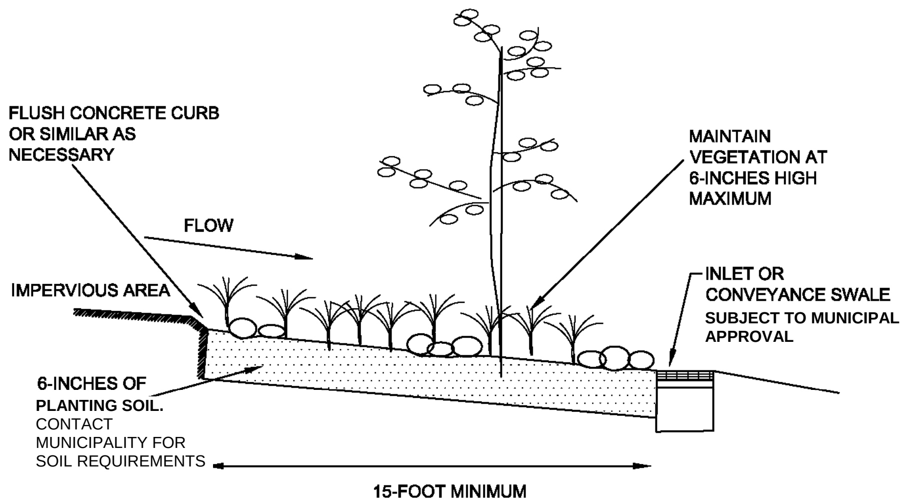


Figure 6-18: Plan View, Vegetated Buffer Strip



PLANTING SOIL WILL BE OF A MINIMUM DEPTH OF AT LEAST 6 INCHES.

15% MAXIMUM SLOPE, 2% MINIMUM SLOPE, 0.5% MINIMUM SLOPE WITH UNDERDRAIN,

LONGITUDINAL LENGTH = LONGITUDINAL LENGTH OF CONTRIBUTING AREA

STRIP SHALL BE FREE OF GULLIES OR RILLS.

Figure 6-19: Profile View, Vegetated Buffer Strip

6.5 Infiltration Trench

Figure 6-20: Infiltration trench. Source: CASQA, 2003

Best Uses

- Limited space
- Adjacent to roadways
- Landscape buffers

Advantages

- Increases groundwater recharge
- Removes suspended solids
- No surface outfalls

Limitations

- Susceptible to clogging; fails with no maintenance
- No high water tables
- Infiltration rate of existing soils must exceed 0.5 in/hr
- No steep slopes
- Drainage area less than 5 acres

An infiltration trench is a long, narrow, excavated trench backfilled with a stone aggregate, and lined with a filter fabric. Runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. Pretreatment using buffer strips, swales, or detention basins is important for limiting amounts of coarse sediment, which can clog and render the trench ineffective. Infiltration practices, such as infiltration trenches, remove suspended solids, particulate pollutants, coliform bacteria, organics, and some soluble forms of metals and nutrients from stormwater runoff. The infiltration trench treats the design volume of runoff either underground or at grade. Pollutants are filtered out of the runoff as it infiltrates the surrounding soils. Infiltration trenches also provide groundwater recharge and preserve base flow in nearby streams. Infiltration trenches have a high rate of failure where soil conditions are not suitable.

Design and Sizing Guidelines

DRAINAGE AREA AND SETBACK CONSIDERATIONS

- When the drainage area exceeds 5 acres, other treatment measures shall be considered.
- Infiltration trenches work best when the upgradient drainage area slope is less than 5 percent. The downgradient slope shall be no greater than 20 percent to minimize slope failure and seepage.
- In-situ/undisturbed soils shall have a low silt and clay content and have percolation rates greater than 0.5 inches per hour. In-situ testing is required to confirm percolation rate of trench site. CASQA's BMP Handbook recommends against using infiltration trenches in Type C or D soils.
- There shall be at least 10 feet between the bottom of the trench and the groundwater table to prevent potential groundwater problems.
- Trenches shall also be located at least 100 feet upgradient from water supply wells.

- A setback of 100 feet from building foundations is recommended, unless a smaller setback is approved by geotechnical engineer and local standard.

TREATMENT DIMENSIONS AND SIZING

- The infiltration trench shall be sized to store the full 48-hour water quality volume.
- A site-specific trench depth can be calculated based on the soil infiltration rate, aggregate void space, and the trench storage time. The stone aggregate used in the trench is normally 1.5 to 2.5 inches in diameter, which provides a void space of 35 to 40 percent. A minimum drainage time of 6 hours shall be provided to ensure satisfactory pollutant removal in the infiltration trench. Trenches may be designed to provide temporary storage of storm water. Trench depths are usually between 3 and 8 feet, with a depth of 8 feet most commonly used.
- The trench surface may consist of stone or vegetation (contact local municipality to determine if vegetation is allowed) with inlets to evenly distribute the runoff entering the trench. Runoff can be captured by depressing the trench surface or by placing a berm at the down gradient side of the trench. The basic infiltration trench design utilizes stone aggregate in the top of the trench to promote filtration; however, this design can be modified by substituting pea gravel for stone aggregate in the top 1-foot of the trench. Typically, there is about 35 to 40% void space within the rock.
- Use trench rock that is 1.5 to 2.5 inches in diameter or pea gravel to improve sediment filtering and maximize the pollutant removal in the top 1 foot of the trench.
- Place permeable filter fabric around the walls and bottom of the trench and 1 foot below the trench surface. The filter fabric shall overlap each side of the trench in order to cover the top of the stone aggregate layer. The filter fabric prevents sediment in the runoff and soil particles from the sides of the trench from clogging the aggregate. Filter fabric that is placed 1 foot below the trench surface will maximize pollutant removal within the top layer of the trench and decrease the pollutant loading to the trench bottom, reducing frequency of maintenance.
- The infiltration trench shall drain within 5 days to avoid vector generation.
- An observation well is recommended to monitor water levels in the trench. The well can be 4 to 6-inch diameter PVC pipe, which is anchored vertically to a foot plate at the bottom of the trench.

INLET TO THE TREATMENT MEASURE

- A vegetated buffer strip at least 5-feet wide, swale or detention basin shall be established adjacent to the infiltration trench to capture large sediment particles in the runoff before runoff enters the trench. If a buffer strip or swale is used, installation should occur immediately after trench construction using sod instead of hydroseeding. The buffer strip shall be graded with a slope between 0.5 and 15 percent so that runoff enters the trench as sheet flow. The vegetated swale or detention basin shall be sized according to Sections 6.4 and 6.7 respectively.
- If runoff is piped or channeled to the trench, a level spreader shall be installed to create sheet flow.

IF VEGETATION IS ALLOWED AT TRENCH SURFACE

- Infiltration trenches can be modified by adding a layer of organic material (peat) or loam to the trench subsoil. This modification enhances the removal of metals and nutrients through adsorption. The modified trenches are then covered with a permeable geotextile membrane overlain with topsoil and grass or stones.

- If surface landscaping of the trench is desired, contact local municipality to determine if this is allowed.
- Plant species should be suitable to well-drained soil. See planting guidance in Appendix B.
- Use integrated pest management (IPM) principles in the landscape design to help avoid or minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Irrigation shall be provided as needed to maintain plant life.

CON STRUCTION REQUIREMENTS

- The drainage area must be fully developed and stabilized with vegetation before constructing an infiltration trench. High sediment loads from unstabilized areas will quickly clog the infiltration trench. During project construction, runoff from unstabilized areas shall be diverted away from the trench into a sedimentation control BMP until vegetation is established.
- When excavating, avoid spreading fines of the soils on bottom and sides. Remove any smeared soiled surfaces and provide a natural soil interface into which water may percolate.
- Minimize compaction of existing soils. Protect from construction traffic.

MAINTENANCE CONSIDERATIONS FOR ALL TREATMENT MEASURES

- A Maintenance Agreement shall be provided.
- Maintenance Agreement shall state the parties' responsibility for maintenance and upkeep.
- Prepare a maintenance plan and submit with Maintenance Agreement. Maintenance plan templates are in Appendix H.

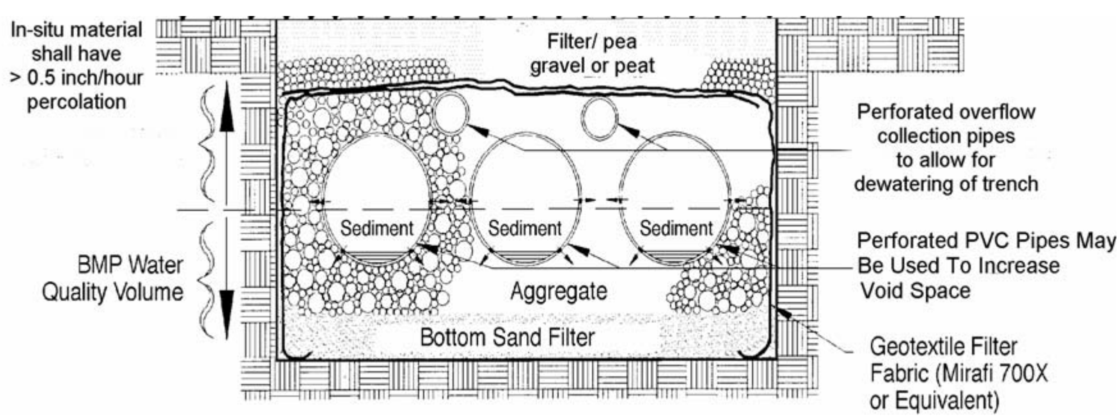


Figure 6-21: Infiltration trench cut-away view

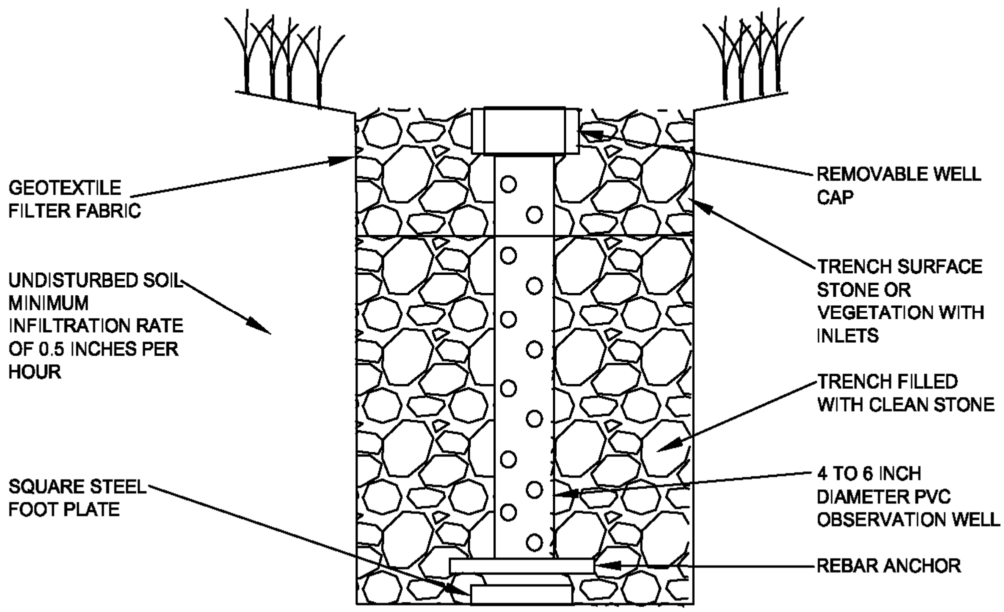


Figure 6-22: Observation Well Detail: Infiltration Trench

6.6 Extended Detention Basin

Figure 6-23: Extended detention basin. Source: California BMP Handbook (CASQA, 2003)

Best uses

- Detain low flows
- Can be expanded to detain peak flows
- Sedimentation of suspended solids
- Sites larger than 5 acres

Advantages

- Easy to operate
- Inexpensive to construct
- Treatment of particulates
- Low maintenance

Limitations

- Land requirements
- Not a stand-alone treatment measure after 12/1/11

Extended detention ponds (a.k.a. dry ponds, dry extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for a minimum of 48 hours to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a permanent pool. They can also be used to provide hydromodification management and/or flood control by including additional flow duration control and/or flood detention storage above the treatment storage area.

Beginning December 1, 2011, projects will no longer be allowed to meet stormwater treatment requirements with stand-alone extended detention basins that are designed to treat stormwater through the settling of pollutants and gradual release of detained stormwater through an orifice. However, this type of extended detention basin could be used as part of a treatment train, in which the basin stores a large volume of water, which is gradually released to a bioretention area that meets the new MRP requirements for biotreatment soils and surface loading area.

Design and Sizing Guidelines

TREATMENT DIMENSIONS AND SIZING

- Extended detention basins shall be sized to capture the required water quality volume over at least a 48-hour period. At least 10 percent additional storage shall be provided to account for storage lost to deposited sediment.
- Extended detention basin shall have no greater than 3:1 side slopes.
- The optimal basin depth is between 2 and 5 feet.
- A safety bench shall be added to the perimeter of the basin wall for maintenance when basin is full.

- Extended detention basin shall empty within five days of the end of a 6-hour, 100-year storm event to avoid vector generation.
- A 12-foot wide maintenance ramp leading to the bottom of the basin and a 12-foot wide perimeter access road shall be provided. If not paved, the ramp shall have a maximum slope of 5 percent. If paved, the ramp may slope 12 percent.
- The extended detention basin shall have a length to width ratio of at least 1.5:1.
- A fixed vertical sediment depth marker shall be installed in the sedimentation forebay. The depth marker shall have a marking showing the depth where sediment removal is required. The marking shall be at a depth where the remaining storage equals the design water quality volume.
- The detention basin is a volume-based treatment measure and requires detention time to be effective. The basin shall not empty more than 50% of its treatment volume in less than 24 hours to allow settling of sediment and associated pollutants.

INLETS TO TREATMENT MEASURE

- The inlet pipe shall have at least 1 foot of clearance to the basin bottom.
- Piping into the extended detention basin shall have erosion protection. As a minimum, a forebay with a 6-inch thick layer of Caltrans Section 72, Class 2 rock slope protection shall be placed at and below the inlet to the extent necessary for erosion protection.
- Check with municipality regarding trash screen requirements. Trash screen installation may be required upstream of the pipe conveying water into the pond, in order to capture litter and trash in a central location where it can be kept out of the pond until it is removed.

OUTLETS AND ORIFICES

- The outlet shall be sized with a drawdown time of 48 hours for the design water quality volume. The outlet shall have two orifices at the same elevation sized using the following equation:

$$a = (7x10^{-5}) * A * (H-Ho)^{.5} \ / \ CT$$

Where:

a = area of each orifice in square feet
A = surface area of basin at mid-treatment storage elevation (square feet)
H = elevation of basin when filled by water treatment volume (feet)
Ho = final elevation of basin when empty (bottom of lowest orifice) (feet)
C = orifice coefficient (0.6 typical for drilled orifice)
T = drawdown time of full basin (hours)

(Caltrans Method, Appendix B, Stormwater Quality Handbook, September 2002)

- Orifices shall each be a minimum diameter of 1 inch. Extended detention basins are not practical for small drainage areas because the minimum orifice diameter cannot be met.
- Each orifice shall be protected from clogging using a screen with a minimum surface area of 50 times the surface area of the openings to a height of at least 6 times the diameter. The screen shall protect the orifice openings from runoff on all exposed sides.
- For each outlet, provide documentation regarding adequacy of outlet protection, and a larger stone size may be necessary depending on the slope and the diameter of the outfall.

VEGETATION

- Plant species should be adapted to periods of inundation. See planting guidance in Appendix B.

- Use integrated pest management (IPM) principles in the landscape design to help avoid or minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Irrigation shall be provided as needed to maintain plant life.
- If vegetation is not established by October 1st, sod shall be placed over loose soils. Above the area of inundation, a 1-year biodegradable loose weave geofabric may be used in place of sod.

SOIL CONSIDERATIONS

- If the groundwater level is within 10 feet of the ground surface, a liner shall be provided.
- Beginning December 1, 2011, if the extended detention basin is designed to meet biotreatment requirements, soils in the area of inundation within the facility shall meet biotreatment soil specifications approved by the Regional Water Board (Appendix L). The minimum percolation rate for the biotreatment soil is 5 inches per hour. The long-term desired maximum infiltration rate is 10 inches per hour, although initial infiltration rate may exceed this to allow for tendency of infiltration rate to reduce over time.
- Also beginning December 1, 2011, if the extended detention basin is designed to meet biotreatment requirements, the surface area shall be no smaller than what is required to accommodate a 5" per hour stormwater runoff surface loading rate. This may be accomplished using a combination flow and volume design basis described in Section 5.1.
- Beginning December 1, 2011, if the extended detention basin is NOT designed to meet biotreatment requirements, it cannot function as a stand-alone treatment measure and may only be used as part of a treatment train, followed by a biotreatment measure.

MAINTENANCE CONSIDERATIONS FOR ALL TREATMENT MEASURES

- A Maintenance Agreement shall be provided.
- Maintenance Agreement shall state the parties' responsibility for maintenance and upkeep.
- Prepare a maintenance plan and submit with Maintenance Agreement. Maintenance plan templates are in Appendix H.

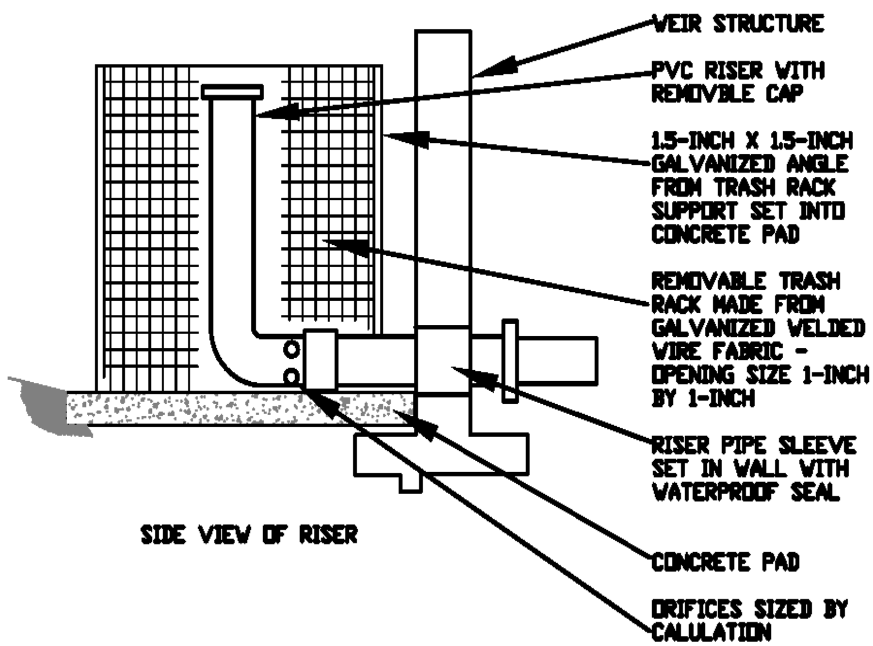


Figure 6-24: Side view of riser, extended detention basin

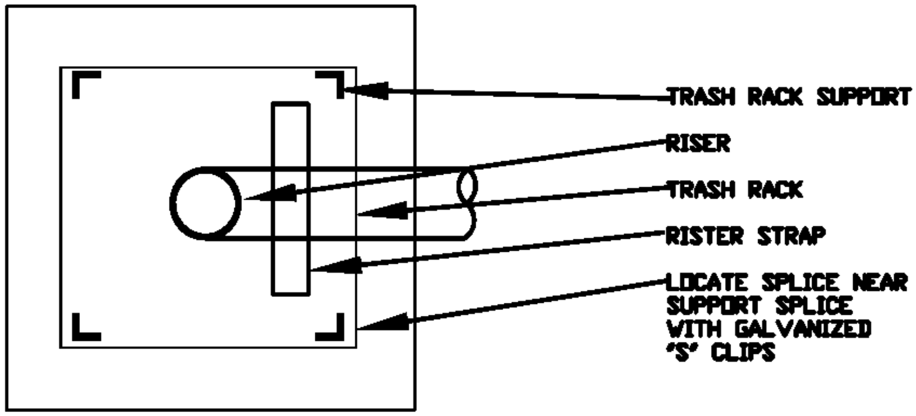


Figure 6-25: Top view of riser, extended detention basin (square design)

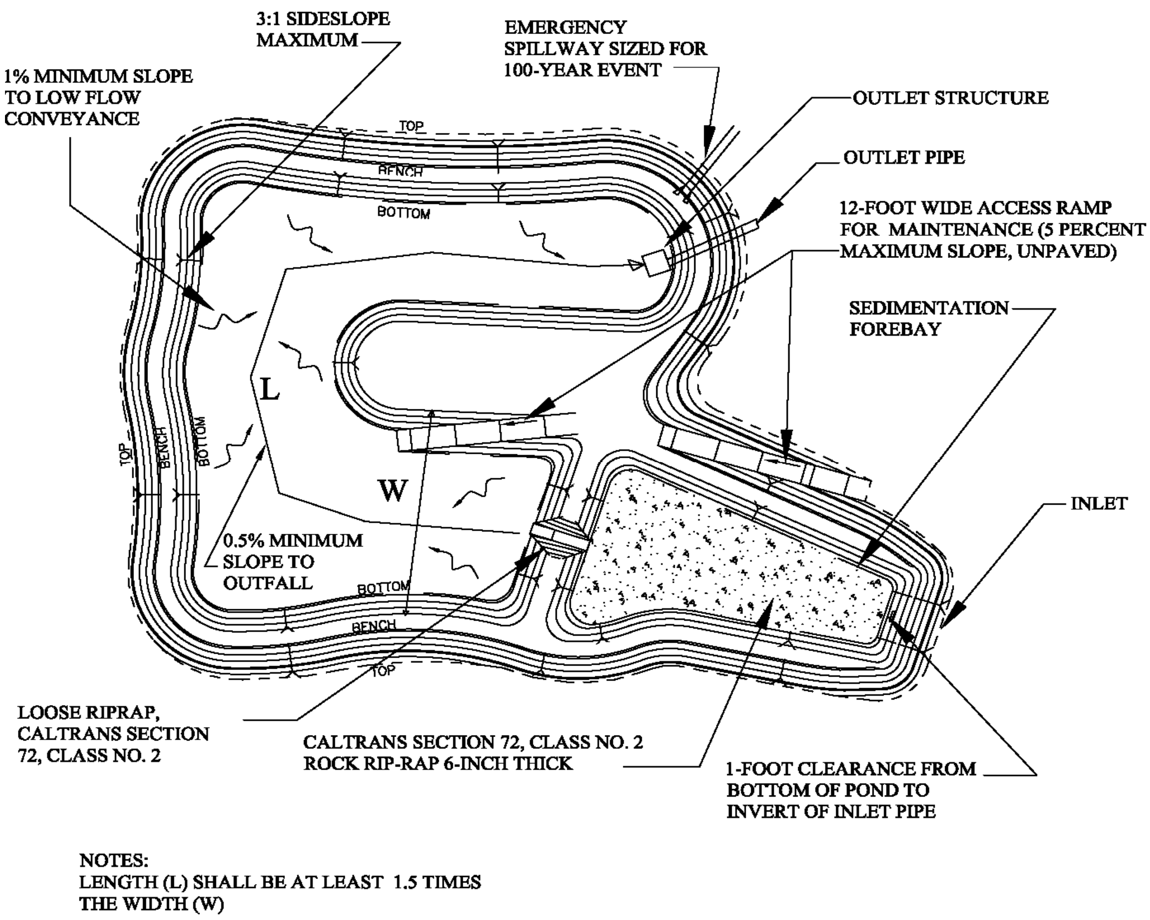


Figure 6-26: Plan View, Typical Extended Detention Basin

6.7 Pervious Paving

Figure 6-27: Parking Lot with Pervious Pavement, Emeryville

BEST USES

- Parking areas
- Common areas
- Pathways

ADVANTAGES

- Flow attenuation
- Removes fine particulates
- Reduces need for treatment

LIMITATIONS

- May clog without periodic vacuum cleaning
- Lightly trafficked areas only
- Higher installation costs

Pervious paving is used for areas with light vehicle loading and lightly trafficked areas, such as automobile parking areas. The term pervious paving describes a system comprised of a load-bearing, durable surface together with an underlying layered structure that temporarily stores water prior to infiltration or drainage to a controlled outlet. The surface is porous allowing water to infiltrate across the entire surface of the material (e.g., crushed aggregate, porous concrete or porous asphalt). Where pervious paving is underlain with pervious soil or pervious storage material sufficient to hold the Municipal Stormwater Regional Permit Provision C.3.d volume of rainfall runoff, it is not considered impervious and can function as a self-treating area.

Design and Sizing Guidelines

The design of each layer of the pavement must be determined by the likely traffic loadings and the layers' required operational life. The following criteria shall be considered:

SUBGRADE AND SITE REQUIREMENTS

- The sub-grade shall be able to sustain traffic loading without excessive deformation.
- The sub-grade shall be ungraded in-situ material with a percolation rate of 5-inches per hour, or underdrain shall be installed to remove detained flows within the pervious paving and base.
- Depth to groundwater shall be at least 10 feet from bottom of base.
- Slopes of pervious pavement should not exceed 5%, or up to 16% with underdrains. On steep slopes, provide cut-off trenches lateral to the slope to intercept, store and infiltrate drainage from the base course.

BASE LAYER

- The granular capping and base layers shall give sufficient load-bearing to provide an adequate construction platform and base for the overlying pavement layers.

- The base aggregate particles shall be selected based on strength and durability when saturated and subjected to wetting and drying.
- If the base layer is sized to hold at least the Municipal Stormwater Regional Permit Provision C.3.d volume of rainfall runoff, the area of pervious paving is not considered an impervious surface and can function as a self-treating area, as described in Section 4. 1.
- If the base layer has sufficient capacity in the void space to store the C.3.d amount of runoff for both the area of pervious paving and the area that drains to it, it is not considered an impervious surface and can function as a self-retaining area, described in Section 4.2.
- If an underdrain is used, position a minimum of 2 inches above bottom elevation of base course. To be considered a self-treating area or self-retaining area, the underdrain shall be positioned above the portion of the base layer that is sized to meet the C.3.d sizing criteria.
- Design calculations for the base shall quantify the following:
  - Type of soil, type of fill if used, permeability of base, k-values (psi/cubic inch)
  - Compressibility (clay and silt contents, organics, muck)
  - Traffic loading (in 18,000 lb. single axle loads)
  - Drainage routing of detained flows within the pervious pavement and base (infiltration through minimum 5-inch per hour sub-base into in-situ soils, or collection in underdrain if percolation rate cannot be met)

PAVEMENT MATERIALS

- The pavement materials shall not crack or suffer excessive rutting under the influence of traffic. This is controlled by the horizontal tensile stress at the base of these layers.
- Pervious pavements require a single size grading to give open voids. Materials choice is therefore a compromise considering stiffness, permeability and storage capacity.

DESIGN AND INSTALLATION

- Design shall be reviewed by the manufacturer or National Ready Mixed Concrete Association (NRMCA) (www.nrmca.org), or as directed by the municipality.
- Installation shall be by contractors familiar with pervious paving installation. Only contractors with certification from NRMCA should be considered. More information can be found at www.concreteparking.org.
- Protect area from construction traffic and excessive compaction.

Maintenance

- Maintenance plan shall be provided. Typical requirements are described in Chapter 8.

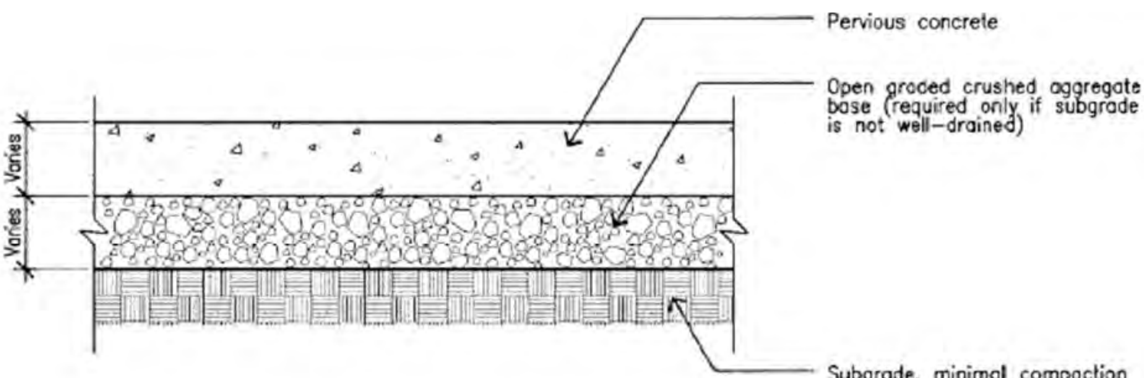


Figure 6-28: Side View of Parking Lot with Pervious Paving (Source, BASMAA, Start at the Source, 1999)

6.8 Turf Block and Permeable Joint Pavers

Figure 6-29: Turf block fire access (Source: City of Pleasanton

BEST USES
- Parking areas
- Common areas
- Lawn/landscape buffers
- Pathways

ADVANTAGES
- Flow attenuation
- Removes fine particulates
- Reduces need for treatment

LIMITATIONS
- May clog without periodic cleaning
- Weeds
- Lightly-trafficked areas only
- Higher installation costs

Turf block and permeable joint pavers are used for areas with light vehicle loading, such as automobile parking areas, and areas with little to no vehicle traffic, such as fire access lanes, and walkways. The terms turf block and permeable joint pavers describe systems comprised of a load-bearing, durable surface together with a pervious soil that temporarily stores water, with overflow conveyed to an outlet. The turf block surface is constructed of impermeable blocks separated by spaces and joints, filled with soil. The soil can be planted with turf through which water drains. Permeable joint pavers are impermeable tiles or rock plates with permeable joints to allow runoff to percolate to subsurface layers. Where subgrade soil permeability is low, an underdrain system connected to the storm drain system may be needed. Areas of turf block may be considered "self-treating areas," and may drain directly to the storm drain system if they do not receive runoff from impervious surfaces and if allowed by the local municipality. If an area of permeable joint pavers is underlain with pervious soil or pervious storage material, such as a gravel layer sufficient to hold at least the Municipal Stormwater Regional Permit Provision C.3.d volume of rainfall runoff, it is not considered an impervious surface and can function as a self-treating area, as described in Section 4. 1.

Design and Sizing Guidelines

The design of each layer of the turf block and permeable joint pavers must be determined by the likely traffic loadings and the layers' required operational life. To provide satisfactory performance, the following criteria shall be considered:

SUBGRADE AND SITE REQUIREMENTS

- The subgrade shall be able to sustain traffic loading without excessive deformation.
- An underdrain is required in clay soils.

BASE LAYER

- If the base layer is sized to hold at least the Municipal Stormwater Regional Permit Provision C.3.d volume of rainfall runoff, the area of permeable joint paving is not considered impervious and can function as a self-treating area, per Section 4.1.
- If the base layer has sufficient capacity in the void space to store the C.3.d amount of runoff for both the area of pervious paving and the area that drains to it, it is not considered an impervious surface and can function as a self-retaining area, described in Section 4.2.
- If an underdrain is used, position a minimum of 2 inches above bottom elevation of base course. To be considered a self-treating area or self-retaining area, the underdrain shall be positioned above the portion of the base layer that is sized to meet the C.3.d sizing criteria.
- Both turf block and pavers require a single size grading to give open voids. Materials choice is therefore a compromise considering stiffness, permeability and storage capacity.
- The uniformly graded single size material cannot be compacted and is liable to move when construction traffic passes over it. This effect can be reduced by the use of angular crushed rock material with a high surface friction.
- The sub-base shall be sized for strength and durability of the aggregate particles when saturated and subjected to wetting and drying. Crushed rock on geogrid fabric matrix is a typical example of turf block and pavers' sub-base. Other examples of sub-base are uncompacted soil with a sand bed to support the turf block or paver. The sub-base should be reviewed by the manufacturer of turf blocks or pavers.

PAVER MATERIALS

- The turf block or permeable joint pavers shall give sufficient load-bearing to provide an adequate support for loading.
- The paver materials should not crack or suffer excessive breakage under traffic.

CONSTRUCTION

- Protect area from construction traffic and excessive compaction.

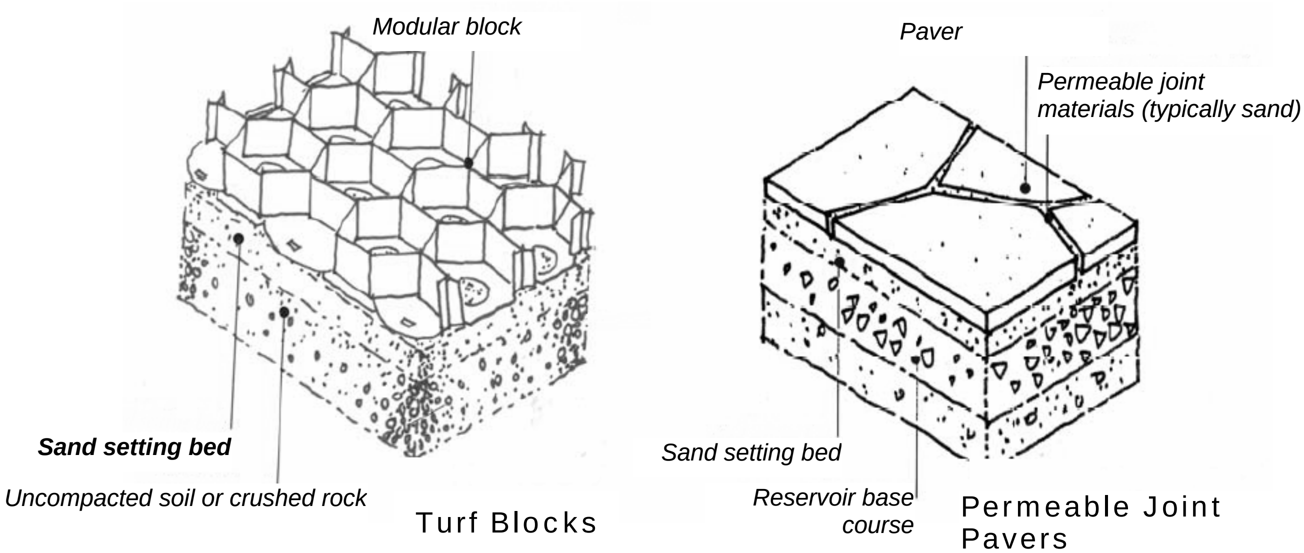


Figure 6-30: Surface and Side Views of Turf Block and Permeable Joint Pavers (Source, BASMAA. Start at the Source. 1999)

Maintenance

- A maintenance plan shall be provided. Typical maintenance requirements described in Chapter 8.

Figure 6-31: Permeable Joint Pavers at High Density Housing Project, Berkeley

6.9 Green Roofs

Figure 6-32: Extensive Green Roof in Emeryville

Best Uses

- For innovative architecture
- Urban centers

Advantages

- Minimizes roof runoff
- Reduces "heat island" effect
- Absorbs sound
- Provides bird habitat
- Longer "lifespan" than conventional roofs

Limitations

- Sloped roofs require steps
- Non-traditional design
- High installation costs

A green roof can be either ***extensive***, with a 3 to 7 inches of lightweight substrate and a few types of low-profile, low-maintenance plants, or ***intensive*** with a thicker (8 to 48 inches) substrate, more varied plantings, and a more garden-like appearance. The extensive installation at the Gap Headquarters in San Bruno (Figure 6-32), has experienced relatively few problems after nearly a decade in use. Native vegetation may be selected to provide habitat for endangered species of butterflies, as at the extensive green roof of the Academy of Sciences in San Francisco.

Design and Sizing Guidelines

- Green roofs are considered "self-treating areas" or "self-retaining areas" and may drain directly to the storm drain, if they meet the following requirements, specified in the MRP, as amended on November 28, 2011:
  - The green roof system planting media shall be sufficiently deep to provide capacity within the pore space of the media to capture 80 percent of the average annual runoff.
  - The planting media shall be sufficiently deep to support the long-term health of the vegetation selected for the green roof, as specified by the landscape architect or other knowledgeable professional.
- Extensive green roof systems contain layers of protective materials to convey water away from the roof deck. Starting from the bottom up, a waterproof membrane is installed, followed by a root barrier, a layer of insulation (optional), a drainage layer, a filter fabric for fine soils, the engineered growing medium or soil substrate, and the plant material.
- The components of intensive green roofs are generally the same as those used in extensive green roofs, with differences in depth and project-specific design application.
- Design and installation is typically completed by an established vendor.
- Follow manufacturer recommendations for slope, treatment width, and maintenance.

- Either grass or a diverse selection of other low growing, drought tolerant, native vegetation should be specified. Vegetation whose growing season corresponds to the wet season is preferred. See Appendix B for planting guidance.
- Green roof shall be free of gullies or rills.
- Irrigation is typically required.

Maintenance

- Inspection required at least semiannually. Confirm adequate irrigation for plant health.
- Fertilize and replenish growing media as specified by landscape designer and as needed for plant health. See Appendix B for alternatives to quick release fertilizers.

See www.greenroofs.com for information about and more examples of green roofs.

Figure 6-33: Extensive Green Roof at Gap Corporate Headquarters, San Bruno (William McDonough & Partners)

Figure 6-34: Intensive Green Roof at Kaiser Center, Oakland

Figure 6-35: Plants selected to support endangered butterflies (California Academy of Sciences)

6.10 Rainwater Harvesting and Use

Figure 6-36: Rainwater is collected and used for flushing toilets at Mills College, Oakland.

Best Uses

- High density residential or office towers with high toilet flushing demand.
- Park or low density development with high irrigation demand.
- Industrial use with high non-potable water demand.

Advantages

- Helps obtain LEED or other credits for green building.

Limitations

- High installation and maintenance costs.
- Low return on investment.
- Municipal permitting requirements not standardized.

Rainwater harvesting systems area engineered to store a specified volume of water with no discharge until this volume is exceeded. Storage facilities that can be used to harvest rainwater include above-ground or below-ground cisterns, open storage reservoirs (e.g., ponds and lakes), and various underground storage devices (tanks, vaults, pipes, arch spans, and proprietary storage systems). Rooftop runoff is the stormwater most often collected in harvesting/use system, because it often contains lower pollutant loads than surface runoff, and it provides accessible locations for collection. Rainwater can also be stored under hardscape elements, such as paths and walkways, by using structural plastic storage units, such as RainTank, or other proprietary storage products. Water stored in this way can be used to supplement onsite irrigation needs, typically requiring pumps to connect to the irrigation system. Rain barrels are often used in residential installations, but typically collect only 55 to 120 gallons per barrel; whereas systems that are sized to meet Provision C.3 stormwater treatment requirements typically require thousands of gallons of storage.

Uses of Harvested Water

Uses of captured water may potentially include irrigation, indoor non-potable use such as toilet flushing, industrial processing, or other uses. As indicated in Appendix J, the Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report (Feasibility Report) identified toilet flushing as the use that is most likely to generate sufficient demand to use the C.3.d amount of runoff. The demand for indoor toilet flushing is most likely to equal to the C.3.d

6.11 Media Filter

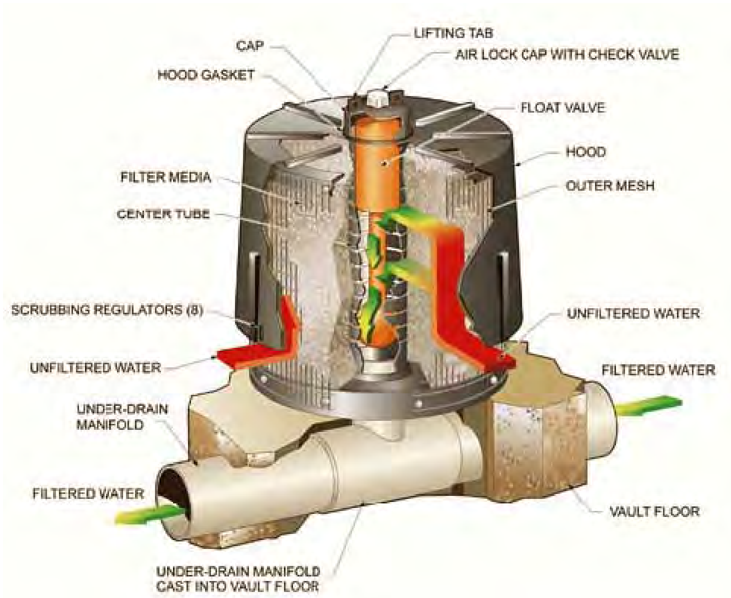


Figure 6-37: System C Filter Cartridge, Typically Used as Part of Array. Source: CONTECH Stormwater Solutions, 2006. (Note: Proprietary products shown are for general information only and are not endorsed by the Clean Water Program. An equivalent filter may be used.)

Best Uses

- "Special Projects" per Appendix K
- Limited space
- Underground
- Used following a separation unit, such as swirl concentrator

Advantages

- Less area required
- Customized media
- Customized sizing

Limitations

- No removal of trash without pre-treatment
- High installation and maintenance costs.
- Media filtration will be allowed only for some "special projects" beginning December 2011

Stormwater media filters are usually two-chambered, including a pretreatment settling basin and a filter bed filled with sand or other absorptive filtering media. As stormwater flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as stormwater flows through the filtering media in the second chamber. There are currently three types of manufactured stormwater media filter systems. Two are similar in that they use cartridges of a standard size (filter types B and C, seen above). The cartridges are placed in vaults; the number of cartridges is a function of the design flow rate. The water flows laterally (horizontally) into the cartridge to a center well, then downward to an underdrain system. The third product (type A) is a flatbed filter, similar in appearance to sand filters.

Note: Beginning December 1, 2011, the ***use of media filters will not be allowed***, except as may be indicated in Special Projects criteria (Appendix K).

Design and Sizing Guidelines

There are generally three types of stormwater filter systems:

Filter System A:

- This system is similar in appearance to a slow-rate sand filter.
- The media is cellulose material treated to enhance its ability to remove hydrocarbons and other organic compounds. The media depth is 12 inches.
- Operates at a very high rate, at peak flows. Normal operating rates are much lower assuming that the stormwater covers the entire bed at flows less than the peak rate.

- System uses a swirl concentrator for pretreatment.
- As the media is intended to remove sediments (with attached pollutants) and organic compounds, it would not be expected to remove dissolved pollutants such as nutrients and metals unless they are complexed with the organic compounds that are removed.

Filter System B:

- Uses a simple vertical filter consisting of 3-inch diameter, 30-inch high slotted plastic pipe wrapped with fabric.
- The standard fabric has nominal openings of 10 microns. The stormwater flows into the vertical filter pipes and out through an underdrain system. Several units are placed vertically at 1-foot intervals to give the desired capacity.
- The filter bay has a typical emptying time of 12 to 24 hours.
- In a cartridge filter the media is fabric, therefore the system may not remove dissolved pollutants. It does remove pollutants attached to the sediment that is removed.

Filter System C:

- The system uses vertical cartridges in which stormwater enters radially to a center well within the filter unit, flowing downward to an underdrain system.
- Flow is controlled by a passive float valve system, which prevents water from passing through the cartridge until the water level in the vault rises to the top of the cartridge.
- Full use of the entire filter surface area and the volume of the cartridge is assured by a passive siphon mechanism as the water surface recedes below the top of the cartridge.
- A balance between hydrostatic forces assures a more or less equal flow potential across vertical face of filter surface. Filter surface receives suspended solids evenly in this system.
- Absent the float valve and siphon systems, the amount of water treated over time per unit area in a vertical filter is not constant, decreasing with the filter height; furthermore, a filter would clog unevenly.
- Restriction of the flow using orifices ensures consistent hydraulic conductivity of the cartridge as a whole by allowing the orifice, rather than the media, whose hydraulic conductivity decreases over time, to control flow.
- Manufacturers offer several media types used singly or in combination (dual- or multi-media). Total media thickness is about 7 inches. Some media, such as fabric and perlite, remove only suspended solids (with attached pollutants). Dissolved pollutants may be targeted for removal by using media consisting of compost, zeolite, and iron-infused polymer. Pretreatment occurs in an upstream unit and/or the vault within which the cartridges are located. Water quality volume or flow rate (depending on the product) is determined by local governments or sized so that 85% of annual runoff volume is treated.

All 3 types of media filter require a pretreatment system in place such as a swirl concentrator.

CONSIDERATIONS FOR PROPRIETARY SYSTEMS

- ***Consider hydraulic depth.*** Different types of manufactured treatment measures have different head losses. Your options may be limited if the site has limited hydraulic depth or other constraints.
- ***Allow for necessary field changes.*** In the planning permit application submittal, request approval to use more than one manufactured treatment measure product in the project. Format the design, details, and specifications to identify the approved, alternative

manufactured treatment measures, and include these documents in the building permit application submittal. Giving the contractor options to work with will help avoid delays.

- ***Allow design flexibility.*** Some manufactured treatment measures have the same invert elevation in and out, while some require a change in elevation between the invert and outlet. If possible, provide for a design that allows for a change in invert elevations.
- ***Consider site constraints.*** Some manufactured treatment measures that require a differential head to operate may not work in a retrofit situation, where inlet and outlet pipe elevations cannot be changed without reinstalling long lengths of existing pipe.
- ***Include sufficient information.*** Contract documents should include enough design information so that the contractor can evaluate and demonstrate that the treatment measure meets the design objectives.
- ***Avoid approval problems.*** If applicable, clarify in the design and construction documents that the contractor will be responsible for obtaining approval from the local jurisdiction for any changes that violate the approved permit plans or conditions.

MAINTENANCE CONSIDERATIONS FOR ALL TREATMENT MEASURES

- A Maintenance Agreement shall be provided.
- Maintenance Agreement shall state the parties' responsibility for maintenance and upkeep.
- Prepare a maintenance plan and submit with Maintenance Agreement. Maintenance plan templates are in Appendix H.

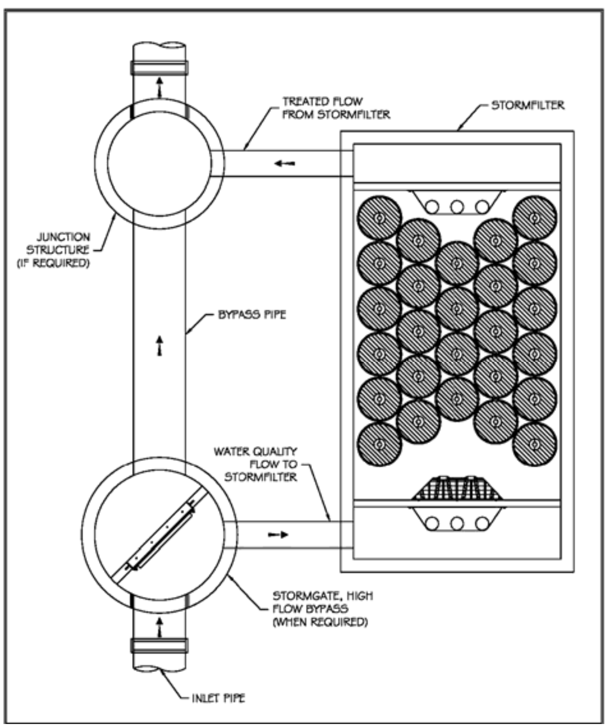


Figure 6-38: Profile View, Typical System C Filter Array. Source: CONTECH Stormwater Solutions, 2006. (Note: The proprietary media filters shown are for general information only and are not endorsed by the Clean Water Program.)

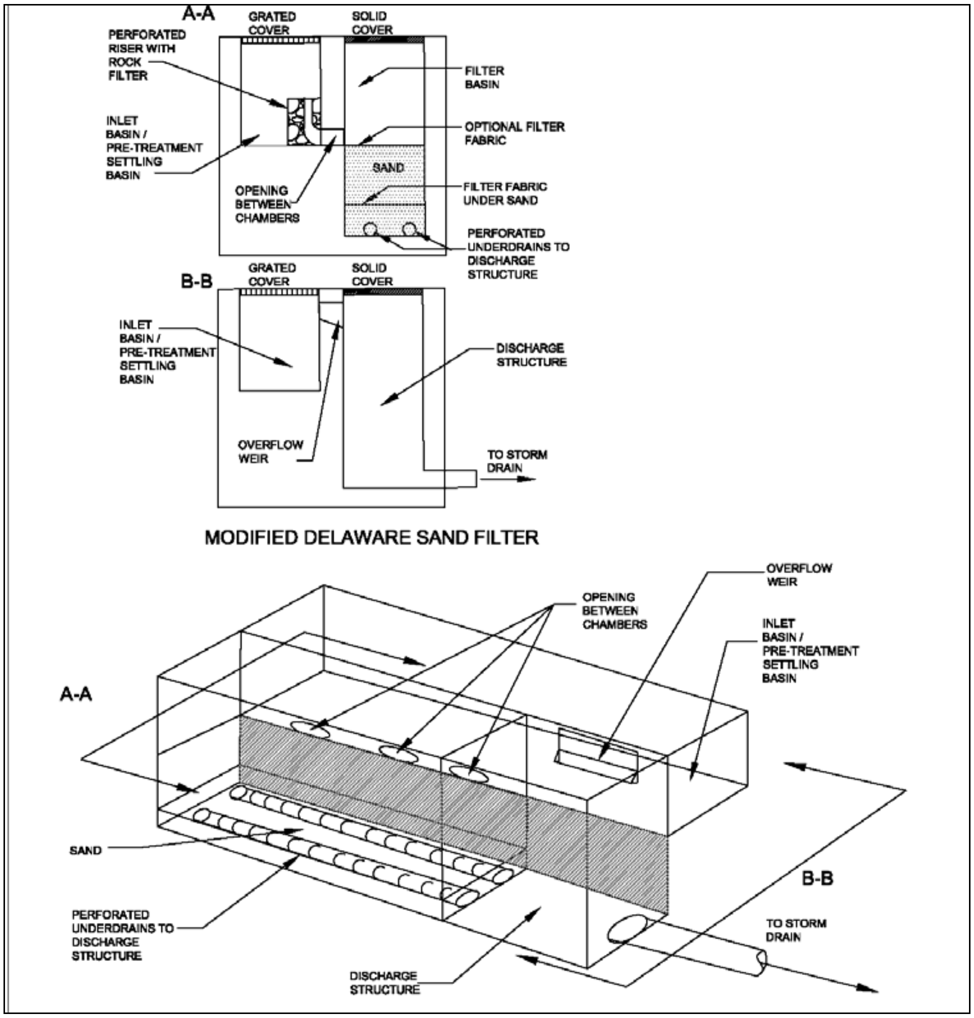


Figure 6-39: Cut Away Profile Views, System A Filter (Modified Delaware Sand Filter)

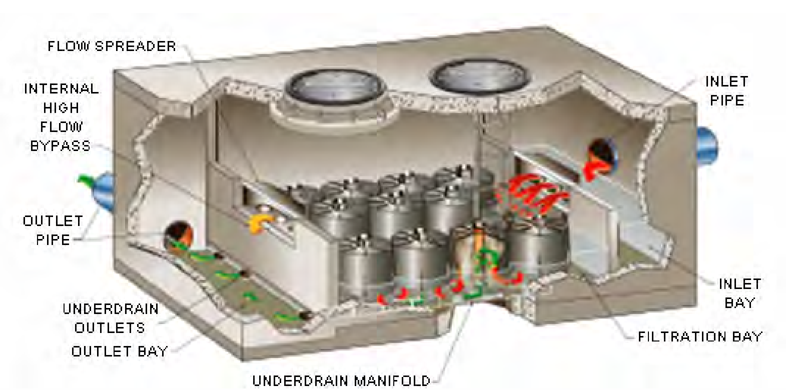


Figure 6-40: Plan View, Typical System C Filter Array. Source: CONTECH, 2006.
(Note: Proprietary media filters shown are for general information only and are not endorsed by the Clean Water Program.)

amount of stormwater in high rise residential or office projects, and in schools. Irrigation demand may equal the C.3.d amount of runoff in projects with a very high percentage of landscaping.

System Components

Rainwater harvesting systems typically include several components: (1) methods to divert stormwater runoff to the storage device, (2) an overflow for when the storage device is full, and (3) a distribution system to get the water to where it is intended to be used. Filtration and treatment systems are typically required for indoor uses of harvested rainwater (see Table 6-2).

LEAF SCREENS, FIRST-FLUSH DIVERTERS, AND ROOF WASHERS

These features may be installed to remove debris and dust from the captured rainwater before it goes to the tank. The initial rainfall of any storm often picks up the most pollutants from dust, bird droppings and other particles that accumulate on the roof surface between rain events. Leaf screens remove larger debris, such as leaves, twigs, and blooms that fall on the roof. A first-flush diverter routes the first flow of water from the catchment surface away from the storage tank to remove accumulated smaller contaminants, such as dust, pollen, and bird and rodent feces. A roof washer may be placed just ahead of the storage tank and filters small debris for systems using drip irrigation. Roof washers consist of a tank, usually between 30- and 50-gallon capacity, with leaf strainers and a filter.

TREATMENT METHODS

The Texas Manual on Rainwater Harvesting (3rd Edition, 2006) identifies two methods of treatment used in rainwater harvesting systems for indoor use: chlorine and UV light. Chlorine has a longer history of use in the US, and is still reported to be used by rainwater harvesters, but it has drawbacks. Chlorine combines with decaying organic matter in water to form trihalomethanes, a by-product that has been found to cause cancer in laboratory rats; some users may find the taste and smell of chlorine objectionable; and chlorine does not kill *Giardia* or *Cryptosporidium*, which are cysts protected by their outer shells. ***UV light has more recently become common practice*** in U.S. utilities. Bacteria, virus, and cysts are killed by exposure to UV light. The water must go through sediment filtration before the ultraviolet light treatment because pathogens can be shadowed from the UV light by suspended particles in the water. In water with very high bacterial counts, some bacteria will be shielded by the bodies of other bacteria cells. UV lights are benign: they disinfect without leaving behind any disinfection by-products, and they use minimal power for operation.

Table 6-2
Typical Water Quality Guidelines from the Texas Rainwater Harvesting Manual

Use	Minimum Water Quality Guidelines	Suggested Treatment Guidance
Non-potable indoor uses	▪ Total coliforms < 500 cfu per 100 mL ▪ Fecal coliforms < 100 cfu per 100 mL	▪ Pre-filtration – first flush diverter ▪ Cartridge filtration – 5 micron sediment filter ▪ Disinfection – chlorination with household bleach or UV disinfection
Outdoor uses	N/A	▪ Pre-filtration – first flush diverter

Source: Low Impact Development Manual for Southern California, Low Impact Development Center, 2010, which, in turn, cites the Texas Rainwater Harvesting Manual for this information.

Design and Sizing Guidelines

HYDRAULIC SIZING

- If a rainwater harvesting system will be designed to meet Provision C.3 stormwater requirements, there must be sufficient demand to use 80 percent of the average annual rainfall runoff, as specified in Provision C.3.d.
- If the project's completed Rainwater Harvesting Worksheet (or other project-specific calculation) indicates that there is sufficient demand, size the cistern (or other storage device) to achieve the maximum drawdown time indicated in Table 9 of the Feasibility Report (included in Appendix J).

DESIGN GUIDELINES FOR ALL SYSTEMS

- Equip water storage facilities covers with tight seals, to reduce mosquito-breeding risk. Follow mosquito control guidance in Appendix G.
- Water storage systems in proximity to the building may be subject to approval by the building official. The use of waterproofing as defined in the building code may be required for some systems, and the municipality may require periodic inspection. Check with municipal staff for the local jurisdiction's requirements.
- Do not install rainwater storage devices in locations where geotechnical/stability concerns, such as a slope above 10%, may prohibit the storage of large quantities of water.
- Provide separate piping without direct connection to potable water piping. Dedicated piping should be color coded and labeled as harvested rainwater, not for consumption. Faucets supplied with non-potable rainwater should include signage identifying the water source as non-potable and not for consumption.\
- The harvesting system must not be connected to the potable water system at any time.
- When make-up water is provided to the harvest/reuse system from the municipal system, prevent cross contamination by providing a backflow prevention assembly on the potable water supply line, an air gap, or both, to prevent harvested water from entering the potable supply. Contact local water system authorities to determine specific requirements.

DESIGN GUIDELINES FOR INDOOR USE

- Avoid harvesting water for indoor use from roofs with architectural copper, which may discolor porcelain.
- Provide filtration of rainwater harvested for indoor non-potable use, as required by the plumbing code and any municipality-specific requirements.

DESIGN GUIDELINES FOR IRRIGATION USE

- Water diverted by a first flush diverter may be routed to a landscaped area large enough to accommodate the volume, or a hydraulically-sized treatment measure.
- First flush diverters shall be installed in such a way that they will be easily accessible for regular maintenance.
- Do not direct to food-producing gardens rainwater harvested from roofs with wood shingles or shakes (due to the leaching of compounds), asphalt shingles, tar, lead, or other materials that may adversely affect food for human consumption.

MAINTENANCE CONSIDERATIONS FOR ALL TREATMENT MEASURES

- A Maintenance Agreement shall be provided and shall state the parties' responsibility for maintenance and upkeep.
- Prepare a maintenance plan and submit with Maintenance Agreement.

Chapter

7

Hydromodification Management Measures

This Chapter summarizes the requirements for controlling erosive flows from development projects.

7.1 Why Require Hydromodification Management?

Changes in the timing and volume of runoff from a site are known as “hydrograph modification” or “hydromodification”. When a site is developed, much of the rainwater can no longer infiltrate into the soils, so it flows offsite at ***faster rates and greater volumes***. As a result, erosive levels of flow occur more frequently and for longer periods of time in creeks and channels downstream of the project. Hydrograph modification is illustrated in Figure 7-1, which shows the stormwater peak discharges after rainstorms in an urban watershed (the red, or dark, line) and a less developed (the yellow, or light, line). The axes indicate the volume of water discharged, and the time over which it is discharged.

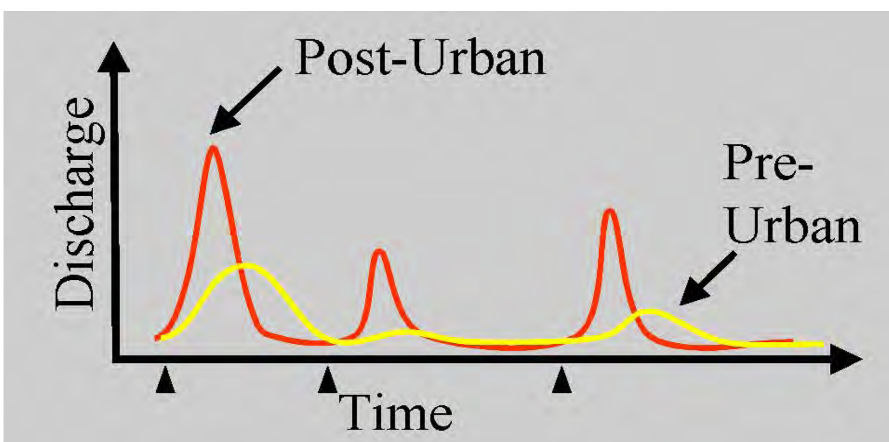


Figure 7-1: Stormwater Peak Discharges in Urban (Red) and Less Developed (Yellow) Watersheds (Source: NEMO-California Partnership, No Date)

In watersheds with large amounts of impervious surface, the larger volumes and faster rates of flow, with extended durations of flows that cause erosion, often cause natural creeks or earthen channels to erode, as the channel enlarges in response to the increased flows. Problems from this additional erosion often include property damage, degradation of stream habitat and loss of water quality, and have not been addressed by traditional detention designs. Figures 7-2 and 7-3 illustrate the effect of increasing urbanization on stormwater volumes.

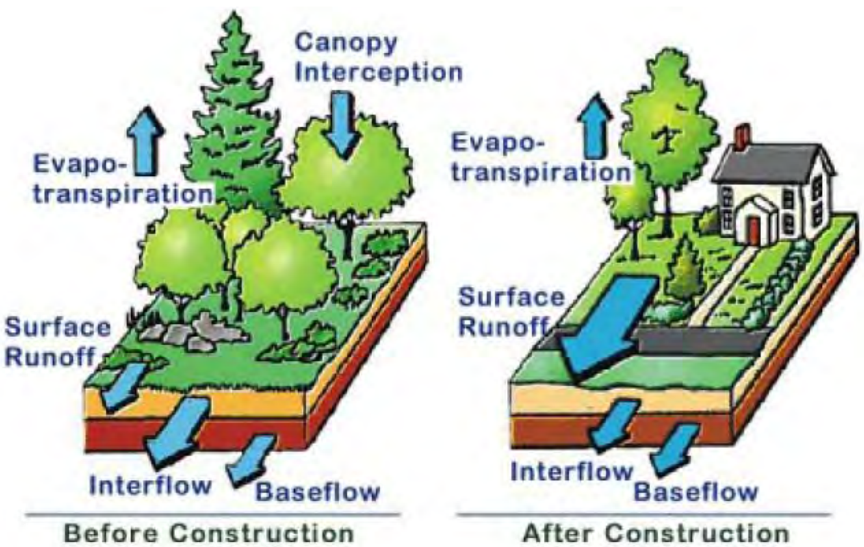


Figure 7-2: Effects of Urbanization on the Local Hydrologic Cycle (Source: 2000 Maryland Stormwater Design Manual)

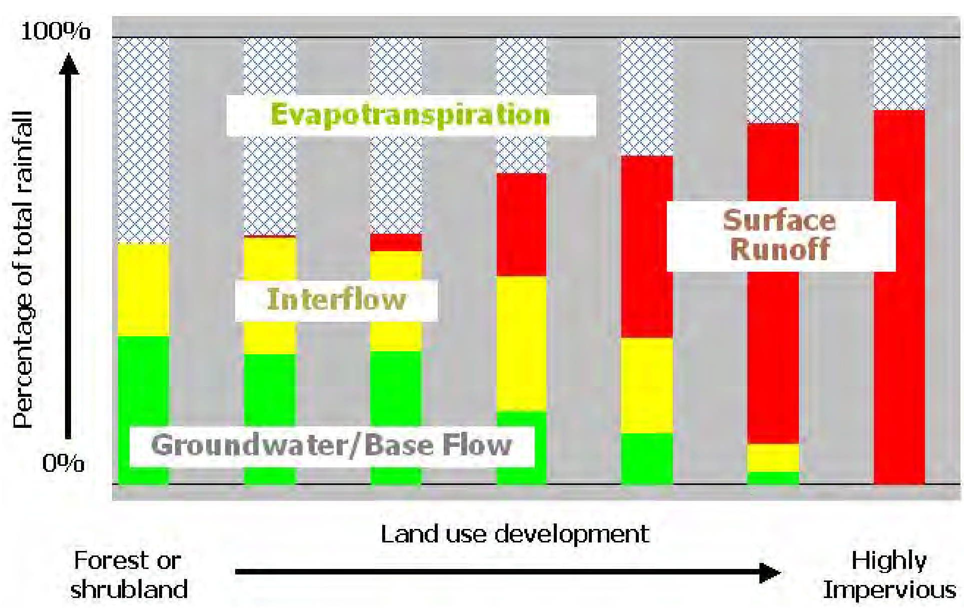


Figure 7-3. Variation in rainfall contribution to different components of the hydrological cycle for areas with different intensity of urban development. (Chart used by permission of Clear Creek Solutions.)

Since 2007, new hydromodification management (HM) techniques have been required in areas across the San Francisco Bay Area that are susceptible to hydromodification. These techniques focus on ***retaining, detaining or infiltrating runoff*** and matching post-project flows and durations to pre-project patterns for a specified range of smaller, more frequent rain events, to prevent increases in channel erosion downstream. Within Alameda County, a simple map-based approach is used to determine which parts of the drainage network are susceptible to hydromodification impacts. Projects that meet certain criteria, and from which runoff passes through the susceptible areas, are be required to incorporate one or more HM measures in the design in order to reduce erosive flows from a wide range of runoff conditions.

Hydromodification management (HM) techniques focus on ***retaining, detaining or infiltrating runoff.***

7.2 Which Projects Need to Implement HM?

Unless it is a single family home that is not part of a larger of development, your project will be required to comply with the HM requirements if it meets the following applicability criteria:

- The project ***creates and/or replaces one acre or more of impervious surface***,
- The project ***will increase impervious surface*** over pre-project conditions, AND
- The project is ***located in a susceptible area***, as shown on the default susceptibility map.

Appendix I shows a schematic view of a portion of the hydromodification susceptibility map. The full map may be downloaded from the Clean Water Program website in an interactive format that enables zooming to a closer view of the project vicinity with local streets. Note that project sites draining to earthen flood control channels are not automatically exempt from HM requirements.

Please note that projects located in susceptible areas are encouraged to include hydrologic source control measures for HM if they are likely to cause hydrograph changes, ***even if they create and/or replace less than one acre of impervious surface.***

7.3 Hydromodification Management (HM) Measures

Hydromodification management (HM) measures can be grouped into three types:

- ***Site design and hydrologic source control measures***, which are generally distributed throughout a project site. These types of measures minimize hydrological changes caused by development beginning with the point where rainfall initially meets the ground. Examples include minimizing impervious area, disconnecting roof leaders and providing localized detention – which also helps reduce stormwater pollution.
- ***On-site structural HM measures*** that manage excess runoff from the site after hydrologic source control measures are applied. These ***"end-of-pipe" measures*** mitigate the effects of hydrograph changes. Stormwater is temporarily detained, and then the runoff is gradually discharged to a natural channel at a rate calculated to avoid adverse effects. Examples include extended detention basins, wet ponds and constructed

wetlands. Please note that there is a difference between the design approach for sizing measures to remove pollutants from stormwater and the approach for designing HM measures to prevent an increase in the potential for creek bank erosion. The treatment of stormwater pollutants targets capture of 80% of average runoff volume, which means that treatment measures will be bypassed every one to two years. Structural HM measures must be sized for ***flow duration control for frequent, small runoff events*** (with average occurrence ranging from less than two-years to approximately ten-years). The structural HM measures are sized to control the statistical duration of a wide range of flow levels under simulated runoff conditions. Depending on pre-project and post-project conditions, the required detention volume is likely to be greater than the capture volume required for treatment.

> Structural HM measures must be sized to control the flow and duration of stormwater runoff according to a ***Flow Duration Control*** standard, which is often greater than size requirements for volume-based treatment.

- ***In-stream or restorative measures*** that modify susceptible watercourses to withstand projected increases in runoff flows and durations without increasing erosion or other impacts to beneficial uses. In-stream measures are more complicated to use than the hydrologic source control and end-of-pipe measures, and are ***best suited for creeks or channels that have already received impacts*** from previous development and have only localized channel instability. Examples include biostabilization techniques using roots of live vegetation roots to stabilize banks and localized structural measures such as rock weirs, boulder clusters or deflectors. These measures will not automatically provide HM protection for channel reaches farther downstream and may require longer planning timelines and cooperation among multiple jurisdictions compared to on-site measures.

7.4 Requirements for Hydromodification Management

For projects subject to HM requirements, consider HM at every stage of project development and incorporate the step-by-step instructions for C.3 submittals, provided in Chapter 3. The most effective use of land and resources may require combining measures from all three categories described above. In general, the strategy for designing HM measures should :

- ***Start with site design*** to minimize the amount of runoff to be managed (see Planning Steps 2 & 3 in Chapter 3).
- Where possible, ***maximize infiltration*** to further reduce detention requirements. Note that infiltration is limited by site constraints such as slope stability concerns, low-permeability soils or groundwater protection constraints.
- Use ***structural HM measures*** to detain the remaining calculated runoff from the site enough to ***control its release*** in a way that meets the remaining runoff design requirements. This may be accomplished with a measure that also provides volume-based treatment, such as an extended detention basin. For some project locations, off-site options may be available to reduce or eliminate the need for onsite detention.

7.4.1 Flow Duration Control

Flow Duration Control (FDC) differs from traditional "design storm" approaches used to design detention facilities for flood control or water quality treatment. Instead of specifying static holding times for one or a few discrete events, the Flow Duration standard manages runoff discharge over the full range of runoff flow levels predicted through continuous hydrologic simulation modeling, based on a long-term precipitation record. Flow Duration Control requires that the increase in surface runoff resulting from new impervious surfaces be ***retained on-site with gradual discharge*** either to groundwater through infiltration, losses by evapotranspiration, and/or discharge to the downstream watercourse at a level below the critical flow that causes creek channel erosion. ***Critical flow,*** or Qc**,** is the lower threshold of in-stream flows that contribute to sediment erosion and sediment transport or effective work. The duration of channel flows below Qc may be increased indefinitely without significant contribution to hydromodification impacts.

> The duration of channel flows below the ***"critical flow"*** may be increased indefinitely without significant contribution to hydromodification impacts.

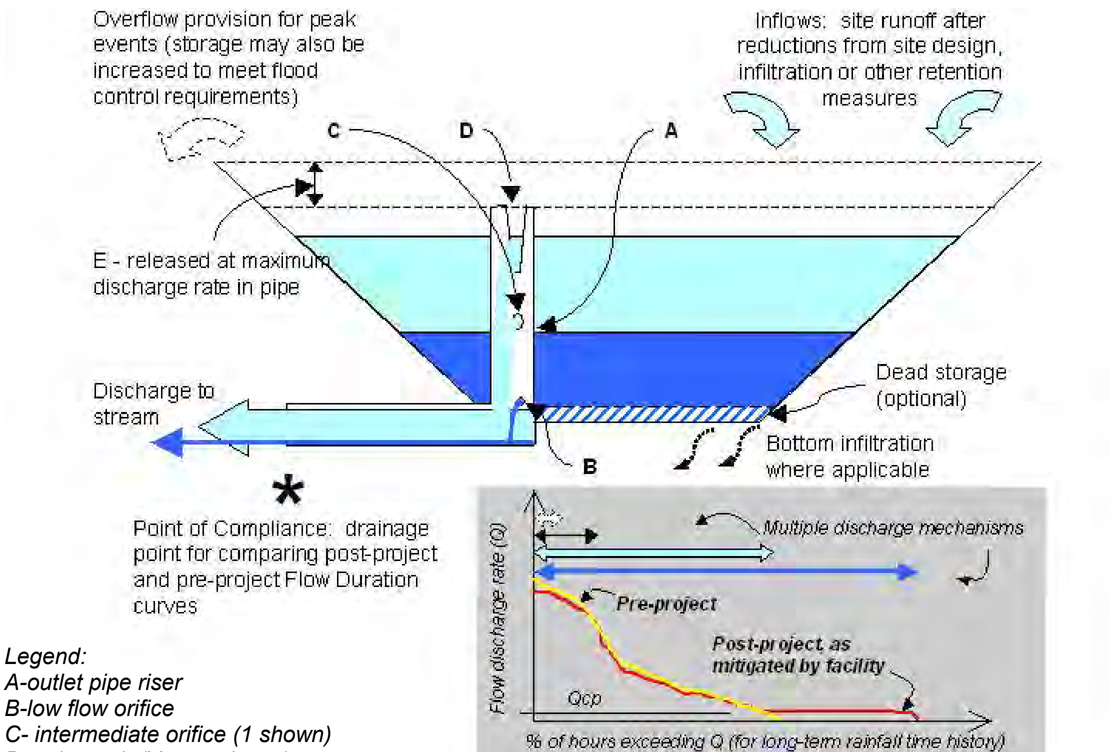
7.4.2 Application of Flow Duration Control to Project Areas

The Flow Duration approach involves a continuous model that applies a time series of at least 20 years of rainfall records to a watershed area or project site to generate a simulated stormwater runoff record based on two sets of inputs, one representing future development and the other representing pre-project conditions. The 20-year precipitation record is the minimum length necessary to capture the range of runoff conditions that are cumulatively responsible for most of the erosion and sediment transport in the watershed, primarily flow levels that would recur at average intervals of 10 years or less in the pre-project condition. The design objective is to preserve the pre- project cumulative frequency distribution of flow durations and sizes under post-project flows. This is done with a combination of site design, infiltration and detention. Typically the post-project increase in surface runoff volume is routed through a ***flow duration control pond*** or other structure that detains a certain portion of the increased runoff and discharges it through a ***specialized outlet structure*** (see Figure 7-4).

The flow duration basin, tank or vault is designed conceptually to incorporate multiple pools that are filled with different frequencies and discharge at different rates. The low-flow pool is the bottom level designed to capture and retain small to moderate size storms, the initial portions of larger storms, and dry weather flows. These flows are discharged through the lowest orifice which allows continuous ***discharge below the critical flow rate*** for a project (Qcp). Successively higher-flow pools store and release higher but less frequent flows through other orifices or graded weir notches to approximate the pre-project runoff durations. In practice the multiple pools are usually integrated into a single detention basin, tank or vault that works as a unit with the specialized outlet structure. Matching the pre-project flow durations is achieved through fine-tuning of the number, heights and dimensions of orifices or weir notches, as well as depth and volume of the basin, tank or vault.

> Flow Duration facilities are subject to ***Operations and Maintenance*** reporting and verification requirements similar to those for numerically sized treatment measures.

As shown in the example chart of Figure 7-4, the post-project flow duration curve (red, or dark line) is reduced by the facility to remain ***at or below the pre-project curve*** (yellow, or light line), except for flows less than Qcp. Minor exceedances are permissible at a limited number of higher flows since at other flow levels the post-project duration is actually less than the pre-project condition.



Legend:
A-outlet pipe riser
B-low flow orifice
C- intermediate orifice (1 shown)
D-weir notch (V-type shown)
E-freeboard above riser (typically 1 foot)

Figure 7-4: Schematic flow duration pond and flow duration curves matched by varying discharge rates according to detained volume.

If feasible, ***combining flow duration and water quality treatment*** into a single facility reduces the overall land requirements for stormwater management. ***Adequate maintenance*** of the low-flow orifice or notch is critical to proper performance. The outlet may be in a protective enclosure to reduce risk of clogging. Please note that Flow Duration facilities are subject to Operations and Maintenance verification requirements similar to those for numerically sized treatment measures.

7.4.3 Bay Area Hydrology Model (BAHM)

To facilitate the simulation modeling aspect of FDC for project proponents and their engineers, the Clean Water Program collaborated with the Santa Clara and San Mateo Counties' stormwater programs to develop a Bay Area Hydrology Model ***software package*** that is adapted from Version 3 of the Western Washington Hydrology Model (WWHM) developed by Clear Creek Solutions for the State of Washington Department of Ecology (WDOE). The

WWHM was specifically developed to help engineers design facilities to meet a Flow Duration Control standard for development projects.

The BAHM is available for downloading at www.bayareahydrologymodel.com, and it includes:

- Databases to automatically assign default ***rainfall conditions*** for a project location selected within the County boundary.
- A user interface for developing a ***schematic drainage model*** of the project site, with forms for entering areas of land use or impervious surface for multiple sub-basins.
- Continuous simulation modeling of ***pre-project and post-project runoff*** from the site using actual long-term rainfall records appropriately scaled for the project location.
- A design module for sizing a ***FDC detention facility*** and designing the discharge structure to meet the Flow Duration standard for matching post-project and pre-project duration-frequency curves. Pre-project and post-project runoff are compared at a "point of compliance" selected by the designer, usually near the point where runoff leaves the project area.
- Options to check facility sizing for ***volume-based treatment***, and incorporate runoff reductions attributable to some common hydrologic source control measures.
- Standardized output ***report files*** that can be saved in Word format, and include all information about data inputs, model runs, facility design, and summary of the hydrological statistics showing the compliance of post-project flow duration curves with the Flow Duration standard. Project input and output data can also be saved in Excel and other formats for other uses.

Training courses on using the BAHM are offered periodically. For more information, please visit www.bayareahydrologymodel.com.

7.5 Area-Specific HM Provisions

Individual municipalities may have special policies or ordinances for creek protection applicable in all or part of their jurisdictions. ***Contact the municipal staff from your jurisdiction*** to identify any special local provisions that may encourage or affect specific forms of HM implementation. Examples of area-specific HM provisions can include:

- Watershed-based land-use planning measures, such as creek buffers, which may be incorporated in local General Plans, zoning codes or watercourse ordinances.
- Special permitting provisions for project design and review of projects on streamside properties.
- Specific plans for regional HM measures or in-stream restoration projects.

> Individual municipalities may have special policies or ordinances for ***creek protection*** applicable in all or part of their jurisdictions.

7.6 When On-site HM is Impracticable

Under specific conditions, the MRP allows projects to meet HM requirements by providing for or contributing financially to an off-site alternative HM project.

7.6.1 Determining Impracticability

In order to use an off-site alternative HM project, you would need to demonstrate the following:

- Due to on site conditions (such as extreme space limitations) the ***total cost to comply with both HM and stormwater treatment requirements*** exceeds two percent of the project construction cost, excluding land costs. (When calculating costs of HM and stormwater treatment measures, do NOT include land costs, soil disposal fees, hauling, contaminated soil testing, mitigation, disposal, or other normal site enhancement costs such as landscaping or grading that are required for other development purposes.)
- There is ***no available regional HM measure*** to which runoff from your project can be directed. A regional HM measure is considered available if there is a planned location from the regional HM measure AND if an appropriate funding mechanism for the regional HM measure is in place by the time of your project's construction.
- Meeting the HM requirements by constructing ***an in-stream measure is not practicable***. An in-stream measure is considered practicable if an in-stream measure for your project's watershed is planned, and an appropriate funding mechanism for the in-stream measure is in place by the time of project construction.

7.6.2 Requirements for Using an Alternative HM Project

If you have demonstrated that on-site HM is impracticable for your project, you will need to implement the following requirements to use an alternative HM project.

- Include site designs in your project that ***provide hydrologic source control***. Examples include minimizing impervious area, disconnecting roof leaders and providing localized detention.
- Include in your project stormwater treatment measures that collectively ***minimize, slow and detain runoff*** to the maximum extent practicable. (This generally includes bioretention areas, vegetated swales, flow-through planters, and other stormwater treatment measures that filter runoff through soil or other media.)
- ***Contribute financially*** to an alternative HM project, such as a stormwater treatment retrofit, HM retrofit, regional HM control, or in-stream measure that is not otherwise required by the Water Board or other regulatory agency. The contribution shall consist of the difference between two percent of the project construction costs and the cost of the treatment measures at the site (based on calculations described in Section 7.6.1).

Figure 7-5: Draining roof runoff to a landscaped area is an example of hydrologic source control.

Chapter

8

Operation and Maintenance

This Chapter summarizes the operation and maintenance requirements for stormwater treatment and structural hydromodification management measures.

8.1 Summary of O&M Requirements

Maintenance is essential for assuring that stormwater treatment and structural hydromodification management (HM) measures continue to function effectively and do not cause flooding, provide habitat for mosquitoes, or otherwise become a nuisance. The maintenance requirements described in this chapter apply to stormwater treatment measures and structural HM measures included in your project. The operation and maintenance (O&M) process can be organized into five phases, as described below:

- Determining ownership and maintenance responsibility,
- Identifying maintenance requirements when selecting treatment measures,
- Preparing the maintenance plan and other documentation,
- Executing a maintenance agreement or other maintenance assurance, and
- Ongoing inspections and maintenance.

> O&M requirements apply to stormwater treatment AND HM measures.

8.1.1. Responsibility for Maintenance

The responsibility for the maintenance of stormwater treatment and structural HM measures ***belongs to the project applicant and/or property owner*** unless other specific arrangements have been made. Ownership and maintenance responsibility for stormwater treatment measures and structural HM measures should be considered at the earliest stages of project planning, typically at the pre-application meeting with municipal staff. The municipal stormwater permit also requires that the project applicant provide a signed statement accepting responsibility for maintenance until this responsibility is legally transferred, as well as ensuring access to municipal, Water Board, and Alameda County Mosquito Abatement District or Vector Control District staff.

8.1.2 Considerations When Selecting Treatment Measures

CONSIDER OPERATION AND MAINTENANCE

When determining which types of treatment measures to incorporate into project plans, be mindful of how maintenance intensive they are. Study the operation manual for any manufactured, proprietary system. Treatment measures must be maintained so that they continue to treat stormwater runoff effectively ***throughout the life of the project*** and do not provide habitat for mosquito breeding. Adequate funds must be allocated to support long-term site maintenance. Manufactured, proprietary systems tend to clog easily and therefore require frequent maintenance to ensure that they operate as intended and do not hold standing water. A properly designed and established bioretention area, by contrast, may require little maintenance beyond the typical requirements for areas of landscaping.

The party responsible for maintenance will also be required to ***dispose of accumulated residuals properly.*** Residuals are defined as trash, oil and grease, filter media and fine sediments that are collected from treatment measures that may or may not be contaminated. At present, research generally indicates that residuals are not hazardous wastes and as such, after dewatering, property owners can generally disposed of residuals in the same way they would dispose of any uncontaminated soil.

The USEPA Fact Sheet titled Storm Water O&M Fact Sheet: Handling and Disposal of Residuals (www.epa.gov/npdes/pubs/handdisp.pdf) provides useful information to help property owners dispose of residuals properly. The fact sheet describes the properties of stormwater residuals, O&M requirements for specific types of treatment measures, key elements for a residual handling and disposal program, and specific information on residual disposal from case studies. Two landfills in Alameda County accept sediment ("soil"), contaminated or otherwise:

- Altamont Landfill and Resource Recovery, 1040 Altamont Pass Road, Livermore, (510) 430-8509
- Vasco Road Sanitary Landfill, 4001 N. Vasco Road, Livermore, (661) 257-3655.

Alternatively, property owners may choose to contract with the treatment device manufacturer to maintain their treatment measures. Services typically provided include inspection, maintenance, handling and disposal of all residuals.

> Except for treatment measures designed to hold permanent pools of standing water, treatment measures should ***drain completely within five days*** to suppress mosquito production.

CONTROL MOSQUITOES

When selecting and installing stormwater treatment devices, you will need to consider the various environmental, construction, and local factors that may influence mosquito breeding. With the exception of certain treatment measures designed to hold permanent pools of standing water, ***treatment measures should drain completely within five days*** to effectively suppress mosquito production. The Clean Water Program has prepared a Vector Control Plan that includes mosquito control design guidance and maintenance guidance for treatment measures, which focus on mosquito control. This guidance is included in Appendix G.

CONSIDER ACCESS

The maintenance agreement for your project will need to guarantee access permission for local municipality staff, the Alameda County Mosquito Abatement District and Water Board staff to enter the property to verify that maintenance is being conducted in accordance with the maintenance plan, throughout the life of the project. Make sure stormwater treatment and structural HM measures are ***readily accessible to the inspectors***, and contact municipal staff to determine whether easements will be needed. Stormwater treatment and structural HM measures must also be accessible to equipment needed to maintain them. Maintenance needs vary by the type of treatment measure that is used. Review the maintenance requirements described in Section 8.2 to identify the accessibility needs for maintenance equipment. By nature, it is more difficult to provide adequate access for below-ground treatment measures than above-ground treatment measures.

8.1.3 Documentation Required with Permit Application

As part of the building permit application, project applicants typically need to prepare and submit the documents listed below. ***Check with the local jurisdiction*** for exact requirements.

- A legible conceptual plan of the site, clearly showing the locations of stormwater treatment measures. Letter-sized plans are preferred; legal-sized plans may be accepted.
- Detailed maintenance plan for stormwater treatment and structural HM measures, including inspection checklists, as appropriate.
- A standard treatment measure O&M report form, to be attached to a maintenance agreement, or other maintenance assurance.

Please note that requirements may vary from one jurisdiction to another. Ask the staff from the local municipality if there are any additional requirements. Appendix H includes templates to assist project applicants in preparing their standard treatment measure O&M report form and maintenance plan. Guidance on preparing these documents is provided in Section 8.2.

8.1.4 Maintenance Agreement or Other Maintenance Assurance

Where a property owner is responsible for maintenance, the property owner is required to enter into a maintenance agreement with the municipality to ensure long-term maintenance of treatment and structural HM measures. The agreement will be ***recorded against the property*** to run with the title of the land. Contact your local jurisdiction to obtain a copy of its standard maintenance agreement. The maintenance agreements require property owners to conduct maintenance inspections of all stormwater treatment measures, and – depending on the municipality – may require the annual submittal of a Standard Treatment Operation and Maintenance Inspection Report form.

For residential properties where the stormwater treatment measures are located within a common area that will be maintained by a homeowner's association, language regarding the responsibility for maintenance must be included in the project's conditions, covenants and restrictions (CC&Rs). Printed educational materials regarding on-site stormwater controls are typically required to be included with the first, and any subsequent, deed transfer. The educational materials typically include the following information:

- Explain the post-construction stormwater controls requirements;

- Provide information on what stormwater controls are present;
- Describe the need for maintenance;
- Explain how necessary maintenance can be performed; and
- For the initial deed transfer, describe the assistance that the project applicant can provide.

If stormwater treatment measures are proposed to be located in a public area for transfer to the municipality, these treatment measures must meet the design guidelines specified in Chapter 6 and shall remain the property owner's responsibility for maintenance until the treatment measures are accepted for transfer.

8.1.5 Ongoing Inspections and Maintenance

After the maintenance agreement is executed, or the municipality approves other maintenance assurance such as CC&Rs, the party responsible for maintenance begins to implement the maintenance plan. Inspection reports are submitted to the municipality as required by the maintenance agreement, or other maintenance assurance.

> The municipality, Water Board and Mosquito Abatement District staff may conduct ***O&M verification inspections*** to make sure that treatment and HM measures are maintained.

The municipality, Water Board and Alameda County Mosquito Abatement District may conduct ***operation and maintenance verification inspections*** to make sure that stormwater treatment measures are being maintained. In the event adequate maintenance is not conducted, the municipality will take necessary steps to restore the treatment measures to good working order. The property owner will be responsible for reimbursing the municipality for expenditures associated with restoring the treatment measures to good working order.

8.2 Preparing Maintenance-Related Documents

This section provides instructions for preparing the following documents that will typically be required as parts of the building permit application, if your project includes stormwater treatment measures and/or structural HM measures:

- A standard treatment measure O&M report form
- A maintenance plan, including a schedule of maintenance activities.

8.2.1 Standard Treatment Measure O&M Report Form

The municipality may require the property owner, or other responsible party, to submit an annual report summarizing the maintenance and inspections of treatment measures included in the project. To standardize and simplify the reporting process, the property owner submits a "Standard Treatment Measure O&M Report Form" with the building permit application, and the municipality includes the report form as an Exhibit to the maintenance agreement. After the agreement is executed, the property owner, or other responsible party, uses this form to prepare the annual report, which is typically submitted by December 31 of each calendar year.

When submitting the completed report form each year, the responsible party will typically be required to attach the inspection forms that were completed during that calendar year.

To help you prepare your Standard Treatment Measure O&M Report Form, a template is included in Appendix H. ***Check with the local jurisdiction*** for an electronic version of the template.

When using the template to prepare your report form, please insert project-specific information where you find highlighted prompts such as the following:

[[== insert name of property owner/responsible party ==]]

8.2.2 Maintenance Plan

The maintenance plan must be sufficiently detailed to demonstrate to the municipality that stormwater treatment measures and/or structural HM measures will receive ***adequate inspections and maintenance*** to continue functioning as designed over the life of the project. A maintenance plan typically includes the following elements:

- Contact information for the property owner or other responsible party.
- Project address and, if required, the Assessors Parcel Number and directions to the site.
- Identification of the number, type and location of all stormwater treatment/structural HM measures on the site.
- A list of specific, routine maintenance tasks that will be conducted, and the intervals at which they are conducted. (For example, "Inspect treatment measure once a month, using the attached checklist.")
- An inspection checklist, specific to the treatment/HM measure(s) included in your project, which indicates the items that will be reviewed during regular maintenance inspections. You will typically be required to submit completed inspection forms as part of the annual Stormwater Treatment Measure O&M Report, as described in Section 8.2.1.

The following materials are available to help you prepare your maintenance plan:

- Maintenance plan templates included in Appendix H. Electronic versions of the templates are available at www.cleanwaterprogram.org (Click on "Businesses," then "Development Related Issues," and go to Appendix H of the C.3 Technical Guidance.
- A list of common maintenance concerns for the frequently used stormwater treatment measures, provided below.

Maintenance plan templates are provided, in Appendix H, for commonly-used stormwater treatment measures.

When using a template to prepare your maintenance plan, please insert project-specific information where you find prompts such as the following: [[== insert name of property owner/responsible party ==]]. Each template includes sample inspection checklists. If your project includes different treatment/HM measures, you may also refer to the ***treatment measure-specific maintenance information*** presented in the following paragraphs.

BIORETENTION AREAS[1] – COMMON MAINTENANCE CONCERNS:

The primary maintenance requirement for bioretention areas is the regular inspection and repair or replacement of the treatment measure's components. Generally, the level of effort is similar to the routine, periodic maintenance of any landscaped area.

- Conduct monthly inspections as follows:
  - Inspect bioretention area for obstructions and trash.
  - Inspect bioretention area for ponded water. If ponded water does not drain within five days, remove surface soils and replace with sand. If mosquito larvae are observed, contact the Alameda County Mosquito Abatement District at 510/783-7744. (In Albany, contact the Alameda County Vector Control District, at 510/567-6800.)
  - Inspect inlets for channels, exposure of soils, or other evidence of erosion. Clear any obstructions and remove any accumulation of sediment.
- Conduct a biannual (twice yearly) evaluation of the health of any plants, and remove any dead or diseased vegetation.
- Treat diseased vegetation, as needed, using preventative and low-toxic measures to the extent possible, and replace any dead plants.
- The use of pesticides and quick-release synthetic fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Maintain vegetation and the irrigation system. Prune and weed, as needed, to keep the bioretention area neat and orderly in appearance.
- Inspect and, if needed, replace mulch before the wet season begins. Mulch should be replaced when erosion is evident or when the bioretention area begins to look unattractive. The entire area may need mulch replacement every two to three years, although spot mulching may be sufficient when there are random void areas.

Figure 8-1: Bioretention Area in the City of Fremont

[1] A bioretention area that is unlined and has a raised underdrain in the underlying rock layer to promote infiltration, as shown in Section 6.1, may also be called a "bioinfiltration area".

FLOW-THROUGH PLANTERS – COMMON MAINTENANCE CONCERNS:

Maintenance objectives include maintaining healthy vegetation at an appropriate size; avoiding clogging; and ensuring the structural integrity of the planter and the proper functioning of inlets, outlets, and the high-flow bypass.

- Conduct a biannual (twice yearly) evaluation of the health of the vegetation and remove and replace any dead or dying plants.
- Treat diseased vegetation, as needed, using preventative and low-toxic measures to the extent possible.
- The use of pesticides and quick-release synthetic fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Maintain vegetation and the irrigation system. Prune and weed as needed to keep the flow-through planter neat and orderly in appearance. Prune or remove any overgrown plants or shrubs that may interfere with planter operation. Clean up fallen leaves or debris.
- Before the wet season begins, check that the soil is at the appropriate depth to allow water to temporarily pond above the soil surface and is sufficient to effectively filter stormwater. Remove any accumulations of sediment, litter, and debris. Till or replace soil (specify sandy loam), as necessary. Confirm that soil is not clogging and that the planter will drain within 3-4 hours after a storm event. Inspect and, if needed, replenish mulch.
- Inspect planter box periodically, and after storms, to ensure structural integrity of the box and that the planter has not clogged.
- Periodically inspect downspouts from rooftops or sheet flow from paving to ensure that flow to the planter is unimpeded. Remove any debris and repair any damaged pipes. Check splash blocks or rocks and repair, replace or replenish as necessary.
- Periodically inspect the overflow pipe to make sure that it can safely convey excess flows to a storm drain. Repair or replace any damaged or disconnected piping.

Figure 8-2: Flow through planter in the City of Emeryville

TREE WELL FILTERS – COMMON MAINTENANCE CONCERNS:

Some manufacturers require a maintenance agreement, under which the manufacturer conducts the maintenance. The following maintenance requirements are typical:

- Conduct a biannual (twice yearly) evaluation of the health of trees and any ground cover. Remove any dead, dying, or missing vegetation.
- Treat diseased vegetation, as needed, using preventative and low-toxic measures to the extent possible.
- The use of pesticides and quick-release synthetic fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Maintain vegetation and the irrigation system. Prune and weed as needed to keep the tree well filter neat and orderly in appearance. Clean up fallen leaves or debris.
- Before the wet season begins, check that the media is at the appropriate depth. Remove any accumulations of sediment, litter, and debris. Confirm that the tree well filter is not clogging and will drain per design specifications. Till or replace the media as necessary.
- Inspect tree well filter periodically, and after storms, to ensure that it has not clogged.
- Periodically inspect the overflow pipe to make sure that it can safely convey excess flows to a storm drain. Repair or replace any damaged or disconnected piping.

Figure 8-3: Series of non-proprietary tree well filters installed along roadway, City of Fremont

VEGETATED BUFFER STRIPS – COMMON MAINTENANCE CONCERNS:

Vegetated buffer strips mainly require vegetation management. Typical maintenance requirements are as follow:

- Mow and irrigate during dry weather to the extent necessary to keep vegetation alive. Where six-inch high grasses are used, the grass height shall be at least three inches after mowing. Where mowed grasses are shown on the plans, the grass shall be mowed when the height exceeds three inches. Dispose of grass clippings properly.
- Remove obstructions and trash from the vegetated buffer strip.
- Conduct monthly inspections as follows:
  - Inspect vegetated buffer strip for and remove obstructions and trash,
  - Confirm that any ponded flow drains within five days after a rainfall event. If ponding is observed for longer than five days, grading is required to improve positive drainage.
  - Confirm that grasses are in good condition.
  - Identify and correct any erosion problems.
- The use of pesticides and quick-release synthetic fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.

Figure 8-4: Vegetated Buffer Strip (Source: California Stormwater Quality Association, 2003)

INFILTRATION TRENCHES – COMMON MAINTENANCE CONCERNS:

The primary maintenance objective is to prevent clogging, which may lead to trench failure. Typical inspection and maintenance tasks are as follows:

- Inspect infiltration trench after large storm events and remove any accumulated debris or material.
- Check the observation well 2 to 3 days after storms to confirm drainage.
- Repair any erosion at inflow or overflow structures.
- Conduct thorough inspection annually, including monitoring of the observation well to confirm that the trench is draining within the specified time.
- Trenches with filter fabric should be inspected annually for sediment deposits by removing a small section of the top layer.
- If inspection indicates that the trench is partially or completely clogged, it shall be restored to its design condition.
- Mow and trim vegetation around the trench as needed to maintain a neat and orderly appearance.
- The use of pesticides and quick-release synthetic fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Routinely remove trash, grass clippings and other debris from the trench perimeter and dispose of these materials properly. Trees or other large vegetation should be prevented from growing adjacent to the trench to prevent damage to the trench.

Figure 8-5: Infiltration Trench (Source: California Stormwater Quality Association)

EXTENDED DETENTION BASINS – COMMON MAINTENANCE CONCERNS:

Primary maintenance activities include vegetation management and sediment removal, although mosquito control is a concern in extended detention basins that are designed to include pools of standing water. The typical maintenance requirements include:

- Maintenance activities at the bottom of the basin shall NOT be performed with heavy equipment, which would compact the soil and limit infiltration.
- Harvest vegetation annually, during the summer.
- Trim vegetation at beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and mosquito control reasons.
- The use of pesticides and quick-release synthetic fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Conduct a biannual (twice yearly) evaluation of the health of the vegetation and remove and replace any dead or dying plants.
- Conduct semiannual inspection as follows
  - Inspect the outlet, embankments, dikes, berms, and side slopes for structural integrity and signs of erosion.
  - Examine outlets and overflow structures and remove any debris plugging the outlets. Identify and minimize any sources of sediment and debris. Check rocks or other erosion control and replace, if necessary.
  - Check inlets to make sure piping is intact and not plugged. Remove accumulated sediment and debris near the inlet.
  - Inspect for standing water and correct any problems that prevent the extended detention basin from draining as designed.
  - If you observe mosquito larvae, contact Alameda County Mosquito Abatement District, 510/783-7744. (In Albany, Alameda County Vector Control District, 510/567-6800.)
  - Check for slope stability and the presence of rodent burrows. Fill in any holes detected in the side slopes.
  - Inspect for and remove any trash and debris.
  - Confirm that any fences around the facility are secure.
  - Check for sediment accumulation.
- Remove sediment from the forebay when the sediment level reaches the level shown on the fixed vertical sediment marker.
- Remove accumulated sediment and regrade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume.
- Remove accumulated trash and debris from the basin at the middle and end of wet season (January and April), or as needed.

Figure 8-6: Extended Detention Basin, Palo Alto

PERVIOUS CONCRETE AND ASPHALT – COMMON MAINTENANCE CONCERNS:

Standards for Ongoing Maintenance and Upkeep:

- Keep landscaped areas well maintained.
- Prevent soil from washing on to the pavement. Pervious pavement surface shall be vacuum cleaned using commercially available sweeping machines at following times:
  - End of winter (April)
  - Mid-summer (July / August)
  - After autumn leaf-fall (November)
- Inspect outlets yearly, preferably before wet season. Remove accumulated trash/debris.
- When vacuum cleaning, inspect pervious paving for any signs of hydraulic failure.

As needed maintenance:

- If routine cleaning does not restore infiltration rates, then reconstruction of part of the pervious surface may be required.
- The surface area affected by hydraulic failure should be lifted, if possible, for inspection of the internal materials to identify the location and extent of the blockage.
- Surface materials should be lifted and replaced after brush cleaning. Geotextiles may need complete replacement.
- Sub-surface layers may need cleaning and replacing.
- Removed silts may need to be disposed of as controlled waste.

Figure 8-7: Parking Lot with Pervious Pavement, Emeryville

TURF BLOCK AND PERMEABLE JOINT PAVERS – COMMON MAINTENANCE CONCERNS:

Routine maintenance:

- Keep landscaped areas well maintained.
- The surface of the unplanted turf block and permeable joint pavers shall be vacuum cleaned (if joints are tight, i.e., no sand filling) using commercially available sweeping machines at the following times:
  - End of winter (April)
  - Mid-summer (July / August)
  - After autumn leaf-fall (November)
- Planted turf block can be mowed, as needed.
- Inspect outlets yearly, preferably before the wet season. Remove accumulated trash and debris.
- When vacuum cleaning is conducted, inspect turf block and permeable joint pavers for any signs of hydraulic failure.

As needed maintenance:

- If routine cleaning does not restore infiltration rates, then reconstruction of the pervious surface area that is not infiltrating is required.
- The surface area affected by hydraulic failure should be lifted, if possible, for inspection of the internal materials to identify the location and extent of the blockage.
- Surface materials should be lifted and replaced if damaged by brush (or abrasive) cleaning.
- Sub-surface layers may need periodic cleaning and replacing.
- Deposits may need to be disposed of as controlled waste.
- Replace permable joint materials, as necessary.

Figure 8-8: Turf block fire access (Source: City of Pleasanton)

RAINWATER HARVESTING AND USE – COMMON MAINTENANCE CONCERNS:

Routine maintenance:

- Conduct annual inspections of backflow prevention systems.
- If rainwater is provided for indoor use, conduct annual water quality testing.
- Clean gutters and first-flush devices at least annually, and as needed, to prevent clogging.
- Conduct regular inspection and replacement of treatment system components, such as filters and UV lights.
- If the system includes a roof washer, regularly inspect and clean the roof washer to avoid clogging.
- Regularly inspect for and repair leaks.
- Maintenance requirements specific to cisterns:
  - Flush cisterns annually to remove sediment.
  - For buried structures, vacuum removal of sediment is required.
  - Brush the inside surfaces and thoroughly disinfect twice per year.
- Maintenance requirements specific to rain barrels
  - Inspect rain barrels four times per year and after major storms
  - Remove debris from screens as needed.
  - Replace screens, spigots, downspouts, and rain leaders as needed.

Figure 8-9: Rainwater harvesting system, Mills College, Oakland

MEDIA FILTERS – COMMON MAINTENANCE CONCERNS:

Follow manufacturer requirements for maintenance. Clogging is the primary maintenance concern for media filters, although mosquito control is also an issue. Typical maintenance requirements are as follows:

- During the wet season, inspect periodically for standing water, sediment, trash and debris, and to identify potential problems.
- Remove accumulated trash and debris in the sedimentation basin, from the riser pipe, and the filter bed during routine inspections.
- Inspect the media filter once during the wet season after a large rain event to determine whether the facility is draining completely within five days.
- If the facility drain time exceeds five days, remove the top 50 millimeters (2 inches) of sand and dispose of sediment. Restore media depth to 450 millimeters (18 inches) when overall media depth drops to 300 millimeters (12 inches).

Chapter

9

Alternative Compliance

This chapter provides information on using Alternative Compliance options where LID treatment is required.

9.1 What Is Alternative Compliance?

Provision C.3.e of the Municipal Regional Stormwater Permit (MRP) allows municipalities to grant "alternative compliance" to new development or redevelopment projects in lieu of requiring full onsite treatment of the Provision C.3.d amount of stormwater runoff and pollutant loads with low-impact development (LID) measures. ***Projects that receive alternative compliance must still provide LID treatment in full,*** but all of the treatment does not have to take place onsite. There are no special eligibility criteria for using alternative compliance. If your project is required to provide LID treatment, it may use alternative compliance to meet these requirements. There is no requirement to make LID impracticability or infeasibility findings in order to use alternative compliance. The MRP offers two options for using alternative compliance, described in Section 9.2, sets deadlines for constructing offsite alternative compliance projects (Section 9.3), and sets a timeline for the alternative compliance provision to take effect.

9.2 Categories of Alternative Compliance

A project may use either of the alternative compliance options listed below.

9.2.1 Option 1: Partial LID treatment at an off-site location

Projects may treat a portion of the required amount of stormwater runoff using LID on-site (or offsite at a "joint treatment facility" that is shared with an adjoining project), and then ***treat the remaining portion of runoff at an offsite project*** within the same watershed. Offsite LID treatment measures must provide an equivalent quantity of hydraulically-sized treatment of both stormwater runoff and pollutant loads and achieve a net environmental benefit.

JOINT TREATMENT FACILITY

A joint treatment facility ***treats the stormwater from more than one property*** at an offsite but nearby location.

OFFSITE EQUIVALENT TREATMENT PROJECT

An offsite equivalent treatment project provides off-site LID treatment for a surface area or volume and pollutant loading of storm water run off, equivalent to that of the proposed new development or redevelopment project for which alternative compliance is sought. Examples of acceptable equivalent treatment projects include the installation of hydraulically-sized LID treatment measures in a nearby parking lot, or other development where hydraulically-sized LID treatment measures were not previously installed.

9.2.2 Option 2: Payment of in-lieu fees

Projects may treat a portion of the required amount of stormwater runoff using LID on-site or offsite at a joint treatment facility and ***pay equivalent in-lieu fees to treat the remaining amount*** of stormwater runoff with LID treatment measures at a Regional Project.

IN-LIEU FEES

In-lieu fees provide the monetary amount necessary to treat an equivalent quantity of stormwater runoff and pollutant loading with hydraulically-sized LID treatment measures at a Regional Project ***and*** the monetary amount necessary to share a proportionate amount of the operation and maintenance costs of the Regional Project.

REGIONAL PROJECT

A regional project is a regional or municipal stormwater treatment facility located in the same watershed as the project seeking alternative compliance.

9.3 Offsite or Regional Project completion deadlines

9.3.1 Timeline for construction of offsite project

Construction of the offsite LID treatment project must be completed by the time the subject project is completed. If the offsite project is not completed in time, the offsite project must, for each additional year up to three years, provide additional treatment of 10% of the required amount of stormwater runoff and pollutant loads. For example, an offsite project completed two years after the subject project would be required to treat, using LID treatment measures, 20% more stormwater runoff and pollutant loads than it would had the offsite project been completed in time.

9.3.2 Timeline for construction of a Regional Project

The regional project must be completed within three years of the subject project. This can be extended to five years only with Regional Water Board approval. In order for the Water Board to grant the extension to five years, the applicant must have demonstrated good-faith efforts to implement the regional project by applying for the necessary permits and having the necessary funds encumbered for project completion.

9.4 When Does the Alternative Compliance Provision Take Effect?

The use of alternative compliance is optional, but if it is used, the projects must comply with the MRP requirements for implementing alternative compliance ***beginning December 1, 2011***. Any private projects deemed complete before December 1, 2009, that incorporated alternative compliance under the previous municipal stormwater permit are not subject to the MRP requirements for alternative compliance, if the project has been diligently pursued[1] by the project applicant. The requirements for Alternative Compliance do not apply to public projects for which funding has been committed and construction is scheduled to begin by December 1, 2012.

[1] Diligent pursuance may be demonstrated by the project applicant's submittal of supplemental information to the original application, plans, or other documents required for any necessary approvals of the project.

References

American Society of Civil Engineers. 1992. Design and Construction of Sanitary and Storm sewers, Manual of Engineering Practice No. 77.

Atlanta Regional Commission (ARC) / Georgia Department of Natural Resources-Environmental Protection Division. 2003. Georgia Stormwater Management Manual.

Bay Area Stormwater Agencies Association (BASMAA). 1999. Start at the Source.

BASMAA. 2003. Using Site Design Techniques to Meet Development Standards for Stormwater Quality: A Companion Document to Start at the Source.

BASMAA. 2011. Harvest and Use, Infiltration and Evapotranspiration Feasbility/Infeasibility Criteria Report.

Beyerlein, Douglas. May/June 2005. "Flow Duration-Based Stormwater Mitigation Modeling," in *Stormwater*. http://www.stormh2o.com/sw_0505_flow.html

California Stormwater Quality Association (CASQA) 2003. Storm water Best Management Practice Handbook: New Development and Redevelopment.

Caltrans. 2002. Stormwater Quality Handbook: Project Planning and Design Guide.

Cities of Citrus Heights, Elk Grove, Folsom, Galt, Rancho Cordova, Roseville and Sacramento, and the County of Sacramento. 2007. Stormwater Quality Design Manual for Sacramento and South Placer Regions.

City of Emeryville. 2005. Stormwater Guidelines for Green, Dense Development: Storwmater Quality Solutions for the City of Emeryville.

City of Milpitas. 2005. Milpitas C.3 Stormwater Guidebook, 3rd Edition.

City of Portland, Oregon. 2004. Stormwater Management Manual. http://www.portlandonline.com/bes/index.cfm?c=35117

CONTECH Stormwater Solutions, affiliated with CONTECH Construction Products, Inc., 2006. http://www.contech-cpi.com/stormwater/products/14.

Contra Costa Clean Water Program. January 2005. Contra Costa County Stormwater Quality Requirements for Development Applications. Stormwater C.3 Guidebook, 3rd Draft.

Contra Costa Clean Water Program, November 16, 2005. Policy on the Use of Hydrodynamic Separators to Achieve Compliance with NPDES Provision C.3.

Contra Costa Clean Water Program. March 2005. C.3 Stormwater Guidebook, 2nd Edition.

Americast 2006. Filterra Product Information, www.americastusa.com/filterra.html.

County of Sonoma and City of Santa Rosa. 2005. Santa Rosa Area Standard Urban Stormwater Management Guidelines.

Decker, Thomas R. January/February 2006. "Specifying and Permitting Alternative MTDs", in *Stormwater.*

Maryland Department of Environment. 2000. Maryland Stormwater Design Manual.
Metzger, M.E., Messer, D.F., Beitia, C.L, Myers, C.M., Kramer, V.L. April 8, 2003. The Dark Side of Stormwater Runoff Management: Disease Vectors Associated with Structural BMPs. [Online] http://www.forester.net/sw_0203_dark.html.

Melbourne Water (Melbourne Australia). 2006. wsd.melbournewater.com.au.

Montana State University Extension. 2006. Rainwater Harvesting Systems for Montana. http://msuextension.org/publications/agandnaturalresources/mt199707ag.pdf

Northeast Georgia Regional Development Center (NG RDC) and Georgia Department of Natural Resources (GDNR). 2005/06. Aquatics Study Materials.

Prince George's County (Maryland) Department of Environmental Resources (PGDER). 1993. Design Manual for Use of Bioretention in Stormwater Management.

San Francisco Bay Regional Water Quality Control Board (RWQCB). 1994. "Policy on the Use of Constructed Wetlands for Urban Runoff Pollution Control" (Resolution No. 94-102).

San Francisco Bay RWQCB. 2004. Basin Plan. http://www.waterboards.ca.gov/sanfranciscobay/basinplan.htm

San Francisco Bay RWQCB. October 2009. Order No. R2-2009-0074 Issuing NPDES Permit No. CAS612008, Municipal Regional Stormwater Permit.

San Francisco Bay RWQCB. November 28, 2011. Order Amending NPDES Permit No. CAS612008, Municipal Regional Stormwater Permit.

Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP). April 2004. Developments Protecting Water Quality: A Guidebook of Site Design Examples.

SCVURPPP. May 2004. C.3 Stormwater Handbook:

Texas Water Development Board. 2005. Texas Rainwater Harvesting Manual, 3rd edition. http://www.twdb.state.tx.us/publications/reports/rainwaterharvestingmanual_3rdedition.pdf

University of New Hampshire Environmental Research Group, 2006. Tree Box Filter Fact Sheet, www.unh.edu/erg/cstev.

US Army Co rps of Eng ineers (US AC OE). 1 977. Stor age, Treatment, Overf low, Run off Model (STORM) Users Manual.

US Environmental Protection Agency (US EPA). 2003. Protecting Water Quality from Urban Runoff [fact sheet]. www.epa.gov/npdes/pubs/nps_urban-facts_final.pdf

USEPA. No Date. Stormwater Frequently Asked Questions. http://cfpub.epa.gov/npdes/faqs.cfm?program_id=6

Water Environment Federation (WEF) Manual of Practice No. 23/ American Society of Civil Engineers (ASCE) Manual and Report on Engineering Practice No. 87. 1998. Urban Runoff Quality Management.

Wolfe, Bruce H., Executive Officer of the San Francisco Bay Regional Water Quality Control Board. August 5, 2004. Letter to BASMAA Managers.

Appendix A

Local Requirements

Each of the Countywide Program's 17 member agencies may have its own requirements that must be met in the C.3 stormwater submittals that are included with planning and building permit applications. Some of the agencies have made this information available on their websites, as listed below. Contact information for all member agencies is provided on the first page of the Technical Guidance, before the Table of Contents.

Emeryville

Emeryville's ***Stormwater Treatment Requirements*** are described at the following link: www.ci.emeryville.ca.us/index.aspx?nid=335

Stormwater Treatment Requirements information can also be accessed by going to www.ci.emeryville.ca.us, then clicking on "Departments," then "Public Works," then Environmental Services," then "Stormwater."

Fremont

Fremont's stormwater ***Development Submittal Requirements*** are described on Fremont's website at the following link: www.fremont.gov/index.aspx?NID=482.

The Development Submittal Requirements page can also be accessed by going to www.fremont.gov, then clicking on "Departments," then "Environmental Services," then "Stormwater Regulations," then "Development Submittal Requirements."

Appendix

B

Plant List and Planting Guidance for Landscape-Based Stormwater Measures

Table of Contents

B.1 Intr oduction

The purpose of this ap pendix is to provide guidance on the planting techniques and selection of appropriate plant materials for the stormwater measures described in this handbook.

The plant lists described in this appendix are not prescriptive, but should serve as a guide. In selecting pl ant mat erials, it is important t o consider fa ctors that influence pl ant establishment and success, su ch as microclimate , typ e of soil, wa ter ava ilability, proxim ity to saltwater and exposure to sun. Numero us re sources are availa ble to assist in selecting ap propriate p lant species in A lameda Co unty, in cluding Sunset 's *Western Gar den Book* a nd t he Ea st Bay Municipal Util ity Dis trict's *Plants an d Landscapes for S ummer-Dry Clim ates of t he Sa n Francisco Bay Region.*

In addition, the function of the individual stormwater measure should be carefully considered when selecting plant materials. Factors to be considered include inundation period, expected flow of water, and access and maintenance requirements.

The plant lists described in this appendix are not prescriptive, but should ***serve as a guide.*** In selecting plant materials, it is important to consider factors that influence plant establishment and success, such as microclimate, type of soil, water availability, proximity to saltwater and exposure to sun.

B.2 General Recommendations

Avoid the use of invasive species. In selecting plants for stormwater measures, the use of invasive species should be avoided. A complete list of invasive plants can be found at www.cal-ipc.org, the California Invasive Plant Council's Invasive Plant Inventory.

Minimize or eliminate the use of irrigated turf. Effort should be made to minimize the use of irrigated turf, which has higher maintenance requirements and greater potential for polluted runoff.

Select California natives and/or drought tolerant plants. Planting appropriate, drought tolerant California natives or Mediterranean plants reduces water consumption for irrigations, and reduces mowing, fertilizing, and spraying. For the purposes of the plant list on the following pages, "drought tolerant" refers to plants that meet the following critieria:

- Are identified as drought tolerant as follows: California Native Plants for the Garden (Borstein, et al.).
- Are identified as requiring occasional or infrequent irrigation in Borstein, et al., or Plants and Landscapes for Summer Dry Climates (EBMUD).
- Are identified as requiring no summer water in EBMUD.
- Are identified as requiring little or no water in the Sunset Western Garden Book.
- Are identified as requiring low or very low irrigation in the Guide to Estimateing Irrigation Water Needs of Landscape Plantings in California (University of California Cooperative Extension).

Plants not listed in any of the above references will require that the design professional base selection upon successful experience with species on previous projects under similar horticultural conditions.

Site-specific Factors. Given Alameda County spans several Sunset climate zones, with variable humidity, heat, frost, and wind factors, as well as varying soil characteristics, plants need to be selected with an understanding of specific climate and microclimate conditions, and grouped in appropriate hydrozones.

Supplemental watering needs. Many plants listed as drought tolerant per the above references may require more supplemental watering in fast-draining, engineered soils.

B.3 Plants for Stormwater Measures

Plants play an important role in the function of landscape-based stormwater treatment measures:

- Infiltration and evapotranspiration. Plants aid in the reduction of stormwater runoff by both increasing infiltration, and by returning water to the atmosphere through evapotranspiration.
- Sedimentation. Some stormwater treatment measures, such as vegetated swales and vegetated buffer strips, are designed to remove coarse solids through sedimentation that is aided by dense, low-growing vegetation.
- Pollutant trapping. Vegetation helps to prevent the resuspension of pollutants associated with sediment particles. It is essential that pollutants removed during small storms are not remobilized during large storms.
- Phytoremediation. Plants for stormwater treatment measures are important for their role in phytoremediation, the uptake of nutrients and the ability to neutralize pollutants.
- Soil stabilization. As in any landscaped area, established plantings help control soil erosion. This is important both to keep sediment out of stormwater and to retain the surface soils, which help to remove pollutants from infiltrated runoff.
- Aesthetic benefits. Plants within or adjacent to stormwater facilities provide an aesthetic benefit.

Plants suitable for use in stormwater treatment measures are organized according to the following categories:

- **Emergent** refers to those species which occur on saturated soils or on soils covered with water for most of the growing season. The foliage of emergent aquatics is partly or entirely borne above the water surface.
- **Grasses** refer to those species that are monocotyledonous plants with slender-leaved herbage found in the in the Family Poaceae.
- **Herbaceous** refers to those species with soft upper growth rather than woody growth. Some species will die back to the roots at the end of the growing season and grow again at the start of the next season. Annuals, biennials and perennials may be herbaceous.
- **Shrub** is a horticultural distinction that refers to those species of woody plants which are distinguished from trees by their multiple stems and lower height. A large number of plants can be either shrubs or trees, depending on the growing conditions they experience.
- **Tree** refers to those species of woody plants with one main trunk and a rather distinct and elevated head.

Plants suitable for use in stormwater treatment measures are listed in two ways. First, a comprehensive list of all recommended plant species is provided in Table B-1, which lists the plants in alphabetical order by Latin name, in the categories described above. The columns in Table B-1 indicate stormwater treatment measures for which each plant species may be suitable. Following Table B-1 are brief descriptions of the stormwater measures for which technical guidance is included in this handbook, including the suitable plantings from Table B-1.

Invasive species. Under no circumstances shall any plants listed as invasive under http://www.cal-ipc.org/ip/inventory/weedlist.php be specified.

Table B-1 Plant List for Stormwater Measures

		Bioretention Area - including linear treatment measure	Flow-Through Planters	Tree Well Filters[2]	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - intensive	California Native	Drought Tolerant^
Emergent Species													
Artemisia douglasiana	mugwort						✓	✓				✓	
Carex barbarae	Santa Barbara sedge				✓		✓	✓		✓	✓	✓	✓
Carex densa	dense sedge						✓	✓				✓	
Carex obnupta	slough sedge						✓	✓				✓	
Eleocharis macrostachya	creeping spikerush					✓	✓	✓				✓	
Hydrocotyle ranunculoides	marsh pennywort		✓					✓				✓	
Juncus balitcus [1]	baltic rush						✓	✓				✓	
Juncus bufonius	toad rush						✓	✓				✓	
Juncus effusus [1]	Pacific rush						✓	✓				✓	
Juncus leseurii	common rush						✓	✓				✓	
Juncus mexicanus	Mexican rush						✓	✓				✓	
Juncus patens	blue rush	✓	✓		✓	✓	✓	✓			✓	✓	✓
Juncus xiphioides	iris-leaved rush						✓	✓				✓	
Limonium californicum	Marsh rosemary						✓	✓				✓	✓
Phragmites spp.	common reeds						✓	✓					
Scirpus actutus	tule						✓	✓				✓	
Scirpus americanus [1]	three square	✓					✓	✓				✓	
Scirpus californicus [1]	california bulrush						✓	✓				✓	
Spartina foliosa	California cordgrass						✓	✓				✓	
Typha angustifolia	narrowleaf cattail						✓	✓				✓	
Typha latifolia	cattail						✓	✓				✓	
Grass Species													
Agrostis exarata	spike bentgrass						✓	✓	✓			✓	
Alopecurus aequalis	shortawn foxtail						✓	✓				✓	
Alopecurus saccatus	Pacific foxtail						✓	✓				✓	
Aristida purpurea	Purple three-awn	✓	✓		✓						✓	✓	✓
Carex pansa	California meadow sedge			✓	✓		✓	✓	✓	✓	✓	✓	✓
Carex praegracilus	clustered field sedge						✓	✓				✓	
Carex divulsa (tumulicola)	Berkeley sedge							✓				✓	
Chondropetalum tectorum	cape rush	✓	✓		✓	✓	✓	✓			✓		✓
Danthonia californica	California oatgrass						✓	✓				✓	
Deschampsia cespitosa [1]	tufted hairgrass	✓			✓	✓	✓	✓			✓	✓	✓
Deschampsia cespitosa ssp. holciformis	Pacific hairgrass	✓			✓	✓	✓	✓			✓	✓	✓
Deschampsia danthonioides	annual hairgrass						✓	✓			✓	✓	
Distichlis spicata	salt grass						✓	✓				✓	
Eleocharis palustris	creeping spikerush						✓	✓				✓	
Elymus glaucus	blue wild rye	✓			✓			✓		✓	✓	✓	✓
Festuca californica	California fescue	✓	✓	✓	✓						✓	✓	✓
Festuca idahoensis	Idaho fescue		✓	✓	✓				✓		✓	✓	
Festuca rubra[1]	red fescue		✓	✓	✓				✓		✓	✓	✓
Festuca rubra 'molate'	Molate fescue		✓	✓	✓				✓		✓	✓	✓
Hordeum brachyantherum [1]	meadow barley	✓			✓		✓	✓				✓	✓
Leymus triticoides	creeping wildrye	✓			✓	✓		✓			✓	✓	✓
Linum usitatissimum [1]	flax	✓	✓										✓
Lolium perenne [1]	ryegrass	✓	✓			✓							
Melica californica	California melic				✓							✓	✓
Grass Species cont'd													
Melica imperfecta	coast range melic	✓	✓		✓							✓	✓
Muhlenbergia rigens	deergrass	✓	✓		✓	✓	✓	✓			✓	✓	✓

** Denotes riparian species with limited drought tolerance*
[1] Denotes species with phytoremediation capabilities
[2] Non-tree species to be used only with adequate planting surface and when infiltration rates are 5-10 inches/hour

Table B-1 Plant List for Stormwater Measures

Species	Common name	Bioretention Area - including linear treatment measure	Flow-Through Planters	Tree Well Filters[2]	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - intensive	California Native	Drought Tolerant^
Nasella pulchra	purple needlegrass	✓		✓	✓	✓					✓	✓	✓
Nassella lepida	Foothill needlegrass			✓	✓	✓					✓	✓	✓
Panicum coloratum [1]	kleingrass	✓	✓		✓	✓							
Panicum virgatum [1]	switchgrass	✓	✓		✓	✓							
Phalaris californica	California canarygrass	✓			✓	✓						✓	
Pleuropogon californicus	semaphore grass				✓	✓						✓	
Sisyrinchium bellum	blue-eyed grass		✓		✓	✓				✓		✓	✓
Sisyrinchium douglasii	purple-eyed grass					✓				✓		✓	
Herbaceous Species													
Achillea millefolium [1]	common yarrow		✓	✓	✓					✓	✓	✓	✓
Allium spp.	wild onion	✓	✓		✓					✓	✓		
Anthemis nobilis (Chamaemelum nobile)	chamomile			✓					✓				✓
Armeria maritima	sea pink		✓	✓	✓					✓	✓	✓	✓
Clarkia spp.	Clarkia	✓			✓					✓	✓	✓	✓
Epilobium densiflorum	dense spike-primrose	✓	✓		✓	✓						✓	✓
Eriogonum latifolium	coast buckwheat			✓	✓							✓	✓
Eriogonum fasciculatum	flattop buckwheat			✓	✓							✓	✓
Eschscholzia californica	California poppy	✓	✓		✓				✓	✓	✓	✓	✓
Layia platyglossa	tidy tips				✓					✓	✓	✓	✓
Limonium californicum	marsh rosemary	✓	✓		✓	✓	✓	✓				✓	✓
Linanthus spp.	Linanthus	✓			✓					✓	✓	✓	✓
Lotus scoparius	deerweed	✓			✓					✓	✓	✓	✓
Mimulus aurantiacus	common monkeyflower	✓	✓		✓						✓	✓	✓
Mimulus cardinalis	scarlet monkeyflower	✓	✓	✓	✓		✓	✓			✓	✓	
Monardella spp.	coyote mint	✓			✓							✓	✓
Nepeta spp.	catmint	✓		✓	✓						✓		✓
Penstemon spp.	bearded tongue	✓		✓	✓						✓	✓	✓
Sedum spp.	stonecrop				✓					✓	✓		✓
Sempervivum spp.	hen and chicks				✓					✓	✓		✓
Solidago spp. [1]	goldenrod		✓		✓					✓	✓		
Thymus pseudolanuginosus	woolly thyme	✓	✓	✓	✓				✓	✓	✓		
Vigna unguiculata [1]	cowpea		✓		✓						✓		
Shrub Species													
Adenostoma fasciculatum	chamise				✓						✓	✓	✓
Arctostaphylos densiflora 'McMinn'	manzanita 'McMinn'	✓	✓		✓						✓	✓	✓
Arctostaphylos manzanita	common manzanita		✓		✓						✓	✓	✓
Arctostaphylos uva-ursi 'Emerald Carpet'	manzanita 'Emerald Carpet'	✓	✓	✓	✓						✓	✓	✓
Baccharis pilularis 'Twin Peaks'	coyote brush prostrate	✓	✓	✓	✓						✓	✓	✓
Baccharis salicifolia	mulefat				✓		✓	✓				✓	
Buddleia spp.	butterfly bush	✓			✓								✓
Calycanthus occidentalis	Spicebush	✓	✓		✓	✓						✓	✓
Carpenteria californica	bush anemone	✓	✓		✓							✓	✓
Shrub Species cont'd													
Ceanothus hearstiorum	ceanothus	✓			✓						✓	✓	✓
Ceanothus spp.	ceanothus	✓			✓						✓	✓	✓
Cercocarpus betuloides	mountain mahogany				✓							✓	✓
Cistus spp.	rockrose				✓								✓
Cornus sericea (same as C. stolonifera)	western dogwood	✓	✓		✓	✓	✓	✓				✓	
Garrya elliptica	coast silk tassle		✓		✓						✓	✓	✓
Echium candicans	pride-of-madeira		✓		✓						✓		✓
Heteromeles arbutifolia	toyon	✓	✓		✓						✓	✓	✓
Holodiscus sp.	oceanspray	✓			✓							✓	✓
Lavandula spp.	lavender		✓	✓	✓						✓		✓
Lavatera spp.	tree mallow				✓								✓

** Denotes riparian species with limited drought tolerance*
[1] Denotes species with phytoremediation capabilities
[2] Non-tree species to be used only with adequate planting surface and when infiltration rates are 5-10 inches/hour

Table B-1 Plant List for Stormwater Measures

		Bioretention Area - including linear treatment measure	Flow-Through Planters	Tree Well Filters[2]	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - intensive	California Native	Drought Tolerant^
Lepechina calycina	pitcher sage				✓							✓	✓
Lupinus albifrons	bush lupine				✓							✓	✓
Mahonia aquifolium	Oregon grape	✓	✓		✓						✓	✓	✓
Mahonia repens	creeping Oregon grape	✓	✓	✓	✓						✓	✓	✓
Myrica californica	Pacific wax myrtle				✓						✓	✓	✓
Physocarpus capitatus	Pacific ninebark	✓		✓	✓		✓	✓			✓	✓	
Pittosporum tobira	mock orange		✓		✓								✓
Prunus ilicifolia	holleyleaf cherry				✓	✓						✓	✓
Rhamnus Californica	coffeeberry	✓	✓		✓						✓	✓	✓
Rhus integrifolia	lemonade berry				✓							✓	✓
Ribes aureum	golden currant	✓	✓		✓	✓						✓	✓
Ribes malvaceum	chaparral currant				✓							✓	✓
Ribes sanguineum	red-flowering currant				✓							✓	✓
Rosa californica	California wild rose	✓	✓		✓	✓						✓	✓
Rubus parviflorus	thimbleberry	✓	✓		✓	✓						✓	
Rubus spectabilis	salmonberry	✓	✓		✓	✓						✓	
Rubus ursinus	California blackberry	✓			✓							✓	✓
Salvia brandegii	black sage				✓							✓	✓
Salvia clevelandii	Cleveland sage	✓			✓							✓	✓
Salvia leucophylla	purple sage	✓			✓							✓	✓
Salvia melifera	black sage				✓							✓	✓
Salvia sonomensis	creeping sage	✓	✓	✓	✓							✓	✓
Sambucus mexicana	elderberry	✓	✓		✓							✓	✓
Santolina spp.	santolina	✓	✓		✓							✓	✓
Symphoricarpos albus	snowberry		✓		✓							✓	✓
Stachys spp.	lambs ear	✓		✓	✓					✓	✓		✓
Styrax officinalis redivivus	California snowdrop	✓			✓							✓	✓
Trichostema spp.	wooly blue curls	✓			✓						✓	✓	✓
Vaccinium ovatum	evergreen huckleberry	✓	✓		✓							✓	
Zauschneria californica (Epilobium c.)	California fuchsia			✓	✓						✓	✓	✓
Tree Species													
Acer circinatum	Vine Maple	✓		✓	✓	✓					✓	✓	
*Acer macrophyllum**	big leaf maple	✓			✓							✓	
Acer negundo v. Californicum*	box elder	✓		✓	✓	✓	✓	✓				✓	
Aesculus californica	buckeye				✓							✓	✓
*Alnus rhombifolia **	white alder	✓		✓	✓		✓	✓				✓	
*Alnus rubra**	red alder	✓		✓	✓	✓	✓	✓				✓	
Arbutus menziesii	Madrone				✓							✓	✓
Arbutus unedo	strawberry tree				✓						✓		✓
Betula nigra	river birch	✓		✓	✓	✓							
Calocedrus decurrens	incense cedar				✓							✓	
Celtis occidentalis	common hackberry				✓								✓
Cercidium floridum	Blue palo verde				✓							✓	✓
Cercis occidentalis	redbud				✓						✓	✓	✓
Chionanthus retusus	Chinese fringe tree				✓								

** Denotes riparian species with limited drought tolerance*
¹ Denotes species with phytoremediation capabilities
2 Non-tree species to be used only with adequate planting surface and when infiltration rates are 5-10 inches/hour

Table B-1 Plant List for Stormwater Measures

		Bioretention Area - including linear treatment measure	Flow-Through Planters	Tree Well Filters[2]	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - intensive	California Native	Drought Tolerant^
Corylus cornuta v. Californica	California hazelnut	✓		✓	✓							✓	✓
Crataegus	Hawthorn			✓							✓		✓
Fraxinus latifolia	Oregon ash	✓		✓	✓	✓	✓	✓				✓	
Geijera parviflora	Australian willow				✓								
Lagerstroemia spp.	crepe myrtle				✓						✓		✓
Lyanothamnus floribundus asplendifolius	Catalina Ironwood				✓							✓	✓
Morus alba (fruitless var.)¹	white mulberry				✓								
Platanus acerifolia	london plane tree				✓								✓
*Platanus racemosa**	sycamore	✓			✓		✓	✓				✓	
Populus fremontii ¹*	Fremont's cottonwood	✓		✓	✓	✓						✓	
Prunus, spp.	plum				✓								✓
Quercus agrifolia	California live oak				✓							✓	✓
Quercus kellogii	California black oak				✓							✓	✓
Quercus lobata	valley oak	✓			✓							✓	✓
Quercus palustris	pin oak				✓								
Quercus virginiana	Southern live oak			✓									
Salix laevigata¹	red willow	✓			✓	✓	✓	✓				✓	
Salix lasiolepis¹	arroyo willow	✓			✓	✓	✓	✓				✓	
Salix lucida ssp. lasiandra ¹	shining willow	✓			✓	✓	✓	✓				✓	
Sequoia sempervirens	coast redwood				✓		✓	✓				✓	
Umbellularia californica	California bay				✓							✓	

** Denotes riparian species with limited drought tolerance*
¹ Denotes species with phytoremediation capabilities
2 Non-tree species to be used only with adequate planting surface and when infiltration rates are 5-10 inches/hour

A brief paragraph describing each stormwater measure is provided below, including the key factors that should influence planting techniques and plant selection. For suitable plantings, please refer to Table B-1.

Bioretention Area (including linear treatment measures)

Bioretention areas are intended to act as filters with plants. Plants in bioretention areas help with phytoremediation and infiltration. Therefore, nutrient uptake and the ability to neutralize pollutants are priorities for species selection. Plants for these areas should be able to withstand periods of inundation as well as extended periods of drought. Emergent, grass and herbaceous species can be planted in the bioretention area, while shrub and tree species should be concentrated on the outer edges. Grasses can also be planted along the exterior to slow the velocity of flow and allow the sedimentation of coarse solids, which helps minimize clogging of the bioretention area. Supplemental irrigation will be necessary to maintain emergent species during extremely dry conditions.

Flow-through planter

Plant species for flow-through planters will depend on the size of the planter. Shrubs and trees should be planted in planters only when there is sufficient space. Recommended minimum soil depth for shrubs is 18", and for small trees is 36". Plant species should be adapted to well-drained soils. Irrigation is typically required, but selecting plants adapted to extended dry periods can reduce irrigation requirements.

Tree well filter

Trees and shrubs planted in tree well filters should be an appropriate size for the space provided. Because plant roots are confined to the container, it is recommended that small trees and shrubs with shallow, fibrous roots be planted in the tree well filter. Provided that site conditions allow, it may be possible to work with the manufacturer to design a container that would allow for the planting of larger trees or shrubs. Plants for tree well filters should be tolerant of frequent, but temporary periods of inundation as well as adapted to extremely well-drained soils. Species with the ability to neutralize contaminants are preferred.

Vegetated buffer strips

Vegetated buffer strips should be designed to function and appear as natural vegetated areas adjacent to development. They treat surface runoff from adjacent impervious areas so a variety of trees, shrubs, and grass and herbaceous species should be included in order to maximize water and nutrient uptake, as well as to retain sediment.

Infiltration Trench

An infiltration trench is an aggregate filled trench that receives and stores stormwater runoff in the void spaces between the aggregate and allows it to infiltrate into the surrounding soil. Vegetated filter strips of grass species on either side of the trench can slow and pre-treat the runoff while the trench can physically remove fine sediment and other suspended solids.

Extended Detention Basin

Extended detention basins are intended to capture and detain water for much longer periods (up to 5 days) than bioretention areas. They are designed to drain completely between storms. Plants in extended detention basins increase pollutant removal and assist with soil stabilization;

therefore nutrient uptake and the ability to neutralize pollutants are priorities for species selection. Because extended detention basins are intended to capture and move large quantities of water, trees should not be planted in the basins, and shrubs are typically not specified for extended detention basins. Subject to approval by the municipality, trees and shrubs may be included on the outer perimeter (top of bank), provided that they do not interfere with detention. Species should be adapted to periodic inundation and saturation and extended periods of dry conditions. Emergent, grass and herbaceous species for extended detention basins should consists of species that are able withstand extended periods of inundation. Supplemental irrigation will be necessary to maintain emergent species during extremely dry conditions. Extended detention basins typically have typically not been constructed with special soil, and beginning December 1, 2011, basins designed without biotreatment soil (having a long-term infiltration rate of 5 to 10 inches per hour) may not be used as stand-alone treatment measures, although they could be used as part of a treatment train, along with biotreatment measures (more information in Section 6.6). Table B-1 includes two planting lists for extended detention basins: one for basins designed WITH biotreatment soil, and another for basins designed WITHOUT biotreatment soil.

Pervious paving – Turf Block Pavers

Some pervious paving systems can be planted with grass or herbaceous species in order to assist with erosion prevention as well as promote infiltration and pollutant uptake. Plant species should be tolerant of compaction, have the ability to neutralize contaminants, and should not interfere with maintenance and use of the paved surface. Most plant species cannot tolerate frequent vehicular compaction. Therefore, turf block pavers are best suited for areas requiring infrequent access, such as emergency vehicle access routes. Paver manufacturer should be consulted regarding recommended and acceptable plant species.

Green roof

A green roof is intended to capture precipitation and roof runoff. Green roofs utilize a lightweight, porous planting substrate as a medium for plant growth. The depth and composition of this substrate is extremely important in determining types of plants that will be successful as part of a green roof system. Intensive green roofs, which can have up to 48” of substrate, can support a wider variety of plant types. The list in Table B-1 is only a sample of plants that could be suitable for an intensive green roof. Please note that shrub species may be used only if the substrate has a minimum depth of 12 inches; a minimum dept of 36 inches is required for planting trees.

Extensive green roofs, which have a depth of 3” to 7” of planting medium, are suitable for a limited number of grass and herbaceous species. These roofs generally require little maintenance and should be designed to succeed with minimal irrigation. In addition to the species listed in Table B-1, pre-vegetated mats can be utilized on extensive green roofs. Information can be found at:: www.thehenryford.org/rouge/leedlivingroof.aspx.

B.4 Planting Specifications

Planting plans and specifications must be prepared by a qualified professional and coordinated with other site development details and specifications including earthwork, soil preparation and irrigation (if used). Plans indicating a planting layout, with species composition and density, should be prepared on a site-specific basis. Reference Alameda County's Bay Friendly Landscaping Guidelines prepared by Stopwaste.Org (available at www.bayfriendly.org), which outline principles and practices to minimize waste, protect air and water quality, conserve energy and water, and protect natural ecosystems, including:

- Evaluate site and assess the soil;
- Consider potential for fire;
- Select plants for appropriate size upon maturity, do not over-plant;
- Irrigation, if required, should be designed as a high efficiency, water conserving system; and
- Utilize compost (see the specification in the Bay-Friendly Landscaping Guidelines) and mulch to build healthy soils and increase the water holding capacity of the soil.

Propagation and Planting Methods

The propagation methods for different species will vary, depending upon type of plant and stormwater adaptation. In general, container stock will be utilized most commonly for greenroofs, flow-through planters, tree well filters, vegetated swales and buffer strips and infiltration trenches. Bioretention areas and extended detention basins will generally utilize native plants available as transplants (plugs), pole cuttings and seed mixes.

Container Stock. Planting holes for container stock should be twice as wide and only as deep as the container size. Plant spacing should be determined on a site-specific basis. When planting, the root collar and base of the stem should be 1" above the adjacent soil surface. Soils should be backfilled and tamped down to assure contact with the roots. The planting should be watered-in promptly to promote the settling of soil. If appropriate, container plantings may receive a balanced time-released fertilizer tablet, quantity and placement per manufacturer's recommendation, placed in the planting hole prior to installation of the plant. Planting berms for water retention and mulch shall be used to enhance plant establishment. Trees shall be staked or guyed to provide interim support until established.

Transplants (Plugs). Transplanted plant divisions, referred to here as "plugs", should be planted during the fall dormant period, preferably between October 1 and November 15 after first soaking rain. Plugs should be collected from a suitable collection site in the vicinity of the constructed basins. Plugs are clumps of plant roots, rhizomes or tubers combined with associated soil that can be manually removed, or salvaged with an excavator or backhoe. The maximum recommended size is 1 foot x 1 foot. Whole plants or plant divisions can be utilized. The plugs should be from healthy specimens free of insects, weeds and disease. The plugs should be spaced from 1 foot to 6 feet apart, depending on the size of the plug. Smaller plugs can be planted at the minimum distance to promote faster spreading and cover. Larger plugs from cattail and bulrush species should be planted at 3-foot to 6-foot intervals.

To plant a plug, a hole slightly wider than the diameter of the plug should be prepared and the roots system of the plug placed in the hole. Do not over-excavate the hole depth or the plant will settle below grade. A shovel could be used to create the planting hole. Manual planting with a spade is recommended for wet soils. Power augers can be used for creating holes in dry soils. Alternatively, a trench could be created along the narrow axis of the extended detention basin, and planting material manually placed at specified elevations in relation to the proximity of permanently saturated soils. To plant a plug with an established root system, the base of the stem and top of the root collar should be level with the ground surface. Tubers should be secured to prevent floating. Rhizomes should be placed in the soil with a slight upward angle.

The hole or trench containing the plug(s) should be backfilled with soil and the soil tamped down to assure good soil contact and secure the plug. The vegetative portion of the plant should be cut back to prevent water loss and wilting, and encourage the growth of roots and new shoots. Plugs of wetland plants should be grown in saturated soil. The soil should not be allowed to dry out after planting. Plugs should be planted immediately, when possible. When necessary, plugs can be stored in a cool, moist, shaded location for a maximum of one day. Plants must be thoroughly watered.

Pole Cuttings. Pole cuttings should be collected from the 1-year old wood of dormant trees and have a minimum of 5 viable nodes. The parent material should be healthy and free of diseases. The basal area of the pole cutting should be a minimum of one to two inches in diameter; however, the diameter at the base should not exceed 2 inches. The optimum diameter width of the base is 1 inch. The length of the cutting should be a minimum of 2 feet and should not exceed a maximum of 4 feet in length. Generally, 75 percent of the length of the cutting should be planted beneath the soil surface.

Pole cuttings should be collected no more than 2 days prior to planting. Cuttings should be placed in cool water to promote swelling of the nodes. Water should be kept fresh by aeration and/or by daily replacement. The pole cuttings should be placed in a hole approximately 3 feet deep (as determined by the length of the cutting) and backfilled with native soil, or a rich organic medium mixed with native soil. Soil should be tamped down to remove air pockets and assure soil contact with the cutting.

Seeding. Seeding should be conducted after plugs, container stock and pole cuttings are installed. Hydroseeding or broadcast method shall be utilized as appropriate for the size and accessibility of the area. The soil surface should be scarified prior to seeding. Do not damage previously planted vegetation. The seeds should be planted in fall, ideally in October.

Seeds should be broadcast or hydroseeded over the specified planting area. With broadcast seeding, the seed should be applied with hand-held spreaders to scarified soil. The soil surface should then be raked to cover the seeds with about one-eighth to one-quarter inch of soil to discourage predation, and tamped or rolled to firm soil surface.

Seeds should be planted at the ratios and rates specified by the supplier. The seed should be free of weeds and diseases. The supplier should provide the certified germination percentage.

Water Level Management and Irrigation for Plant Establishment

All newly planted material needs careful attention to watering requirements to ensure proper establishment. As mentioned in the introduction, it is important to select plants based on specific site conditions, which will affect the availability of water for plant use. Also, grouping plants with similar water needs can help reduce irrigation demand. The specific approach will vary for irrigated and non-irrigated conditions, and for each stormwater application. In most cases, stormwater applications require a permanent irrigation system which shall be designed to maximize water conservation. Irrigation specifications and design plans shall be provided.

Plants such as shrubs and trees grown in naturalized areas that are not saturated to the surface or inundated shall be irrigated with drip irrigation. The irrigation system shall remain in place for a minimum of three years, and should continue until it is demonstrated that the plantings can survive on annual rainfall and/or groundwater. Seeded areas do not need irrigation in years of normal rainfall. If a period of drought occurs after seeding, supplemental watering may be needed for germination in the first year.

The plants on the bottom and edge of the constructed basins should be allowed to become established for one growing season prior to the onset of significant flooding that will inundate the plantings for extended periods. The types of plants recommended for these locations are rushes, sedges, grasses and herbaceous species. Initially, saturated soils are required for the bioretention areas and extended detention basins during the establishment period of the plantings. After the plants have become established, inundation with a surface depth of 1 cm to 2 cm alternating with short dry periods is recommended for the basins during the first year. Periodic shallow flooding of these basins can slow the growth of non-native weedy terrestrial species in the wetland system; however, the water depth should not be greater than the height of the plants. This initial irrigation regime will prevent plant mortality from dry periods or excessive flooding in the first year, and reduce the growth of non-native weedy species.

Emergent species should be planted in saturated soil so the plants will become established. For emergent species, the water level in the first year should be maintained to allow for soil saturation or shallow inundation around the base of the plants. Significant flooding and inundation of stems and leaves of the plants should be avoided the first year. Tall plugs and plantings can tolerate greater depths of inundation if a significant portion of the stems and leaves of the plantings remain above the water surface.

B.5 Monitoring and Maintenance

General Requirements

All planted areas shall be monitored and maintained as required to ensure proper establishment by a Contractor with a valid California C-27 contractor's license. Frequency of site visits and required maintenance practices will vary depending upon the stormwater measure and plant selection. Maintenance shall include watering, cultivation, weeding and pruning as necessary to maintain optimum growth conditions and, as appropriate to the specific stormwater measure, to keep the planted areas neat and attractive in appearance. In all instances, controlling weeds and unwanted growth with chemical applications is prohibited.

The contractor shall be familiar with the design and function of the specific stormwater measure(s) to ensure that the plantings are maintained appropriately and do not interfere with the efficient runoff drainage and filtration.

Ongoing management of invasive weed species is required in all applications. Monthly hand weeding will allow the naturalized vegetation to take hold, and will ultimately be less costly than less frequent, and more intensive clearing. Regular application of compost mulch, or other mulch material that will resist floating with surface runoff, will also help control weed growth.

Erosion Control

Particularly with landscapes that are not fully established, contractors will need to monitor and evaluate potential for erosion and sediment accumulation in the runoff, which will influence irrigation scheduling and as well as determine the need for additional erosion control measures. Soil can be protected from erosion by a number of methods including:

- Keep the soil covered with vegetation to the extent possible;
- Slow water runoff by using compost berms, blanket, socks or tubes along slopes;
- Cover bare soil with a minimum of 2“ mulch cover;
- Minimize the use of blowers in planting beds and on turf;
- On slopes use coarse shredded mulch that is not prone to washing into storms drains;
- Store leaf litter as additional much in planting beds as appropriate.

Irrigation Systems

Where irrigation systems have been installed for temporary or permanent irrigation, the contractor shall maintain the irrigation system for optimum performance, as per manufacturer's specifications. Contractor shall inspect the entire system on an ongoing basis, including cleaning and adjusting all sprinkler and bubbler heads, drip emitters and valves for proper coverage. Contractor shall monitor the irrigation system while operating to identify and correct problems with water runoff or standing water.

Monitor soil moisture within plant root zones using a soil probe or shovel and adjust irrigation schedules accordingly if a soil moisture sensor is not being utilized to signal the irrigation controller. If a Weather-Based Irrigation Controller (WBIC), otherwise known as a “Smart” Controller is not utilized on the project, irrigation shall be scheduled using a water budget approach, basing irrigation frequency on evapotranspiration data (ET) to avoid over-irrigation of plant material. Adjust irrigation frequency within each hydrozone area a minimum of every four weeks to respond to expected adjustments in ET data.

If a standard turf mix is used in lieu of a no-mow variety, implement grasscycling, where appropriate to the stormwater treatment measure. Grass clippings shall not be carried into the drainage structures. Refer to A Landscaper's Guide to Grasscycling available from StopWaste.Org at www.bayfriendly.org .

Bioretention and Extended Detention Basins

In bioretention and extended detention basins, in particular, non-native invasive plant species should be carefully monitored and controlled to reduce competition with the native plantings and to assure the success of the revegetation activities. The establishment of weeds and invasive species in the bottom of the basins can be partially controlled during the establishment period by implementing the watering schedule of initial saturation followed by alternating periods of shallow inundation and dry soil. Manual methods of weed removal should be conducted on the bottom, edge and side of the basins when these areas are not inundated.

Areas with hydroseeding on the banks of the basins should be weeded carefully to avoid removal of the native species.

Weeding should be conducted regularly the first two years to prevent the growth, flowering, and seed set of non-native weeds and invasive species. After the first two years, weeding frequency will be determined on a site-specific basis as determined by the type of weeds and seasonal growth cycle of the weed species. In general, weeding once a month will be necessary to avoid more extensive and costly eradication in the future.

Long-term maintenance tasks on the banks of the basins will include continued control of nonnative weeds and invasive plants, and control of erosion. Erosion could include gullies, rills and sheet erosion. Actions to control erosion should include redirecting or dissipating the water source. Recontouring and subsequent mulching and/or reseeding with erosion control species may be required in bare areas. In the event of extensive die-off of the native plant species, the bare areas should be replanted. Where the event that caused plant mortality was not a natural catastrophic occurrence, the site condition that resulted in the die-off should be investigated and remedial action to correct the problem should be undertaken prior to replanting.

B.6 Bay-Friendly Landscaping and IPM

This section provides a summary of Bay-Friendly landscaping and integrated pest management (IPM) techniques, based on Alameda County's Bay Friendly Landscaping Guidelines prepared by Stopwaste.Org (available at www.bayfriendly.org).

Bay Friendly Landscaping

Bay-Friendly landscaping is a whole systems approach to the design, construction and maintenance of the landscape in order to support the integrity of the San Francisco Bay watershed. Project sponsors are encouraged to use landscape professionals who are familiar with and committed to implementing Bay-Friendly landscaping practices from the initial plant selection through the long-term maintenance of the site. This section summarizes Bay-Friendly Landscaping practices that may be implemented information that project sponsors need about how these practices canto benefit water quality of the Bay and its tributaries.

Bay-Friendly landscaping is based on 7 principles of sustainable landscaping and features the following practices

1. **Landscape Locally.** Landscapes designed to be part of the larger ecosystem of the Bay Area can both protect the health, diversity and sustainability of this valuable resource while making the most of the natural processes of a well-functioning ecosystem. By selecting plants appropriate to the climate, exposure, soils, drainage and topography, plantings can be established more successfully with less consumption of resources and intensive maintenance. Landscape designers are also encouraged to use local, well-adapted plant communities as models and to consider the potential for fire when developing the plant palette for a project.
2. **Less to the Landfill.** Reducing waste –and thus conserving landfill space and fossil fuel for hauling this material to the landfill - starts with not generating it in the first place. Plant trimmings pruning can be reduced by selecting plants that can grow to their natural size is the space allotted them, by avoiding the use of sheared hedges as design elements and

not specifying invasive species (see the list in Ap pendix B). Prune selectively, and avoid excessive plant growth by applying water and fertilizer judiciously..

The second step is to recognize the value of plant debris, and to keep this organic matter on the site, using it as a gardening resource for mulching and composting.

3. **Nurture the Soil.** Returning organic matter to the soil, in the form of plant debris, is the link between protecting our watershed and protecting our watershed. Healthy soil that is rich in organic matter is full of life and can store water and actively cycle nutrients, regulate and partition water fl ow, neutral ize poll utants, an d resis t pests. The fo llowing practic es will encourage a comp lex soil community of micr oorganisms, worm s, and o ther ben eficial creatures. Base the landscape design on a soil analysis and understanding of soil texture, structure and drainage. The following practices are recommended Dduring construction:
   - Remove and store the topsoil for re-spreading after grading;
   - Limit construction traffic to areas that will not be landscaped;
   - Contr ol soil erosion;
   - Amend the soils with compost before planting; and
   - Specify and maintain an adequate layer of or ganic mulch, ta king into a ccount water flow and designing to avoid the loss of mulch with runoff.

   Maintenance pra ctices t o ben efit soils and th e wa tershed include a llowing grass clippings to r emain on the lawn; fe eding soils with naturally based products including compost a nd a water extr act o f matur e compo st, inst ead of sy nthetic, fa st r elease fertilizers and avoiding pesticides.

4. **Conserve Water.** Amending the soil with compost and keeping it covered with mulch can increase so il permeab ility and wat er-holding cap acity, re duce water loss thro ugh evaporation and d ecrease the n eed for ir rigation. Planting a ppropriate, d rought t olerant California natives or Mediterranean plants also reduces water consumption for irrigation, as well as consumption of other resources for mowing, fertilizing, and spraying. Minimize the use of turf grasses that require regular watering and fertilizing to remain green, particularly on slopes or in na rrow, irregular hard to water shapes. Arr ange plants in “hyd rozones” of low, me dium or high wa ter dema nd. Onsite collection systems can a llow t he u se o f rainwater, or the reuse of “graywater” – uncontaminated wastewater from sinks, bathtubs, and wa shing machine s. Specify, in stall a nd ma intain h igh-efficiency ir rigation syst ems, and train landscaping staff to manage irrigation according to need.

5. **Conserve Energy.** Conventional landscapes are very fossil fuel consumptive. Selecting plantings that do n ot require regular mowing or pruning, fertilizing and watering can help reduce this demand and restore our landscapes to those that are more p roductive than consumptive. T ree pl antings ca n be used to mo derate bu ilding t emperatures, and t o shade paved areas and air conditioners. Trees can also intercept significant a mounts o f rainfall ea ch year and t hus he lp cont rol st ormwater runo ff. Spe cify as larg e a tree a s possible but be sure t hat it w ill be allowed t o g row to its n atural sh ape an d size in t he allotted space. Outdoor lighting should be designed to use less energy and minimize “light pollution.” Choose and maintain energy-efficient landscaping equipment to conserve fuel. Specifying local products and suppliers reduces the energy needed to tr ansport products and supports local economies.

6. **Protect Water and Air Quality.** Bay-Friendly landscaping can help protect water quality by increasing on-site infiltration and reducing runoff, reducing pollutants in runoff, and increasing the soil's ability to remove pollutants from runoff. It can help protect air quality by reducing fossil fuel consumption, recycling plant debris onsite, and planting trees to remove carbon dioxide and absorb air pollutants. Many of the practices described previously, such as minimizing high input decorative lawns, keeping soil covered with mulch and planting trees play a critical role in protecting water and air quality. An additional very important component of Bay-Friendly landscaping is reducing the use of pesticides through integrated pest management, which is described in a separate section, below.
7. **Create and Protect Wildlife Habitat.** Although we tend to rely on parks and open space to preserve wildlife habitat, developed landscapes can also provide food, water, shelter and nesting sites for birds, butterflies, beneficial insects, and other creatures. This can be accomplished by providing a diverse landscape that includes annuals, biennials and perennials of many different sizes, shapes, colors and textures; by choosing California natives first; providing appropriate water and shelter for wild life; eliminating the use of pesticides; and planning sites to conserve or restore natural areas and wildlife corridors.

Integrated Pest Management

All creeks in the San Francisco Bay Area exceed water quality toxicity limits, primarily due to the pesticide Diazinon entering urban runoff. Although the residential use of Diazinon is currently being phased out, the use of a group of highly toxic chemicals, called pyrethroids, is increasing. Because all pesticides are toxins, a Iintegrated pest management (IPM) places a priority on avoiding their use. IPM is a holistic approach to mitigating insects, plant diseases, weeds, and other pests. Projects that require a landscaping plan as part of a development project application are required encouraged to use IPM, as indicated in each agency's source control measures list, which is based on the Clean Water Program's Source Control Model (see Appendix D). Avoiding pesticides and quick release synthetic fertilizers are particularly important when maintaining stormwater treatment measures, to protect water quality.

IPM encourages the use of many strategies to first prevent, and then control, but not eliminate, pests. It places a priority on fostering a healthy environment in which plants have the strength to resist diseases and insect infestations, and out-compete weeds. Using IPM requires an understanding of the life cycles of pests and beneficial organisms, as well as regular monitoring of their populations. When pest problems are identified, IPM considers all viable solutions and uses a combination of strategies to control pests, rather than relying on pesticides alone. The least toxic pesticides are used only as a last resort. IPM features the following practices:

- **Prevent Pest Problems.** Fostering a healthy soil and selecting appropriate plant communities for the site helps reduce the susceptibility to disease and other pests. Landscape designs should include a diversity of species that are well-suited to the site; specify resistant varieties and native species, including plants that attract beneficial insects; place plants a proper distance from buildings; avoid over-planting; and include compost in the soil specifications. Cultural methods of avoiding pests during construction and maintenance include the following:
  - Selecting plant material that is free from disease and insects;
  - Planting at the right depth;

- Watering thoroughly but not over-watering;
- Keeping mulch on the soil surface at all times, keeping it away from root crowns;
- Using slow release fertilizer, if necessary, and not over-fertilizing;
- Prun ing judiciously;
- Eliminating noxious weeds before they go to seed or spread;
- Cleaning equipment after use on infected plants;
- Inspecting and removing invasive plant parts or seeds from clothing, tools and vehicle before leaving an infected site; and
- Cleaning up fruit and plant material that is infected with insects or diseases.

- **Watch for and Monitor Problems.** Landscaping firms should provide their staff with the time and resources to learn to identify both pest and beneficial organisms, and train residential clients to monitor and record pest problems. Plants should be checked often for vigor and signs of pests. Clarify which problems are the result of pests and not other environmental problems. Evaluate the results of any treatments, and check regularly with the Bio-Integral Resource Center (www.birc .org) or UC Davis (www. ipm.ucdavis.edu) for up-to-date resources and information.
- **Education is Key.** Many property owners have unrealistic standards of absolute pest control and need to learn how landscapes can tolerate a certain level of pests without resulting in significant, or even noticeable, damage. Landscape professionals should educate their clients and refer them to www.ourw aterourworld.org for fact sheets and information on alternative pest control strategies.
- **Use Physical and Mechanical Controls.** If pests are identified as causing unacceptable levels of damage, physical barriers or mechanical techniques are the first line of control. This can include the carefully timed and conducted pruning of infested plant material or removal of whole plants, spraying aphids with a strong jet of water, using pheromone or sticky traps to keep ants and other insects away or hand-picking large adult insect pests and larvae as they appear
- **Use Biological Controls.** Living organisms can also be used to keep pest populations under control. The most important biological controls appear naturally and will be abundant in a landscape that is not heavily treated with pesticides. Encourage beneficial insects by planting a wide range of plants that flower throughout the year (a list is provided in the Bay-Friendly Landscaping Guidelines), and introduce natural predators. Buy all biological controls from a reputable source, and do not use pesticides except as a last resort.
- **Least Toxic Pesticides are a Last Resort.** The least toxic and least persistent pesticide is used only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. Pesticides are not used on a calendar basis. When used, their efficiency is maximized by understanding the pest and beneficial life cycles, by careful timing and targeted application.

B.7 Nursery Sources for Native Plants

It is recommended that the native plants used in treatment controls be grown by a qualified nursery. Seed collection should be conducted by a qualified botanist and/or nursery staff. Seed should be collected locally from selected sites to maintain the genetic integrity of the native plant species. The seeds shall be propagated by the nursery for planting during the fall dormant season. The appropriate container size for each species shall be used by the nursery.

Berkeley Horticultural Nursery*
1310 McGee Ave., Berkeley, CA
510-526-4704
http://www.berkeleyhort.com/

Clyde Robin Seed Company
Castro Valley, CA
510-785-0425
www.clyderobin.com

East Bay Nursery*
2332 San Pablo Ave., Berkeley, CA
510- 845-6490
http://www.eastbaynursery.com/

Larner Seeds
PO Box 407
Bolinas, California
415-868-9407, info@larnerseeds.com
www.larnerseeds.com/

Mines Road Natives
17505 Mines Road, Livermore, CA
925-371-0887
Note: by appointment only.

Mostly Natives Nursery
27235 Highway 1, Tomales, CA
707-878-2009
www.mostlynatives.com

Native Here Nursery
101 Golf Course Road, Berkeley, CA
510-549-0211
www.ebcnps.org (click on "Native Here Nursery")

Oaktown Native Plant Nursery
1019 Bella Vista Ave., Oakland, CA
510-534-2552
http://www.oaktownnativenursery.info/

Pacific Coast Seed
533 Hawthorne Place
Livermore, CA
925- 373-4417
www.pcseed.com

Watershed Nursery
Berkeley, CA
510-548-4714
www.thewatershednursery.com
* Nurseries with a dedicated native plant section

References

A. StopWaste.Org www.bayfriendly.org

1. Bay-Friendly Landscape Guidelines
2. A Landscaper's Guide to Grasscycling
3. A Landscaper's Guide to Mulch

B. A Guide to Estimating Irrigation of Water Needs of Landscape Plantings, California Dept of Water Resources, http://cdec.water.ca.gov

C. Irrigation water audits, Irrigation Association, www.irrigation.org, and the Irrigation Technology Research Center, www.itrc.org.

D. California Irrigation Management Information System, www.cimis.water.ca.gov, Waste management and recycling, www.ciwmb.ca.gov.

E. The Weed Worker's Handbook, A Guide to Techniques for Removing Bay Area Invasive Plants, The Watershed Council (510) 231-5655 and the California Invasive Plant Council (510) 843-3902

F. Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide, 2nd ed., UC Publication 3359, http://www.ipm.ucdavis.edu

G. A Field Guide to Compost Use, The Composting Council, Alexandria, VA. http://www.compostingcouncil.org/index.cfm

H. City of Santa Rosa. 2005. Appendix A. Landscaping and Vegetation for Storm Water Best Management Practices in New Development and Redevelopment in the Santa Rosa Area.

I. Hogan, E. L., Ed. 1994. Sunset Western Garden Book, Sunset Publishing Corporation, Menlo Park, CA.

J. California Stormwater Quality Association (CASQA). Stormwater BMP Handbook: New Development and Redevelopment. January 2003.

K. Bornstein, Carol, David Fross and Bart O'Brien, California Native Plants for the Garden

L. East Bay Municipal Utility District (EBMUD), Plants and Landscapes for Summer Dry Climates

M. University of California Cooperative Extension, Guide to Estimating Irrigation Water Needs of Landscape Plantings in CA

Appendix C

Example Scenarios

1. **Parking Lot Example**

2. **Podium Type Building Example**

C.1 Parking Lot Example (revised March 2012)

Introduction

This example shows a proposed parking lot in Alameda County with bioretention areas. LID feasibility/infeasibility criteria (Appendix J) shall be used to determine whether bioretention areas may be used and methods to design bioretention areas to maximize infiltration and evapotranspiration.

Typical Parking Lot

Summary of Stormwater Controls

Site Design Measures

- Landscaped areas within two drainage management areas are designed to function as self-treating areas, as described in Section 4.1 of this manual, with one going to the bioretention area and one bypassing the bioretention area

Source Controls

- Stenciling storm drain inlets
- Landscape designer will be asked to follow Integrated Pest Management principles

Treatment Measures

- Bioretention areas

The example parking lot site description:

The project site is 1.2 acres with 1% slope from edge of lot to street.
The site has one ingress/egress point.

Sidewalks shall be graded toward landscaped areas.
The parking lot will have standard asphalt paving.
The parking lot will have landscaping as an amenity.

All areas will be graded to drain to bioretention areas along the perimeter of the site. Parking lot slopes are approximately 1%.

Bioretention areas are sized following the procedures in Section 5.1 and the bioretention area technical guidance in Section 6.1.

Design flow criterion: rainfall intensity – 0.2 in./hr.
Design volume criterion: capture 80% of the average annual runoff
The mean annual precipitation (MAP) at the site is 20 inches
The closest rain gauge to the site is the Oakland Airport gauge (MAP = 18.35")

The following shows sizing and calculations of the site and the treatment measures used.

Typical Linear Bioretention Area

Typical Bioretention Area

Procedure for BMP sizing:

A1. List areas to each treatment measure.

Area A Landscaping 7,868 square feet (to bioretention area)
Area A Paving 6,788 square feet
Total Area A 14,656 square feet

Area B Landscaping 11,497 square feet (self-treating area that bypasses bioretention area)
Area B Paving 24,491 square feet
Total Area B 35,988 square feet

A2. Simplified flow-based sizing method for bioretention area (ignoring storage for a flow based BMP): Multiply the impervious surface from A1. by a sizing factor of 0.04.

The 4% ratio is for planning review and is from 0.2 inches of rainfall per hour inflow divided by 5 inches/hour surface loading rate.

Area A 6,788 square feet * 0.04 = 272 square feet of bioretention treatment area.
Area B 24,491 square feet * 0.04 = 980 square feet of bioretention treatment area.

Total Treatment Area is 1,252 square feet using the flow based approach with no allowance for storage.

A3. Combined flow and volume sizing method. The treatment facility designer has the option of bypassing or treating the runoff from landscaped areas. Landscape areas are considered as self-treating and can be directed to the storm drain system without flowing through treatment facilities. Where landscape areas flow through a bioretention area, convert landscape area to equivalent impervious area by multiplying by 0.1.

At Area A, runoff from the landscape area is directed through the bioretention area.

Area A Landscaping 7,868 square feet * .1 = 787 square feet
Area A Impervious Area for hydraulic sizing 6,788 square feet
Equivalent Impervious Area 7,575

At Area B, runoff from landscaping is conveyed directly to the the storm drain system.

Area B Impervious Area for hydraulic sizing 24,491 square feet

A4. Determine the Unit Basin Storage Volumes for 80 Percent Capture using 48-hour drawdown. Using Table 5.2 of Chapter 5 based on 100 percent impervious area. Adjust this volume for mean annual precipitation. For a site near Oakland with a mean annual precipitation of 20 inches, Use 0.67" rainfall for a 18.35 inch mean annual precipitation for 100 percent impervious area. Adjust to **0.73 inches** (0.67 * 20"/18.35") at 20 inch mean annual precipitation. For both Areas A and B, use 0.73 inches (rounded for these calculations). For this example, a rainfall intensity of 0.2 inches per hour is used to calculate runoff from the flow-based method. Other methods may be used to calculate the rainfall intensity for the flow-based method.

A5. Calculate the Water Quality Design Volume. The water quality design volume is the equivalent impervious area from Step A3 times the adjusted unit basin storage volume. (For Area A, 7,575square feet * 0.73 inches * 1/12 feet per inch = **461 cubic feet**. For Area B, 24,491 * 0.73 inches * 1/12 feet per inch = 1,490 cubic feet.)

A6. Use a constant surface loading rate of **5 inches per hour** as required by the Permit for use with treatment soils.

A7. Determine the Rain Event Duration. Assume that the rain event that generates the required capture volume of runoff determined in Step A4 occurs at a constant intensity of 0.2 inches/hour from the start of the storm (i.e., assume a rectangular hydrograph). Calculate the duration of the rain event by dividing the unit basin storage volume by the intensity. In other words, determine the amount of time required for the unit basin storage volume to be achieved at a rate of 0.2 inches/hour. For example, if the unit basin storage volume is based on 0.73 inches rainfall, the Rain Event Duration is 0.73 inches ÷ 0.2 inches/hour = 3.65 hours. (**for these calculations, round to 3.7 hours**)

A8. Compute Required Depth of Storage for a given treatment area. (Maximum Allowable Depth = 12 inches)

Start by using a bioretention area that is about 25% smaller than the bioretention area calculated in Step A2.

For Area A, 272 – (0.25 × 272) = **204 square feet.** Calculate the volume of runoff that filters through the treatment soil at a rate of 5 inches per hour (the design surface loading rate for bioretention facilities), for the Rain Event Duration calculated in Step A7. For example, for a bioretention treatment area of 204 square feet, with a surface loading rate of 5 inches per hour for a Rain Event Duration of 3.7 hours, the volume of treated runoff = 204 square feet × 5 inches/hour × (1 foot/12 inches) × 3.7 hours = **314 cubic feet**.

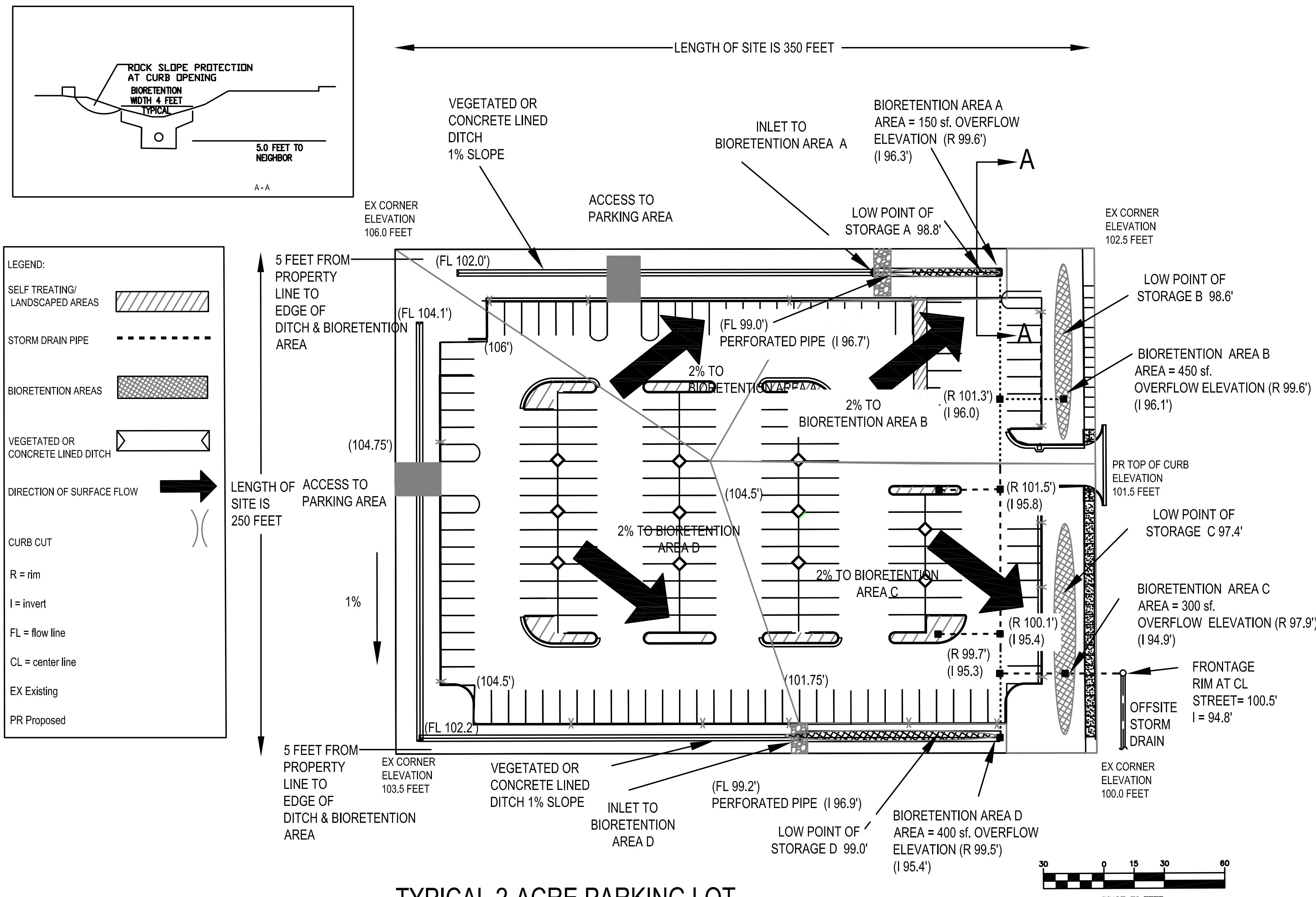
For Area B, 980 – (0.25 × 980) = **735 square feet.** Calculate the volume of runoff that filters through the treatment soil at a rate of 5 inches per hour, for the Rain Event Duration calculated in Step A7. For a bioretention treatment area of 735 square feet with a surface loading rate of 5 inches per hour for a Rain Event Duration of 3.7 hours, the volume of treated runoff = 735 square feet × 5 inches/hour × (1 foot/12 inches) × 3.7 hours = **1,133 cubic feet**.

A9. Calculate the portion of the required capture volume remaining after treatment is accomplished by filtering through the treatment soil. The result is the amount that must be stored in the ponding area above the reduced bioretention area assumed in Step A8.

For Area A, Step A5, the volume of runoff is 461 cubic feet. From Step A8, the amount treated during the storm duration is 314 cubic feet. The difference between the total storm volume and the total treated (461 – 314 cubic feet = **147 cubic feet**) is the amount that must be stored. If this volume is stored over a surface area of 204 square feet, the average ponding depth would be 147 cubic feet ÷204 square feet = **0.72 feet or 8.6 inches.**

For Area B, Step A5, the volume of runoff is 1,490 cubic feet. From Step A8, the amount treated during the storm duration is 1,133 cubic feet. The difference between the total storm volume and the total treated (1,490 – 1,133 cubic feet = **357 cubic feet**) is the amount that must be stored. If this volume is stored over a surface area of 735 square feet, the average ponding depth would be 357 cubic feet ÷735 square feet = **0.49 feet or 5.8 inches.**

A10. Check to see if the average ponding depth is between 6 and 12 inches, which is the recommended allowance for ponding in a bioretention facility or flow-through planter. If the ponding depth is less than 6 inches, the bioretention design can be optimized with a smaller surface area (i.e., repeat Steps A8 and A9 with a smaller treatment area). If the ponding depth is greater than 12 inches, a larger surface treatment area will be required. In the example for Area A, the ponding depth is 8.6 inches, which within the allowable range. This is achieved with a 204 square foot bioretention area, which is about 3 percent of the impervious area draining to the Area A bioretention area. For Area B, the depth is slightly less than 6 inches. The area of the bioinfiltration facility may be made smaller.



TYPICAL 2-ACRE PARKING LOT

APPENDIX C

C.2 Podium Type Building Example (revised March 2012)

Introduction

- This example is to show a proposed podium type building in Alameda County, with flow-through planters. LID feasibility/infeasibility criteria (Appendix J) need to be used to determine whether the use of flow-through planters will be allowed.

Typical Podium Building

Summary of Stormwater Controls

Site Design Measures

- Multistory building above covered parking

Source Controls

- Covered trash storage areas
- Landscape designer will be asked to follow Integrated Pest Management principles

Treatment Measures

- Flow-through planters

The example podium style building site description:

The project site is approximately 25,000 square feet.

The site is Type D soil with expected compaction of 95%.

Lot line is assumed to be to the edge of city right-of-way (sidewalks).

The proposed podium building is a zero lot line design with flow through planters in the center of the building around a concrete patio and down at ground level.

The podium building is a mixed use building with residential units on the top floors, retail space on the second floor and parking on the bottom floor. The building mechanical facilities and trash facilities are also on the bottom floor.

The roof area of the podium building consists of approximately 9,000 square foot patio, 1,000 square feet of landscaping and 15,000 square feet of conventional roof.

Off site sidewalks and driveways will be graded toward street.

The ground floor is a concrete slab with buildings and a covered parking structure. There is no potential for infiltration. The soils within the planter will be at least 18 inches of treatment soil with a surface loading rate of 5 inch/hour. A 12-inch layer of drain rock will be placed around the perforated underdrain to allow for dewatering of the flow through the planter.

The flow through planter areas will connect directly to the storm drain system through a system of perforated underdrains and overflow pipes.

Using the simplified flow-based sizing approach, flow through planters shall be sized to have a surface area that is 4% of the area of the impervious surface to be treated. The flow through planters shall have splash blocks at rain water leader discharge points to protect against erosion.

Design flow criterion: rainfall intensity – 0.2 in./hr.
Design volume criterion: capture 80% of the average annual runoff
The mean annual precipitation (MAP) at the site is 16 inches
The applicable rain gauge is the Oakland Airport gauge (MAP = 18.35”)

The following steps show the sizes and calculations for the Podium building treatment measures.

Source Control

Parking and trash shall be under the building and covered.

Typical Flow Through Planter

City of Portland *2004 Stormwater Manual*

Procedure for BMP sizing:

B1. List areas to each treatment measure. (“A” in Q = CIA)

Impervious Patio Surfaces	9,000 square feet
Patio Landscaping	500 square feet
Roof Surfaces	15,000 square feet
Landscape	500 square feet

B2. Simplified flow-based sizing method (ignoring storage for a flow based BMP): Multiply the impervious surface from B1. by a sizing factor of 0.04.

The total impervious area from Step B2. is 24,000 square feet. 4% of 24,000 square feet is **960 square feet of bioretention treatment area**.

B3. Combined flow and volume sizing method. The approach assumes that all of the design rainfall becomes runoff, and thus it is appropriate for use where the drainage area to the bioretention area is mostly impervious. Convert landscape area to equivalent impervious area by multiplying by 0.1. (Note: In this example, the landscaped area is designed to flow through the planter. For an example where self-treating areas bypass the bioretention area, see the preceding parking lot example.)

Patio Impervious Surfaces	9,000 square feet
Roof Impervious Surfaces	15,000 square feet
Landscape 1,000*0.1 =	100 square feet
Equivalent Impervious Area	**24,100 square feet**

B4. Determine the Unit Basin Storage Volumes for 80 Percent Capture using 48-hour drawdown. using Table 5.2 of Chapter 5 based on 100 percent impervious area. Adjust this volume for mean annual precipitation. For a site near Livermore with a mean annual precipitation of 16 inches, Use 0.67” rainfall for a 18.35 inch mean annual precipitation and adjust to **0.58 inches** (0.67 * 16”/18.35”) at 16 inch mean annual precipitation. For these calculations, round to 0.58 inches.

B5. Calculate the Water Quality Design Volume. The water quality design volume is the area from Step B3 times the adjusted unit basin storage volume. (24,100 square feet * 0.58 inches * 1/12 feet per inch = **1,165 cubic feet**.)

B6. Use a constant surface loading rate of **5 inches per hour** through the soil as required by the Permit for use with treatment soils.

B7. Assume that the rain event that generates the required capture volume of runoff determined in Step B4 occurs at a constant intensity of 0.2 inches/hour from the start of the storm (i.e., assume a rectangular hydrograph). Other methods may be used to calculate the rainfall intensity for the flow-based method. Calculate the duration of the rain event by dividing the unit basin storage volume by the intensity. In other words, determine the amount of time required for the unit basin storage volume to be achieved at a rate of 0.2 inches/hour. For this example, the unit basin storage volume is 0.58 inches, the rain event duration is 0.58 inches ÷ 0.2 inches/hour = **2.9 hours**.

B8. Compute Required Depth of Storage for a given treatment area. (Maximum Allowable Depth = 12 inches)

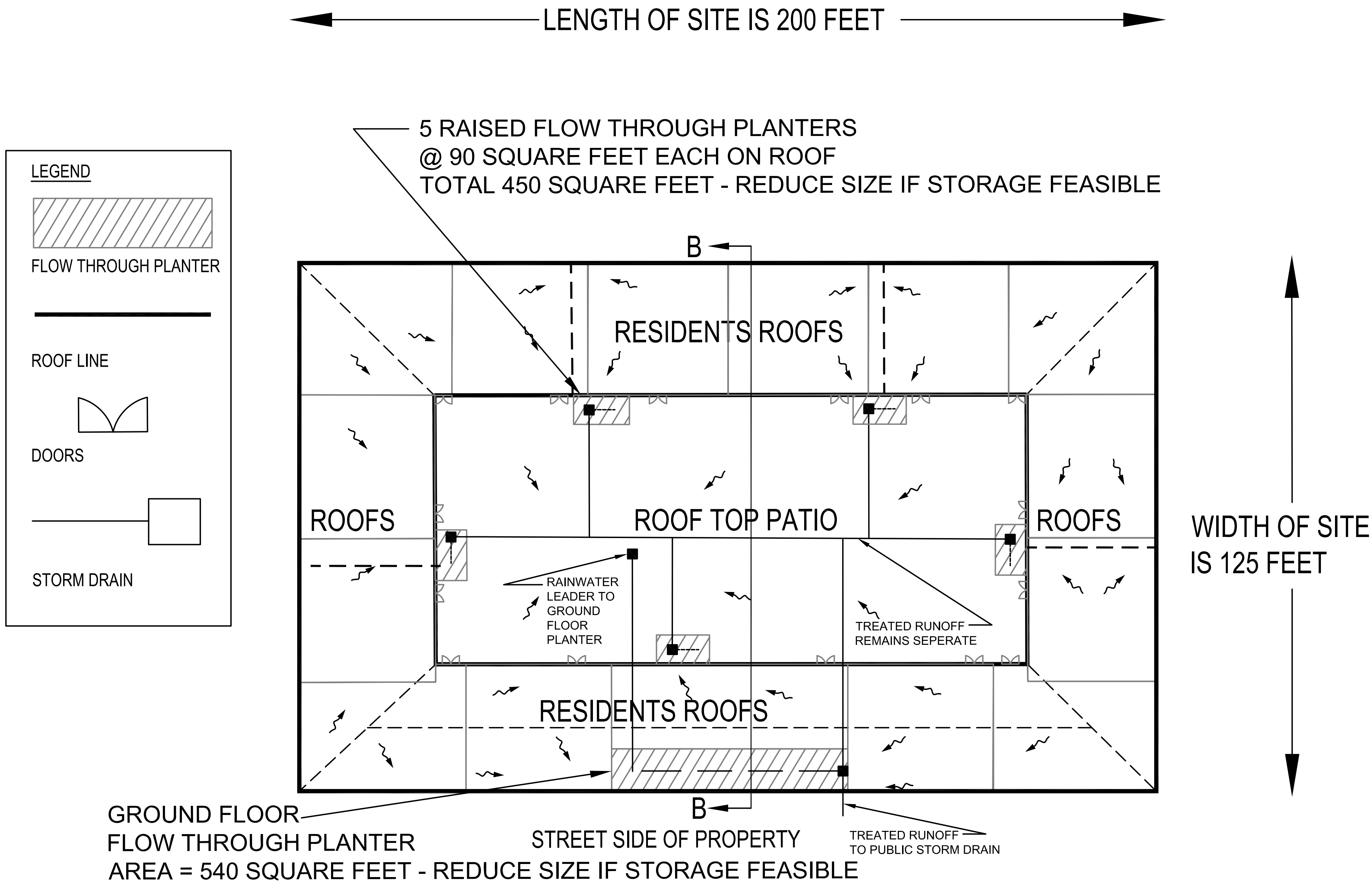
Start by using a bioretention area that is about 25% smaller than the bioretention area calculated in Step B2. Using the example, 960 – (0.25 × 960) = 720 square feet. Calculate the volume of runoff that filters through the treatment soil at a surface loading rate of 5 inches per hour (the design surface loading rate for bioretention facilities), for the duration of the rain event calculated in Step B7. For this example, for a bioretention treatment area of 720 square feet, with a surface loading rate of 5 inches per hour for a duration of 2.9 hours, the volume of treated runoff = 720 square feet × 5 inches/hour × (1 foot/12 inches) × 2.9 hours = **870 cubic feet**.

B9. The difference between the volume of runoff from Step B5 and the volume that flows through the planter for the storm duration from B8 is 1,165 cubic feet – 870 cubic feet = **295 cubic feet**. If this volume is stored over a surface area of 720 square feet, the average ponding depth would be 295 cubic feet ÷ 720 square feet = **0.41 feet or 4.9 inches**.

B10. Check to see if the average ponding depth is between 6 and 12 inches, which is the recommended allowance for ponding in a bioretention facility or flow-through planter. If the ponding depth is less than 6 inches, the bioretention design can be optimized with a smaller surface area (i.e., repeat Steps B8 and B9 with a smaller treatment area). If the ponding depth is greater than 12 inches, a larger surface treatment area will be required. In this example, the ponding depth of 4.9 inches is less than the recommended range of 6 to 12 inches. A repetition of steps B8 and B9 with a bioretention area that is 30 percent smaller than the bioretention area calculated in Step B2 is provided below.

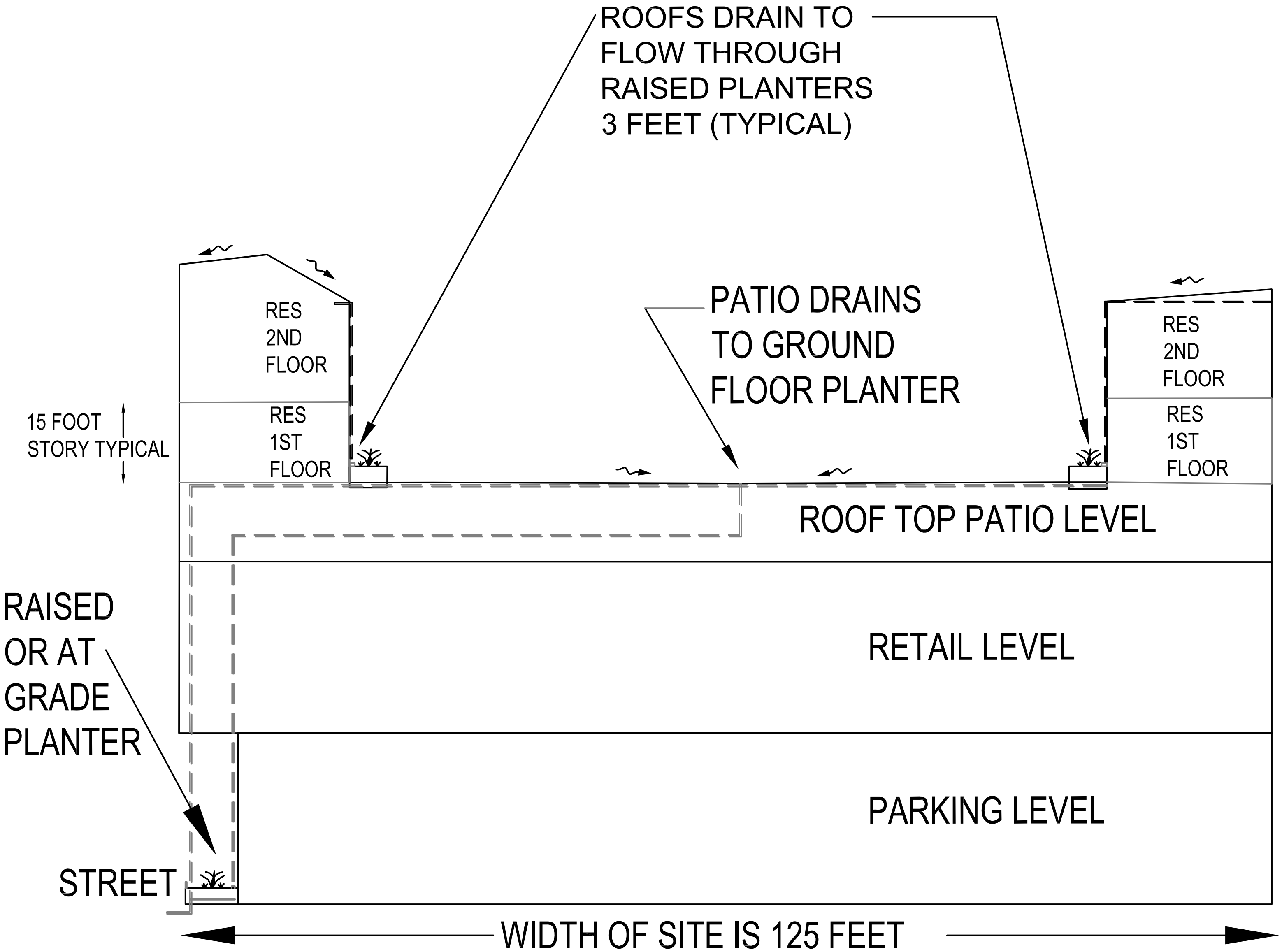
B.11 Repeat Step B8 with a bioretention area 30% smaller than the bioretention area in Step B2: 960 sq.ft. – (0.30 x 960) = 672 sq.ft. Calculate the volume treated during the rain event duration: 672 sq.ft. x 5 in/hr x 1 ft/12 in x 2.9 hours = 812 cubic feet.

Repeat Step B9 for the smaller bioretention area to calculate the volume remaining in the ponded area: 1165 cu.ft. – 812 cu.ft. = 353 cubic feet. Calculate the average ponding depth: 353 cu.ft. / 672 sq.ft. = 0.53 feet or 6.2 inches.



TYPICAL ROOF LAYOUT PLAN VIEW 15 UNITS

APPENDIX C

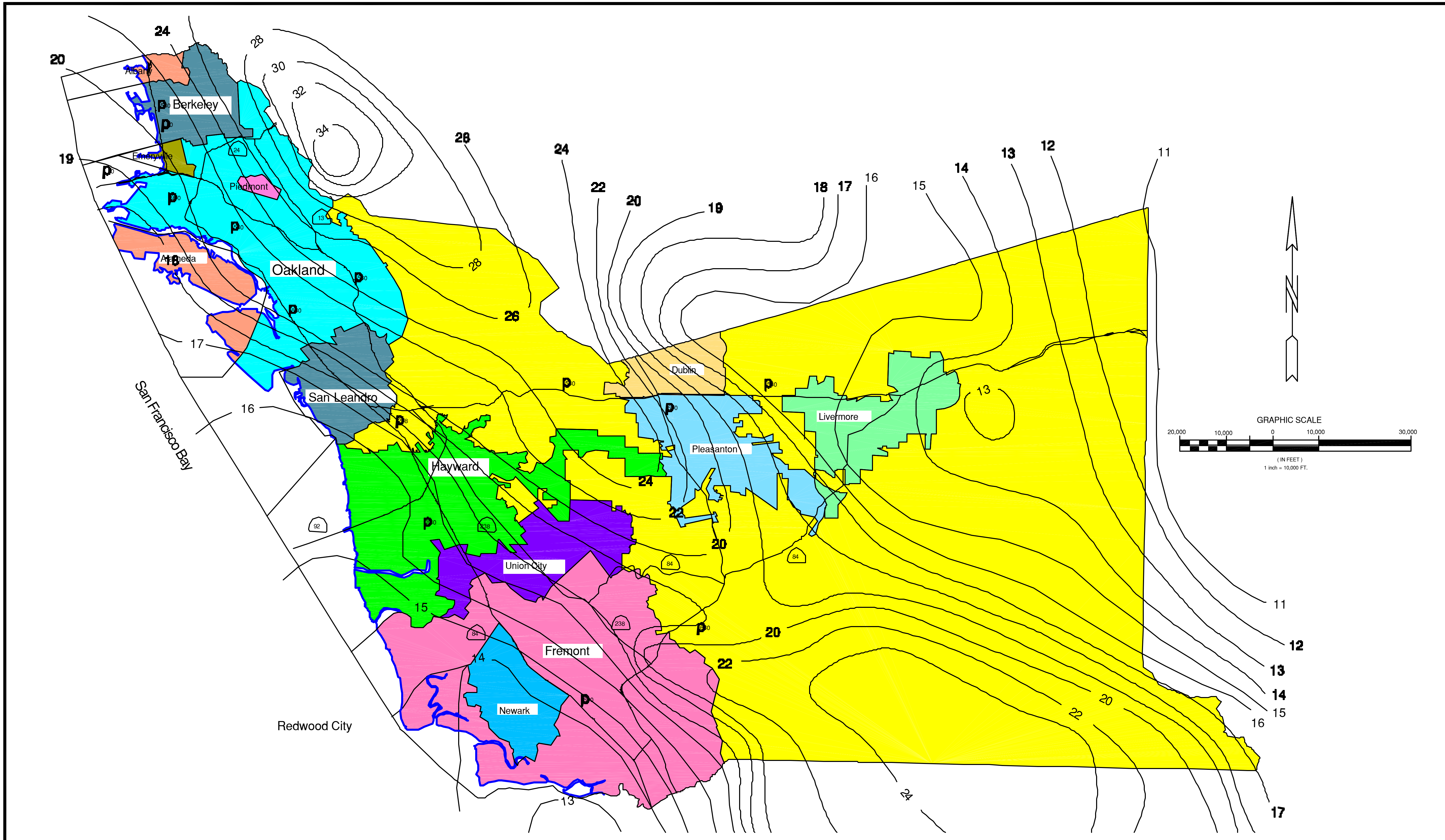


TYPICAL ROOF LAYOUT CROSS SECTION B - B

Appendix

D

Mean Annual Precipitation Map: Alameda County



ALAMEDA COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT

MEAN ANNUAL PRECIPITATION

(VALUES IN INCHES)

DATE: MAY 2003

ATTACHMENT-6

Appendix

E

Applicability of Non-Low Impact Development Treatment Measures

As described in Section 5.2, beginning December 1, 2011, no underground vault systems are allowed for use, except in certain types of "Special Projects," in which media filters may be allowed. Special Projects criteria are included in Appendix K. Three types of underground systems have been shown to have particular difficulty meeting the NPDES stormwater permit standard of removing pollutants to the maximum extent practicable (MEP) These three systems -- inlet filters (also called manufactured drain inserts), oil/water Separators (also called water quality inlets), and hydrodynamic separators – are described below. The Water Board staff's August 2004 letter that describes issues associated with these treatment measures is included at the end of this Appendix. A discussion of media filters precedes the attached letter.

As described below, some of these devices can be extremely effective in removing trash and other gross solid pollutants, as well as sediment and oil. While not adequate to meet the MEP standard alone, their use may be worth considering if used as part of a treatment train.

E.1 Inlet Filters

The California Stormwater Quality Association's (CASQA) New Development BMP Handbook describes storm drain inlet filters (which are also called manufactured drain inserts) as manufactured filters or fabric that are placed in a storm drain inlet to remove sediment and debris. In a letter dated August 5, 2004, the Water Board's Executive Officer described its assessment of studies and literature reviews for this type of treatment measure. The letter reported that these filters are subject to clogging, have very limited ability to remove dissolved pollutants, need very frequent maintenance, and are likely to receive inadequate maintenance. The following conclusion was made regarding inlet filters:

> "Based on our review of these references and experience in the Bay Area, it would be very unlikely for a proposal using inlet filters as the sole treatment measures to meet the MEP standard."[1]

Based on the Water Board staff's statements, the Clean Water Program's member agencies do not approve proposals for the use of inlet filters as permanent, post-construction treatment measures, unless they are part of a stormwater "treatment train" approach that includes other, more effective types of stormwater treatment measures. The use of treatment trains is discussed in Section 5.1.4. Long-term use of inlet filters can be problematic due to their need for frequent maintenance; however they may be used effectively as construction BMPs.

E.2 Oil/Water Separators

Oil/water separators, also called water quality inlets, are described in CASQA's New Development BMP Handbook as consisting of one or more chambers that promote sedimentation of coarse materials and separation of free oil (as opposed to emulsified or dissolved oil). The Water Board's August 5, 2004, letter described oil/water separators as originally developed for industrial uses and recognized as generally ineffective in removing the types of pollutants normally found in urban storm water. The letter included the following summary statement regarding oil/water separators:

> "With the exception of projects where oil and grease concentrations are expected to be very high, and other measures are included in a 'treatment train' approach, Board staff is unlikely to consider oil/water separators as a means of meeting the MEP standard."

As with inlet filters, based on the Water Board staff's statements, Clean Water Program member agencies do not approve proposals for the use of oil/water separators to treat stormwater, unless they are used to treat high concentrations of oil and grease and the stormwater receives further treatment for fine-particulates associated with pollutants.

E.3 Hydrodynamic Separators

The US Environmental Protection Agency (USEPA) has described hydrodynamic separators as "flow-through structures with a settling or separation unit to remove sediments".[2] The energy from the flowing water allows sediments to settle, so no outside power source is needed.

In 2005 the Contra Costa Clean Water Program conducted a literature review that found that hydrodynamic separators were substantially less effective than various landscape-based treatment measures for removing pollutants that are associated with very fine particles and are

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[1] Letter from Bruce H. Wolfe, Executive Officer of the San Francisco Bay Regional Water Quality Control Board to the Bay Area Stormwater Management Agencies Association (BASMAA), dated August 5, 2004, http://www.cleanwaterprogram.org/uploads/RWQCB_letter_re_inlet_filters_etc.pdf.

[2] USEPA, Hydrodynamic Separators Fact Sheet, 1999. http://www.epa.gov/owm/mtb/hydro.pdf.

identified as pollutants of concern in the Contra Costa Countywide NPDES municipal stormwater permit[3]. The technical memorandum also described local experience successfully applying a variety of landscape-based treatment measures to development projects in Contra Costa County, as well as operation and maintenance concerns and mosquito generation potential associated with hydrodynamic separators. Effective December 1, 2011, the stand-alone use of hydrodynamic separators is no longer allowed to meet stormwater treatment requirements.

Hydrodynamic separators can be very effective at removing trash and gross solids from runoff, and may be included as part of a treatment train in order to remove large solids before the stormwater is routed to a treatment measure that is more effective at removing fine particulates.

E.4 Media Filters

A technical description of media filters is provided in Section 6.11. Effective December 1, 2011, the stand-alone use of media filters to meet stormwater treatment requirements is no longer allowed, except for use in Special Projects, as described in Appendix K. While media filters have been demonstrated to remove suspended solids more effectively that the manufactured treatment systems described above, concerns remain about the maintenance of these systems. Media filters have more intensive maintenance requirements than low impact development treatment measures, and, since they are located underground, tend to be "out of sight, out of mind," and often do not receive the maintenance required to function properly. When used in Special Projects, it will be important for municipal staff to conduct regular maintenance verification inspections to verify that these systems are maintained properly and operating as designed.

E.5 Water Board Staff's Letter

A copy of the Water Board staff's August 2004 letter is included in the following pages.

[3] Contra Costa Clean Water Program, November 16, 2005. Policy on the Use of Hydrodynamic Separators to Achieve Compliance with NPDES Provision C.3.

California Regional Water Quality Control Board

San Francisco Bay Region

Terry Tamminen
Secretary for Environmental Protection

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Arnold Schwarzenegger
Governor

Date: August 5, 2004
File No. 1538.09 (KHL, JBO)

BASMAA Managers
c/o Geoff Brosseau
BASMAA Executive Director
1515 Clay Street,
Suite 1400
Oakland, CA 94612

Subject: Use of Storm Drain Inlet Filters and Oil/Water Separators to Meet the Requirements of NPDES Municipal Stormwater Permits

Dear BASMAA Managers:

This letter responds to your requests to clarify the Water Board's review of an aspect of municipal stormwater permittee compliance with requirements to include treatment controls in new development and significant redevelopment projects. Please assist us in distribution of this letter to BASMAA member agencies and other interested parties.

The Board regularly receives inquiries regarding the inclusion of stormwater treatment control measures to remove pollutants from new development and redevelopment project runoff. As a state agency, the Board does not endorse specific treatment control products. Also, there is currently no State certification program that would certify the effectiveness of a particular product.

However, the Board's role does include determining permittees' compliance with their NPDES stormwater permits. This includes determining that municipalities have reduced the discharge of pollutants in storm water to the Maximum Extent Practicable (MEP). While not specifically defined within federal clean water law, MEP refers to implementing best management practices (BMPs) that are effective in addressing pollutants, generally accepted by the public, of reasonable cost, and technically feasible.

When reviewing compliance with permit requirements for new development and redevelopment projects, Board staff looks to see that permittees have required projects to incorporate appropriate source controls to prevent the discharge of pollutants, design measures to reduce impervious surface, and treatment controls to remove pollutants from runoff. We review whether these measures have been appropriately designed to be effective, given the existing state of knowledge. For example, is a vegetated swale designed within parameters specified in existing literature as being effective? Such parameters include minimum residence times, maximum flow depths and velocities, limits on swale longitudinal and side slopes, inclusion of a subdrain if in very tight soils, and similar considerations.

Oil/Water Separators

Another example, vault-based oil-water separators, also known as water quality inlets, was originally designed for industrial use. These have been recognized to be generally ineffective at removing pollutants at concentrations seen in urban stormwater runoff, because removal rates are low and those pollutants that are removed are often flushed out by subsequent storms, especially when a separator is not frequently maintained. With the exception of projects where oil and grease concentrations are expected to be very high, and other controls are included in a "treatment train" approach, Board staff is unlikely to consider oil/water separators as a means of meeting the MEP standard.

Storm Drain Inlet Filters

Storm drain inlet filters, also known as drain inlet inserts, also have been shown to have limited effectiveness in removing pollutants from urban stormwater runoff, due to the nature of their design. Inlet filters are typically either bags or trays of filter media that are designed to catch and treat runoff as it enters the storm drain. They are manufactured stormwater treatment controls, and are typically popular because they have a low capital cost relative to other controls and can be placed into a traditional engineered storm drain design without altering that design.

In determining whether drain inlet filters meet the MEP standard, we reviewed the existing state of knowledge. Board staff's assessment of studies and literature reviews for this class of controls has found the following:

- Filters are subject to clogging and/or blinding by sediment, trash, and vegetation, resulting in runoff bypassing the filter and/or flooding;
- Maintaining filter performance requires very frequent maintenance (as often as during and after every storm). Manufacturers in practice understate the maintenance requirements for this class of devices. In practice, maintenance is not completed at an effective frequency, particularly to avoid bypass of the filter element clogged with debris;
- Inlet filters, by virtue of their location below a storm drain grate, are out of sight. This can lead to reduced maintenance resulting from the filters being out-of-sight, and thus out-of-mind;
- Filter performance may decay rapidly over a time frame that is significantly shorter than typically recommended replacement or maintenance intervals;
- Filters appear to have very limited ability to remove dissolved pollutants, smaller particulates, and emulsified oil and grease, and may have a limited ability to remove

oil and grease as it is found in urban runoff. The filter element in inlet filters is small and easily bypassed if fouled to prevent flooding.

The limited space within a storm drain inlet appears to preclude highly effective treatment. To the extent that treatment is accomplished, it appears that these controls require an intensive maintenance regime—one that is expensive and which, based on our experience in the Bay Area, is ultimately not completed once the controls have been installed.

A list of references reviewed is attached and includes reports prepared by Bay Area municipal stormwater programs that found the effectiveness of existing inlet filter products to be very limited. Based on our review of these references and experience in the Bay Area, it would be very unlikely for a proposal using inlet filters as the sole treatment measures to meet the MEP standard.

Fortunately, there are a variety of effective controls available to project proponents and designers as alternatives to inlet inserts. These include a range of landscape-based controls (e.g., vegetated swales, bioretention areas, planter/tree boxes, ponds, and stormwater wetlands) and a series of manufactured controls (e.g., vault-based hydrodynamic separators, vault-based media filters, and other solids removal devices). With few exceptions, these controls appear to function more reliably to remove pollutants, and thus would better represent "MEP."

Each type of BMP should be used in situations for which it is appropriate. For example, the City of Oakland is working to limit trash discharged into Lake Merritt. For that project, controls that primarily remove trash may be most appropriate. For most new development projects, however, BMPs that address the broad spectrum of urban runoff pollutants, from trash to fine particulates and soluble pollutants, are needed.

We recognize that inlet filter products with substantially improved performance may be developed in the future. Also, certification programs like Washington State's "Evaluation of Emerging Stormwater Treatment Technologies," which reviews technologies to determine whether they are at least as good as existing non-proprietary measures, may establish viable treatment measures. As with any aspect of the NPDES stormwater program, we anticipate that the municipal stormwater programs and the Board will continue to review information as it is developed so as to best determine what constitutes MEP, and to help ensure the reasonable cost in implementation of effective BMPs.

If you have any questions or further comments, please contact Dale Bowyer at (510) 622-2323 or via email to dcb@rb2.swrcb.ca.gov, or Keith Lichten via email to khl@rb2.swrcb.ca.gov, or at (510) 622-2380.

Sincerely,

--*original signed by*--

Bruce H. Wolfe
Executive Officer

Attachment: References Reviewed

ATTACHMENT: REFERENCES REVIEWED

Author	Title	Date	Notes
McDonald, Jonathan / Kristar	Letter & Attachments	September 19, 2003	
Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)	Application of Water-Quality Engineering Fundamentals to the Assessment of Stormwater Treatment Devices	August 28, 2002	
SCVURPPP	An Update of the 1999 Catch Basin Retrofit Feasibility Study Technical Memorandum	June 26, 2002	
SCVURPPP	Catch Basin Retrofit Feasibility Study Technical Memorandum	July 12, 1999	
Woodward-Clyde for SCVURPPP	Parking Lot Monitoring Report	June 11, 1996	
Woodward-Clyde for SCVURPPP	Parking Lot BMP Manual	June 11, 1996	
Minton, Gary R./Abtech Industries	Technical Review of the AbTech Ultra-Urban Filter	January 4, 2002	
URS Greiner Woodward Clyde (now URS) / Alameda County Urban Runoff Clean Water Program (now ACCWP)	Stormwater Inlet Insert Devices Literature Review	April 2, 1999	
USEPA/NSF International	ETV Joint Verification Statement: Hydro-Kleen Filtration System	September 2003	
USEPA/NSF International	Environmental Technology Verification Report; In-Drain Treatment Technologies Equipment Verification; Hydro Compliance Management, Inc., Hydro-Kleen Filtration System	September 2003	

Othmer, Friedman, Borroum, and Currier / Caltrans	Performance Evaluation of Structural BMPs: Drain Inlet Inserts (Fossil Filter and StreamGuard) and Oil/Water Separator	2001	
Woodward-Clyde Consultants / Alameda County Urban Runoff Clean Water Program	Street Sweeping/Storm Inlet Modification Literature Review	December 21, 1994	
Woodward-Clyde in association with UCLA and Psomas & Associates.	Santa Monica Bay Municipal Storm Water/Urban Runoff Pilot Project—Evaluation of Potential Catchbasin Retrofits	September 24, 1998	Prepared for Santa Monica Cities Consortium
Interagency Catch Basin Insert Committee	Evaluation of Commercially-Available Catch Basin Inserts for the Treatment of Stormwater Runoff from Developed Sites	October 1995	ICBIC is comprised of: King County Surface Water Mgmt. Div.; King County Dept. of Metropolitan Svcs.; Snohomish County Surface Water Mgmt. Div.; Seattle Drainage and Wastewater Utility; and Port of Seattle.
Caltrans	BMP Retrofit Pilot Program: Final Report (Report ID CTSW-RT-01-050)	January 2004	
Elizabeth Miller Jennings, Senior Staff Counsel, Office of Chief Counsel, State Water Resources Control Board	Memorandum on Maximum Extent Practicable	February 11, 1993	

Appendix

F

Infiltration Guidelines

As a stormwater management method, infiltration means ***retaining or detaining water within soils*** to reduce runoff. Infiltration can be a cost-effective method to manage stormwater – if the conditions on your site allow. These infiltration guidelines identify categories of stormwater infiltration methods, and describe factors that affect the feasibility of their use.

F.1 Stormwater Controls that Promote Infiltration

A wide-range of site-design measures and stormwater treatment measures allow stormwater infiltration and can be categorized as described below and illustrated in Figure F-1.

A. ***Site design measures*** -- such as clustering development or otherwise laying out the site to reduce impervious area, routing drainage from building roofs to landscaped areas, and using pervious pavement.

B. ***Indirect infiltration methods***, which allow storm water runoff to percolate into surface soils. The infiltrated water may either percolate down into subsurface soils and eventually reach groundwater, or it may be underdrained into subsurface pipes. Examples of indirect infiltration methods include bioretention areas and vegetated buffer strips.

C. ***Direct infiltration methods***, which are designed to bypass surface soils and transmit runoff directly to subsurface soils and eventually groundwater. These types of devices must be located and designed to limit the potential for groundwater contamination. Examples of direct infiltration methods include infiltration trenches, infiltration basins, and dry wells.

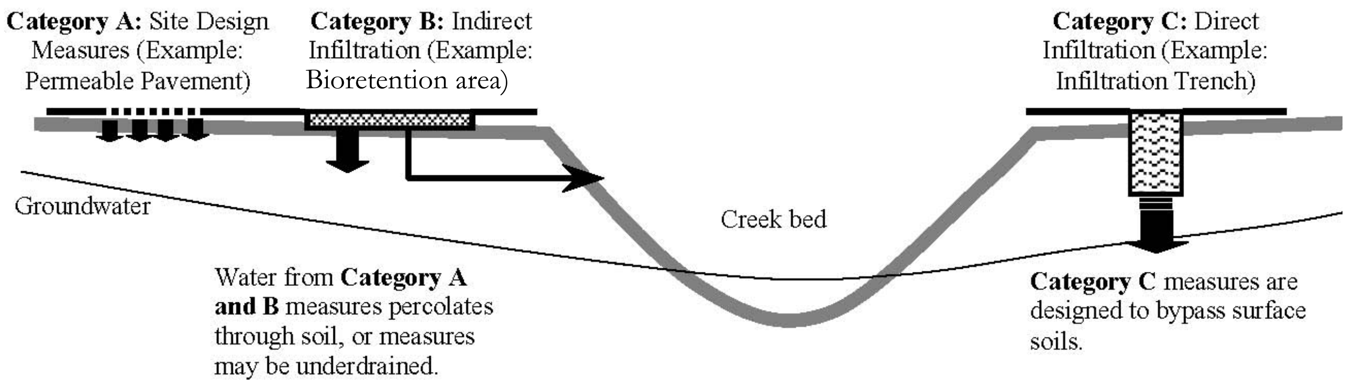

Figure F-1: Stormwater Infiltration Methods (Source: Contra Costa County Clean Water Program, 2005)

Table F-1 describes common stormwater controls and groups them according to whether they meet the above definitions of categories A, B and C. References to the applicable section of Chapter 5 or 6 are given for stormwater controls that have specific technical guidance included in this handbook.

Table F-1
Infiltration Methods in Commonly-Used Stormwater Controls

Stormwater Control	Description	Guidance in Section
	Category A: Site Design Measures	
Disconnected Downspouts	Instead of connecting directly to storm drains, roof runoff is directed away from the building to nearby landscaped areas.	N/A
Site Grading	Using gentler slopes and concave areas to reduce runoff and encourage infiltration.	N/A
Site Layout Practices	Examples: Use compact, multi-story buildings to reduce building footprint, cluster buildings to reduce street length and protect sensitive areas, design narrow streets, use sidewalks on one side of street.	N/A
	Category B: Indirect Infiltration	
Bioretention Area	Briefly ponds stormwater on the surface of a shallow depression and allows it to percolate through permeable soil. May require underdrain if native soils drain poorly.	6.1
Vegetated Buffer Strip	Sloped area with low-growing vegetation that treats runoff by slowing the velocity so sediment and associated pollutants can settle, along with some infiltration.	6.4

Table F-1 Infiltration Methods in Commonly-Used Stormwater Controls		
Stormwater Control	**Description**	**Guidance in Section**
Category B: Indirect Infiltration (continued)		
Pervious Pavements	Special mixes of concrete and asphalt. Require a base course of crushed aggregate and installation by experienced crews.	6.7
Turf Block	A load-bearing, durable surface of impermeable blocks separated by spaces and joints in which soil is planted with turf.	6.8
Unit Pavers	Traditional bricks or other pavers on sand or fine crushed aggregate.	6.8
Cisterns	Above ground storage vessels, sometimes with a manually operated valve, provide infiltration if runoff is stored for post-storm discharge to landscaping.	6.10
	Category C: Direct Infiltration	
Infiltration Trench	A trench with no outlet, filled with rock or open graded aggregate.	6.4
Infiltration Basin	An excavation that exposes relatively permeable soils and impounds water for rapid infiltration.	N/A
Dry Well	Small, deep hole filled with open graded aggregate. Sides may be lined with filter fabric or may be structural (i.e., an open bottom box sunk below grade). Typically receives roof runoff.	N/A
Sources: Contra Costa Clean Water Program, 2005; CASQA, 2003.		

F.2 Factors Affecting Feasibility of Infiltration

The Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report (Feasibility Report) submitted to the Regional Water Board by BASMAA on April 29, 2011 identified the following factors affecting the feasibility of infiltration. These factors are grouped according to whether they apply to "infiltration measures," which provide indirect infiltration, or "infiltration devices," which provide direct infiltration. The MRP defines "infiltration device" as any structure that is deeper than wide and designed to infiltrate stormwater into the subsurface and, as designed, bypass the natural groundwater protection afforded by surface soil. The MRP lists the following as examples of infiltration devices: dry wells, injection wells, infiltration trenches, and French drains.

F.2.1 Factors Affecting Feasibility of Both Indirect and Direct Infiltration

The permeability of the underlying soil is a key factor in determining the feasibility of either direct or indirect infiltration. Additionally there are various factors that may preclude the use of both infiltration measures (indirect infiltration) and infiltration devices (direct infiltration). These include the following:

- Development sites where pollutant mobilization in the soil or groundwater is a documented concern;
- Locations with potential geotechnical hazards;

- Conflicts with the location of existing or proposed underground utilities or easements.

F.2.2 Factors Affecting Feasibility of Direct Infiltration

Factors that specifically preclude the use of infiltration devices (direct infiltration) include the following:

- Locations where policies of local water districts or other applicable agencies preclude infiltration.
- Locations within 100 feet of a groundwater well used for drinking water;
- Appropriate pollution prevention and source control measures, including a minimum of two feet of suitable soil to achieve a maximum of 5 inches/hour infiltration rate;
- Adequate maintenance is provided to maximize pollutant removal capabilities;
- Vertical distance from the base of any infiltration device to the seasonal high groundwater mark is at least 10 feet (or greater if the site has highly porous soils or there are other concerns for groundwater protection);
- Unless stormwater is first treated by a method other than infiltration, infiltration devices are not approved as a treatment measure for stormwater runoff from areas of industrial areas, areas of high vehicular traffic or land uses that pose a high threat to water quality;
- Infiltration devices are not placed in the vicinity of known contaminated sites; and
- Infiltration devices are located a minimum of 100 feet horizontally away from any known water supply wells, septic systems, and underground storage tanks (or greater if the site has highly porous soils or there are other concerns for groundwater protection).

F.3 Dealing with Common Site Constraints

The following tips are intended to help manage constraints to infiltration that are common in Alameda County.

- Where infiltration of the C.3.d amount of runoff is infeasible, bioretention areas may be used if drainage is sufficient or underdrains are provided. The design should maximize infiltration to the underlying soil, as shown in Section 6.1.
- Infiltration is generally infeasible on ***steep or unstable slopes***. Site design measures that limit impervious area may be appropriate if approved by a geotechnical engineer. Consider detaining runoff in green roofs and cisterns, or using stormwater treatment measures that do not infiltrate water into the natural ground, such as flow-through planters.
- Green roofs, cisterns, flow-through planters, and other stormwater controls that are isolated from underlying soils are also appropriate for areas with ***high ground water*** and/or ***groundwater contamination***.
- A variety of ***site design measures*** can often be used even on sites with the constraints described above, including (but not limited to) structural soils, grading

landscaping to a concave form, designing taller buildings with smaller footprints, and concentrating development on less sensitive portions of the site.

F.4 Infiltration Devices and Class V Injection Well Requirements

In order to protect underground sources of drinking water, the USEPA regulates some infiltration devices as Class V wells under its Underground Injection Control (UIC) Program. A Class V injection well is defined as "… any bored, drilled, or driven shaft, or dug hole that is deeper than its widest surface dimension, or an improved sinkhole, or a subsurface fluid distribution system."[1] The USEPA's regulations state that stormwater drainage wells are "authorized by rule" (40 CFR 144), which means they do not require a permit if they do not endanger underground sources of drinking water, and they comply with federal UIC requirements. The USEPA's fact sheet, "When Are Storm Water Discharges Regulated as Class V Wells?" is included at the end of this appendix.

If your project includes one or more infiltration devices that are regulated as Class V injection wells, you will need to submit basic inventory information about the device(s) to the regional office of the USEPA. Instructions for submitting this information are available on the USEPA Region 9 website at http://www.epa.gov/region09/water/groundwater/uic-classv.html. Project sponsors are responsible for constructing, operating and closing the drainage well in a manner that does not risk contaminating underground sources of drinking water. The USEPA may place additional requirements on the infiltration device. Project sponsors should contact the appropriate USEPA staff, identified on the Internet link provided above, to learn what inventory information should be submitted, and when the submittal should be made.

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[1] USEPA Office of Ground Water and Drinking Water, "When Are Storm Water Discharges Regulated as Class V Wells?," June 2003.

Appendix

G

Mosquito Control Guidelines

This appendix presents the guidance for designing and maintaining storm water treatment measures to control mosquitoes from the Clean Water Program's Vector Control Plan. Project sponsors are responsible for incorporating in their treatment measure designs and maintenance plans the Vector Control Plan's design and maintenance guidance, which is presented below.

G.1 Design Guidance for Mosquito Control

The following design considerations were adapted from guidance prepared by the California Department of Health Services,[1] and are provided for project sponsors to use when selecting, designing, and constructing stormwater treatment measures.

General Design Principles

- Preserve natural drainage. Better site design measures reduce the amount of stormwater runoff and provide for natural on-site runoff control. This will reduce the number of stormwater treatment measures required.
- In flat areas, where standing water may occur for more than five days under existing conditions, consider grading to make minor increases in slope to improve surface drainage and prevent standing water.
- Select stormwater treatment measures based on site-specific conditions. Designs that take into account site conditions tend to improve drainage and limit the occurrence of stagnant water.
- Careful consideration should be made before intermittently flooded stormwater treatment measures are selected for handling stormwater. Facilities that pond water temporarily (e.g., extended detention basins) should be designed to drain water completely within five days of a storm event. Avoid placement of extended detention basins and underground structures in areas where they are likely to remain wet (i.e., high water tables). The principal outlet should have positive drainage.

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[1] Metzger, Marco, Vector-Borne Disease Section, California Department of Health Services. "Managing Mosquitoes in Stormwater Treatment Devices," 2004.

- When a new stormwater treatment measure is being installed, consider selecting a type that does not require a wet pond or other permanent pool of water.
- Properly design storm drains. The sheltered environment inside storm drains can promote mosquito breeding. Pipes should be designed and constructed for a rate of flow that flushes the system of sediment and prevents water backing up in the pipe. Storm drains should be constructed so that the invert out is at the same elevation as the interior bottom to prevent standing water.
- Use grouted rock energy dissipaters instead of loose rock.
- In practice, many stormwater treatment measures, not only wet ponds, hold water for over five days, sometimes due to their outdated designs, and possibly due to improper construction and maintenance. To ensure that public health and safety are protected, the following suggestions should be considered for any structure that holds water for over five days:
  - Select or design an alternative (or modified) device that provides adequate - pollutant removal and complete drainage in five days. This is the most reliable and cost-effective choice.
  - Contact state or local public health or vector control agencies to determine whether local mosquito species and local factors may preclude rapid mosquito emergence, thus safely allowing water residence times to exceed five days. In some areas this may require a detailed study that should be funded by the soliciting party.

General Access Requirements for Mosquito Control

The following requirements are necessary to provide mosquito abatement personnel access to treatment measures for inspection and abatement activities.

- Design stormwater treatment measures to be easily and safely accessible without the need for special requirements (e.g., OSHA requirements for “confined space”).
- If utilizing covers, include in the design spring-loaded or light-weight access hatches that can be opened easily for inspection.
- Provide all-weather road access (with provisions for turning a full-size work vehicle) along at least one side of large above-ground structures that are less than 25 feet wide. For structures that have shoreline-to-shoreline distances in excess of 25 feet, a perimeter road is required for access to all sides.

Dry System Design Principles for Mosquito Control

- Structures should be designed so they do not hold standing water for more than five days.
- Incorporate features that prevent or reduce the possibility of clogged discharge orifices (e.g., debris screens). The use of weep holes is not recommended due to rapid clogging.

- Use the hydraulic grade line of the site to select a stormwater treatment measure that allows water to flow by gravity through the structure. Pumps are not recommended because they are subject to failure and often require sumps that hold water.
- Design distribution piping and containment basins with adequate slopes to drain fully and prevent standing water. The design slope should take into consideration buildup of sediment between maintenance periods. Compaction during grading may also be needed to avoid slumping and settling.
- Avoid the use of loose riprap or concrete depressions that may hold standing water.
- Avoid barriers, diversions, or flow spreaders that may retain standing water.
- Use mosquito net to cover sand media filter sump pumps.
- Use aluminum "smoke proof" covers for any vault sedimentation basins.
- Properly design storm drain measures. The sheltered environment inside storm drains can promote mosquito breeding. Pipes should be designed and constructed for a rate of flow that flushes the system of sediment and prevents water backing up in the pipe.

Sumps, Wet Vaults, and Catch Basin Design Principles for Mosquito Control

- Completely seal structures that retain water permanently or longer than five days to prevent entry of adult mosquitoes. Adult female mosquitoes may penetrate openings as small as 1/16 inch (2 mm) to gain access to water for egg laying. Screening (24 mesh screens) can exclude mosquitoes, but it is subject to damage and is not a method of choice.
- If covers are used, they should be tight fitting with maximum allowable gaps or holes of 1/16 inch (2 mm) to exclude entry of adult mosquitoes. Gaskets are a more effective barrier when used properly.
- Any covers or openings to enclosed areas where stagnant water may pool must be large enough (2 feet by 3 feet) to permit access by vector control personnel for surveillance and, if necessary, abatement activities.
- If the sump, vault, or basin is sealed against mosquitoes, with the exception of the inlet and outlet, use a design that will submerge the inlet and outlet completely to reduce the available surface area of water for mosquito egg-laying (female mosquitoes can fly through pipes).
- Creative use of flapper or pinch valves, collapsible tubes and "brush curtains" may be effective for mosquito exclusion in certain designs.
- Design structures with the appropriate pumping, piping, valves, or other necessary equipment to allow for easy dewatering of the unit, if necessary.

Wet Ponds And Wetlands Design Principles for Mosquito Control

- If a wet pond or constructed, modified, or restored wetland must be built, appropriate and adequate funds must be allocated to support long-term site maintenance as well as routine monitoring and management of mosquitoes by a qualified agency.

- Long-term management of mosquitoes in wet ponds and wetlands should integrate biological control, vegetation management and other physical practices, and chemical control as appropriate.
- Provide for regular inspection of sites for detection of developing mosquito populations. Local factors may influence the overall effectiveness of certain approaches for mosquito reduction.
- Wet ponds and wetlands should maintain water quality sufficient to support surface-feeding fish such as mosquito fish (*Gambusia affinis*), which feed on immature mosquitoes and can aid significantly in mosquito control.
- If large predatory fish are present (e.g., perch and bass), mosquito fish populations may be negatively impacted or eradicated. In this case, careful vegetation management remains the only nonchemical mosquito control system.
- Where mosquito fish are not allowed, careful vegetation management remains the only nonchemical mosquito control system. Other predators such as dragonflies, diving beetles, birds, and bats feed on mosquitoes when available, but their effects are generally insufficient to preclude chemical treatment.
- Perform routine maintenance to reduce emergent plant densities. Emergent vegetation provides mosquito larvae with refuge from predators, protection from surface disturbances, and increased nutrient availability while interfering with monitoring and control efforts.
- Whenever possible, maintain wet ponds and wetlands at depths in excess of 4 feet to limit the spread of invasive emergent vegetation such as cattails (*Typha* spp.). Deep, open areas of exposed water are typically unsuitable for mosquito immatures due to surface disturbances and predation. Deep zones also provide refuge areas for fish and beneficial macroinvertebrates should the densely vegetated emergent zones be drained.
- Build shoreline perimeters as steep and uniform as practicable to discourage dense plant growth.
- Use concrete or liners in shallow areas to discourage unwanted plant growth where vegetation is unnecessary.
- Eliminate floating vegetation conducive to mosquito production, such as water hyacinth (*Eichhornia* spp.), duckweed (*Lemna* and *Spirodela* spp.), and filamentous algal mats.
- Make shorelines accessible to maintenance and vector control crews for periodic maintenance, control, and removal of emergent vegetation, as well as for routine mosquito monitoring and abatement procedures, if necessary.
- Improve designs of permanent pools. Minimize shallow depths and increase circulation in ponds. Permanently flooded measures should be stocked with native *Gambusia* minnows to foster biological predation on mosquito larvae.
- Do not use stormwater structures to meet endangered species mitigation requirements. Aquatic habitat for endangered species should not be created near areas populated by humans.

G.2 Maintenance Guidance for Mosquito Control

Routine and timely maintenance is critical for suppressing mosquito breeding as well as for meeting local water quality goals. If maintenance is neglected or inappropriate for a given site, even structures designed to be the least "mosquito friendly" may become significant breeding sites. Although general principles of vector control are described here, maintenance guidelines for individual treatment measures are often site-specific.

The maintenance principles given below are intended to reduce the mosquito population. These principles should be incorporated, as appropriate, in maintenance plans developed for stormwater treatment control measures and in the ongoing maintenance and inspection of treatment measures.

General Maintenance Principles

- With the exception of certain treatment control measures designed to hold permanent water, treatment measures should drain completely within five days to effectively suppress vector production.
- Any circumstances that restrict the flow of water from a system as designed should be corrected. Debris or silt build-up obstructing an outfall structure should be removed. Under drains and filtration media should be inspected periodically and cleaned out or replaced as needed.
- Conduct maintenance activities regularly, in accordance with a municipality-approved maintenance plan.

Vegetation Management Maintenance Principles

- Conduct annual vegetative management, such as removing weeds and restricting growth of aquatic vegetation to the periphery of wet ponds.
- Remove grass cuttings, trash and other debris, especially at outlet structures.
- Avoid producing ruts when mowing (water may pool in ruts).

Dry System Maintenance Principles for Mosquito Control

- Extended detention basins are usually designed to detain water for 40 or 48 hours. If they detain water for longer than five days, they are poorly maintained.
- If a detention basin has been installed at an inappropriate location (e.g., on a site where the water table is too close to the surface), and if elimination or modification of the system isn't possible then mosquitoes must be controlled with larvicides. The larvicide operation, in order to be effective, must be supported by a quality inspection program. Larvacides should only be applied by licensed pesticide applicators.

Underground Structure Maintenance Principles for Mosquito Control

- Prevent mosquito access to underground treatment control measures that may have standing water (i.e., seal openings that are 1/16-inch in diameter or greater).
- Provide vector control agencies access to underground measures that may have standing water.

Infiltration and Filtration Device Maintenance Principles for Mosquito Control

- Infiltration trenches and sand filter structures should not hold water for longer than 24 hours. If they retain water for longer than 48 hours, they are poorly maintained.

Appendix

H

Operation & Maintenance Document Templates

Example templates are provided to assist project applicants in preparing the following documents, which municipalities may require as exhibits to a stormwater treatment measure maintenance agreement:

- Standard Treatment Measure O&M Report Form
- How to Use the Maintenance Plan Templates
- Maintenance Plan for Bioretention[1] Area
- Maintenance Plan for Flow-through Planter
- Maintenance Plan for Tree Well Filter
- Maintenance Plan for Vegetated Buffer Strip
- Maintenance Plan for Infiltration Trench
- Maintenance Plan for Extended Detention Basin
- Maintenance Plan for Media Filter

Requirements vary from one municipality to the next. Contact the local jurisdiction to obtain electronic files for use in preparing these documents, and to obtain information on municipality-specific requirements.

[1] A bioretention area that is unlined and has a raised underdrain in the underlying rock layer to promote infiltration, as shown in Section 6.1, may also be called a "bioinfiltration area".

Bioretention Area[1] Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets_______________________________________

Assessor's Parcel No.: ________________________________

Property Owner: __________________________ Phone No.:__________________

Designated Contact: _______________________ Phone No.:__________________

Mailing Address:____

The property contains [[== insert number ==]] bioretention area(s), located as described below and as shown in the attached site plan[2].

- **Bioretention Area No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other bioretention areas, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead tobioretention area failure. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Bioretention Areas

No.	Maintenance Task	Frequency of Task
1	Remove obstructions, debris and trash from bioretention area and dispose of properly.	Monthly, or as needed after storm events
2	Inspect bioretention area to ensure that it drains between storms and within five days after rainfall.	Monthly, or as needed after storm events
3	Inspect inlets for channels, soil exposure or other evidence of erosion. Clear obstructions and remove sediment.	Monthly, or as needed after storm events
4	Remove and replace all dead and diseased vegetation.	Twice a year
5	Maintain vegetation and the irrigation system. Prune and weed to keep bioretention area neat and orderly in appearance.	Before wet season begins, or as needed
6	Check that mulch is at appropriate depth (3 inches per soil specifications) and replenish as necessary before wet season begins.	Monthly
7	Inspect bioretention area using the attached inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material

II. Prohibitions

The use of pesticides and quick release fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed:

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.

[1] Bioretention areas include linear treatment measures designed for water to filter through biotreatment soils. A bioretention area that is unlined and has a raised underdrain in the underlying rock layer to promote infiltration, as shown in Section 6.1, may also be called a "bioinfiltration area".
[2] Attached site plan must match the site plan exhibit to Maintenance Agreement.

2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.
4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is preferable. Check with municipality for specific requirements.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer's instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

Standing water shall not remain in the treatment measures for more than five days, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Bioretention Area Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Bioretention Area

Inspection and Maintenance Checklist

Property Address: ______________________________ Property Owner: ______________________

Treatment Measure No.: __________ Date of Inspection: __________ Type of Inspection: Monthly Pre-Wet Season After heavy runoff End of Wet Season Other:__________

Inspector(s): ______________________________

Defect	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	Results Expected When Maintenance Is Performed
1. Standing Water	When water stands in the bioretention area between storms and does not drain within five days after rainfall.			There should be no areas of standing water once inflow has ceased. Any of the following may apply: sediment or trash blockages removed, improved grade from head to foot of bioretention area, or added underdrains.
2. Trash and Debris Accumulation	Trash and debris accumulated in the bioretention area.			Trash and debris removed from bioretention area and disposed of properly.
3. Sediment	Evidence of sedimentation in bioretention area.			Material removed so that there is no clogging or blockage. Material is disposed of properly.
4. Erosion	Channels have formed around inlets, there are areas of bare soil, and/or other evidence of erosion.			Obstructions and sediment removed so that water flows freely and disperses over a wide area. Obstructions and sediment are disposed of properly.
5. Vegetation	Vegetation is dead, diseased and/or overgrown.			Vegetation is healthy and attractive in appearance.
6. Mulch	Mulch is missing or patchy in appearance. Areas of bare earth are exposed, or mulch layer is less than 3 inches in depth.			All bare earth is covered, except mulch is kept 6 inches away from trunks of trees and shrubs. Mulch is even in appearance, at a depth of 3 inches.
7. Miscellaneous	Any condition not covered above that needs attention in order for the bioretention area to function as designed.			Meet the design specifications.

Stormwater Treatment Measure Operation and Maintenance
Inspection Report to the [[== Insert Name of Agency==]], California

This report and attached Inspection and Maintenance Checklists document the inspection and maintenance conducted for the identified stormwater treatment measure(s) subject to the Maintenance Agreement between the City and the property owner during the annual reporting period indicated below.

I. Property Information:

Property Address or APN: ____

Property Owner: ____

II. Contact Information:

Name of person to contact regarding this report:_____________________________

Phone number of contact person:_______________ Email:______________________

Address to which correspondence regarding this report should be directed:

____

____

III. Reporting Period:

This report, with the attached completed inspection checklists, documents the inspections and maintenance of the identified treatment measures during the time period from ____________ to __________.

IV. Stormwater Treatment Measure Information:

The following stormwater treatment measures (identified treatment measures) are located on the property identified above and are subject to the Maintenance Agreement:

Identifying Number of Treatment Measure	Type of Treatment Measure	Location of Treatment Measure on the Property

V. Summary of Inspections and Maintenance:

Summarize the following information using the attached Inspection and Maintenance Checklists:

Identifying Number of Treatment Measure	Date of Inspection	Operation and Maintenance Activities Performed and Date(s) Conducted	Additional Comments

VI. Sediment Removal:

Total amount of accumulated sediment removed from the stormwater treatment measure(s) during the reporting period: __________ cubic yards.

How was sediment disposed?

☐ landfill

☐ other location on-site as described in and allowed by the maintenance plan

☐ other, explain ____________________

VII. Inspector Information:

The inspections documented in the attached Inspection and Maintenance Checklists were conducted by the following inspector(s):

Inspector Name and Title	Inspector's Employer and Address

VIII. Certification:

I hereby certify, under penalty of perjury, that the information presented in this report and attachments is true and complete:

____ ____________________
Signature of Property Owner or Other Responsible Party Date

____
Type or Print Name

____
Company Name

____
Address

Phone number:____________________ Email:__________________________________

Using the Maintenance Plan Templates for Stormwater Treatment Measures

The New Development Subcommittee (NDS) of the Clean Water Program has prepared templates that project applicants may use to prepare maintenance plans for the following stormwater treatment measures:

- Bioretention[1] areas,
- Flow-through planters,
- Tree well filters,
- Vegetated buffer strips,
- Infiltration trenches,
- Extended detention basins, and
- Media filters.

These are treatment measures for which technical guidance has been provided in Chapter 6 of the Clean Water Program's C.3 Stormwater Technical Guidance, which may be downloaded from www.cleanwaterprogram.org (click on "for businesses," then "New Development"). In some cases, a treatment measure may be sized to function as both a treatment and hydromodification management (HM) measure, as described in Chapter 7 of the Clean Water Program's C.3 Technical Guidance. If your project includes treatment and/or HM measures that are not listed above, but have been approved by the municipality, you may customize one of the maintenance plan templates with information specific to your treatment/HM measure(s).

Microsoft Word documents of the maintenance plan templates may be downloaded from the above link to the Clean Water Program's New Development webpage. When using a template to prepare your maintenance plan, please insert project-specific information where you find prompts such as the following: [[== insert name of property owner/responsible party ==]]. You will need to attach to your maintenance plan a legible, letter-size (8.5-by-11-inch) site plan showing the location(s) of the treatment/HM measure(s). Also, be sure to contact the municipality to learn about any requirements specific to the local jurisdiction. Agency contact information is provided inside the front cover of the C.3 Technical Guidance.

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[1] A bioretention area that is unlined and has a raised underdrain in the underlying rock layer to promote infiltration, as shown in Section 6.1 of the C.3 Technical Guidance, may also be called a "bioinfiltration area".

Bioretention Area[1] Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets____

Assessor's Parcel No.: ________________________________

Property Owner: __________________________ Phone No.:__________________

Designated Contact: _______________________ Phone No.:__________________

Mailing Address:____

The property contains [[== insert number ==]] bioretention area(s), located as described below and as shown in the attached site plan[2].

- **Bioretention Area No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other bioretention areas, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead tobioretention area failure. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Bioretention Areas

No.	Maintenance Task	Frequency of Task
1	Remove obstructions, debris and trash from bioretention area and dispose of properly.	Monthly, or as needed after storm events
2	Inspect bioretention area to ensure that it drains between storms and within five days after rainfall.	Monthly, or as needed after storm events
3	Inspect inlets for channels, soil exposure or other evidence of erosion. Clear obstructions and remove sediment.	Monthly, or as needed after storm events
4	Remove and replace all dead and diseased vegetation.	Twice a year
5	Maintain vegetation and the irrigation system. Prune and weed to keep bioretention area neat and orderly in appearance.	Before wet season begins, or as needed
6	Check that mulch is at appropriate depth (3 inches per soil specifications) and replenish as necessary before wet season begins.	Monthly
7	Inspect bioretention area using the attached inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material

II. Prohibitions

The use of pesticides and quick release fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed:

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.

[1] Bioretention areas include linear treatment measures designed for water to filter through biotreatment soils. A bioretention area that is unlined and has a raised underdrain in the underlying rock layer to promote infiltration, as shown in Section 6.1, may also be called a "bioinfiltration area".
[2] Attached site plan must match the site plan exhibit to Maintenance Agreement.

2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.
4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is preferable. Check with municipality for specific requirements.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer's instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

Standing water shall not remain in the treatment measures for more than five days, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Bioretention Area Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Bioretention Area

Inspection and Maintenance Checklist

Property Address: ______________________________ Property Owner: ______________________

Treatment Measure No.: __________ Date of Inspection: ________ Type of Inspection: Monthly Pre-Wet Season After heavy runoff End of Wet Season

Inspector(s): ______________________ Other:____________

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Results Expected When Maintenance Is Performed**
1. Standing Water	When water stands in the bioretention area between storms and does not drain within five days after rainfall.			There should be no areas of standing water once inflow has ceased. Any of the following may apply: sediment or trash blockages removed, improved grade from head to foot of bioretention area, or added underdrains.
2. Trash and Debris Accumulation	Trash and debris accumulated in the bioretention area.			Trash and debris removed from bioretention area and disposed of properly.
3. Sediment	Evidence of sedimentation in bioretention area.			Material removed so that there is no clogging or blockage. Material is disposed of properly.
4. Erosion	Channels have formed around inlets, there are areas of bare soil, and/or other evidence of erosion.			Obstructions and sediment removed so that water flows freely and disperses over a wide area. Obstructions and sediment are disposed of properly.
5. Vegetation	Vegetation is dead, diseased and/or overgrown.			Vegetation is healthy and attractive in appearance.
6. Mulch	Mulch is missing or patchy in appearance. Areas of bare earth are exposed, or mulch layer is less than 3 inches in depth.			All bare earth is covered, except mulch is kept 6 inches away from trunks of trees and shrubs. Mulch is even in appearance, at a depth of 3 inches.
7. Miscellaneous	Any condition not covered above that needs attention in order for the bioretention area to function as designed.			Meet the design specifications.

Flow-Through Planter Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets____

Assessor's Parcel No.: ________________________________

Property Owner: _________________________ Phone No.:__________________

Designated Contact: ______________________ Phone No.:__________________

Mailing Address:____

The property contains [[== insert number ==]] Flow-Through Planter(s), located as described below and as shown in the attached site plan[1].

- **Flow-Through Planter No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other Flow-Through Planters, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objectives are to ensure that water flows unimpeded into the flow-through planter and landscaping remains attractive in appearance. Table 1 shows the routine maintenance activities, and the frequency at which they will be conducted.

Table 1
Routine Maintenance Activities for Flow-Through Planters

No.	Maintenance Task	Frequency of Task
1	Evaluate health of trees and groundcover. Remove and replace all dead and diseased vegetation. Treat vegetation using preventative and low-toxic methods.	Twice a year
2	Maintain vegetation and the irrigation system. Prune and weed to keep flow-through planter neat and orderly in appearance.	As needed
3	Check that mulch is at appropriate depth (3 inches per soil specifications) and replenish as necessary.	Monthly
4	Check that soil is at appropriate depth. Till or replace soil as necessary to maintain a minimum of 6 inches between top of mulch and overflow weir.	Before wet season and as necessary
5	Remove accumulated sediment, litter and debris from flow-through planter and dispose of properly. Confirm that no clogging will occur and that the box will drain within three to four hours.	Before wet season and as necessary
6	Inspect flow-through planter to ensure that there are no clogs. Test with garden hose to confirm that the planter will drain within three to four hours.	Monthly during the wet season, and as needed after storm events
7	Inspect downspouts from rooftops and sheet flow from paved areas to ensure flow to planter box is unimpeded. Remove debris and repair damaged pipes. Check splash blocks or rocks and repair, replace and replenish as necessary.	Monthly during the wet season, and as needed after storm events
8	Inspect overflow pipe to ensure that it will safely convey excess flows to storm drain. Repair or replace any damaged or disconnected piping.	Before the wet season, and as necessary
9	Inspect flow-through planter to ensure that box is structurally sound (no cracks or leaks). Repair as necessary.	Annually
10	Inspect flow-through planter using the attached inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material

[1] Attached site plan must match the site plan exhibit to Maintenance Agreement.

II. Prohibitions

The use of pesticides and quick release fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed:

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.
2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.
4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is preferable. Check with municipality for specific requirements.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer's instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

Standing water shall not remain in the treatment measures for more than five days, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Flow-Through Planter Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Flow-Through Planter
Inspection and Maintenance Checklist

Property Address: ____ Property Owner: ____________________________

Treatment Measure No.: __________ Date of Inspection: _________ Type of Inspection: Monthly Pre-Wet Season After heavy runoff End of Wet Season Other:_______________

Inspector(s): ______________________________

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Results Expected When Maintenance Is Performed**
1. Vegetation	Vegetation is dead, diseased and/or overgrown.			Vegetation is healthy and attractive in appearance.
2. Soil	Soil too deep or too shallow.			Soil is at proper depth (per soil specifications) for optimum filtration and flow.
3. Mulch	Mulch is missing or patchy in appearance. Areas of bare earth are exposed, or mulch layer is less than 3 inches in depth.			All bare earth is covered, except mulch is kept 6 inches away from trunks of trees and shrubs. Mulch is even in appearance, at a depth of 3 inches.
4. Sediment, Trash and Debris Accumulation	Sediment, trash and debris accumulated in the flow-through planter. Planter does not drain as specified.			Sediment, trash and debris removed from flow-through planter and disposed of properly. Planter drains within 3-4 hours.
5. Clogs	Soil too deep or too shallow. Sediment, trash and debris accumulated in the flow-through planter. Planter does not drain within five days after rainfall.			Planter drains per design specifications.
6. Downspouts and Sheet Flow	Flow to planter is impeded. Downspouts are clogged or pipes are damaged. Splash blocks and rocks in need of repair, replacement or replenishment.			Downspouts and sheet flow is conveyed efficiently to the planter.
7. Overflow Pipe	Does not safely convey excess flows to storm drain. Piping damaged or disconnected.			Overflow pipe conveys excess flow to storm drain efficiently.
8. Structural Soundness	Planter is cracked, leaking or falling apart.			Cracks and leaks are repaired and planter is structurally sound.
9. Miscellaneous	Any condition not covered above that needs attention in order for the flow-through planter to function as designed.			Meet the design specifications.

Tree Well Filter Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets____

Assessor's Parcel No.: ________________________________

Property Owner: __________________________ Phone No.:__________________

Designated Contact: _______________________ Phone No.:__________________

Mailing Address:____

The property contains [[== insert number ==]] tree well filter(s), located as described below and as shown in the attached site plan[1].

- **Tree Well Filter No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other tree well filters, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead to tree well filter failure. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Tree Well Filters

No.	Maintenance Task	Frequency of Task
1	Evaluate health of trees and groundcover. Remove and replace all dead and diseased vegetation. Treat vegetation using preventative and low-toxic methods.	Twice a year
2	Maintain vegetation and the irrigation system. Prune and weed to keep tree well filter neat and orderly in appearance.	As needed
3	Check that planting mix is at appropriate depth and replenish as necessary.	Before wet season and as necessary
4	Check that mulch is at appropriate depth (3 inches per soil specifications) and replenish as necessary.	Monthly
5	Remove sediment, litter and debris from tree well filter. Confirm that no clogging will occur and that the filter will drain per the design specifications. Dispose of sediment, litter and debris properly.	Before wet season and as necessary
6	Inspect Tree Well Filter to ensure that it drains between storms and within five days after rainfall.	Periodically or as needed after storm events
7	Inspect overflow pipe to ensure that it will safely convey excess flows to storm drain. Repair or replace any damaged or disconnected piping.	As necessary
8	Inspect tree well filter using the attached inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material

[1] Attached site plan must match the site plan exhibit to Maintenance Agreement.

II. Prohibitions

The use of pesticides and quick release fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed:

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.
2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.
4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is preferable. Check with municipality for specific requirements.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer's instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

Standing water shall not remain in the treatment measures for more than five days, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Tree Well Filter Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Tree Well Filter
Inspection and Maintenance Checklist

Property Address: ____ Property Owner: _____________________________

Treatment Measure No.: ___________ Date of Inspection: __________ Type of Inspection: Monthly Pre-Wet Season After heavy runoff End of Wet Season

Inspector(s): ________________________________ Other:________________

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Results Expected When Maintenance Is Performed**
1. Vegetation	Vegetation is dead, diseased and/or overgrown.			Vegetation is healthy and attractive in appearance.
2. Planting Mix	Planting mix too deep or too shallow.			Planting mix is at proper depth for optimum filtration and flow.
3. Mulch	Mulch is missing or patchy in appearance. Areas of bare earth are exposed, or mulch layer is less than 3 inches in depth.			All bare earth is covered, except mulch is kept 6 inches away from trunks of trees and shrubs. Mulch is even in appearance, at a depth of 3 inches.
4. Trash and Debris Accumulation	Trash and debris accumulated in the tree well filter. Filter does not drain as specified.			Trash and debris removed from tree well filter and disposed of properly. Filter drains per design specifications.
5. Sediment	Evidence of sedimentation in tree well filter.			Material removed so that there is no clogging or blockage. Sediment is disposed of properly.
6. Standing Water	When water stands in the tree well filter between storms and does not drain within five days after rainfall.			There should be no areas of standing water once inflow has ceased. Any of the following may apply: sediment or trash blockages removed, overflow pipe repaired.
7. Overflow Pipe	Does not safely convey excess flows to storm drain. Piping damaged or disconnected.			Overflow pipe conveys excess flow to storm drain efficiently.
8. Miscellaneous	Any condition not covered above that needs attention in order for the tree well filter to function as designed.			Meet the design specifications.

Vegetated Buffer Strip Maintenance Plan for [[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets______________________________________

Assessor's Parcel No.: ______________________________

Property Owner: ________________________ Phone No.:_________________

Designated Contact: ______________________ Phone No.:_________________

Mailing Address:____

The property contains [[== insert number ==]] vegetated buffer strip(s), located as described below and as shown in the attached site plan[1].

- **Vegetated Buffer Strip No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other vegetated buffer strips, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective for vegetated buffer strips is to achieve the pollutant removal efficiency of the buffer strip, as designed, by maintaining a dense, healthy vegetated cover. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Vegetated Buffer Strips

No.	Maintenance Task	Frequency of Task
1	Mow turf grass to [[==indicate height ==]]. Remove grass cuttings. Avoid producing ruts when mowing.	[[== insert frequency ==]]
2	Irrigate during dry weather.	[[== insert frequency to maintain design height ==]]
3	Remove obstructions and trash from vegetated buffer strip and dispose of properly.	Monthly, or as needed
4	Inspect buffer strip to check for erosion and sediment and debris accumulation. Dispose of sediment and debris properly.	Twice a year: 1) one inspection at the end of the wet season in order to plan and schedule summer maintenance, 2) the other inspection after periods of heavy runoff
5	Remove sediment accumulating near culverts and in channels when it builds up to 75 millimeters (3 inches) at any spot, or if it covers vegetation. Dispose of sediment properly.	As needed
6	Inspect buffer strip using the attached inspection checklist.	Monthly, or as needed

II. Prohibitions

The use of pesticides and quick release fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed:

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.
2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.

[1] Attached site plan must match the site plan exhibit to Maintenance Agreement.

4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is preferable. Check with municipality for specific requirements.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer's instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

Standing water shall not remain in the treatment measures for more than five days, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Bioretention Area Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Vegetated Buffer Strip
Inspection and Maintenance Checklist

Property Address: ______________________________ Property Owner: ______________________

Treatment Measure No.: __________ Date of Inspection: __________ Type of Inspection: Monthly Pre-Wet Season After heavy runoff End of Wet Season

Inspector(s): ______________________ Other:__________

Defect	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	Results Expected When Maintenance Is Performed
1. Sediment Accumulation on Vegetation	Sediment accumulating near culverts and/or in channels builds up to 75 millimeters (3 inches) at any spot, or it covers vegetation			Remove accumulated sediment deposits. When finished, buffer strip should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased. Dispose of sediment properly.
2. Standing Water	Water stands in the buffer strip between storms and does not drain within five days after rainfall.			There should be no areas of standing water once inflow has ceased. Any of the following may apply: sediment or trash blockages removed, improved grade from head to foot of buffer strip, removed clogged check dams, added underdrains or converted to a wet buffer strip.
3. Flow spreader (if any)	Flow spreader uneven or clogged such that flows are not uniformly distributed through entire buffer strip width.			Spreader leveled and cleaned so that flows are spread evenly over entire buffer strip width.
4. Constant Baseflow	When small quantities of water continually flow through the buffer strip, even when it has been dry for weeks, and an eroded, muddy channel has formed in the buffer strip bottom.			No eroded, muddy channel on the bottom. A low-flow pea-gravel drain may be added the length of the buffer strip.
5. Poor Vegetation Coverage	When planted vegetation is sparse or bare or eroded, patches occur in more than 10% of the buffer strip bottom.			Vegetation coverage in more than 90% of the buffer strip bottom. Determine why growth of planted vegetation is poor and correct that condition. Replant with plugs of vegetation from the upper slope: plant in the buffer strip bottom at 8-inch intervals, or reseed into loosened, fertile soil.

Defect	**Conditions When Maintenance is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Results Expected When Maintenance Is Performed**
6. Vegetation	When the planted vegetation becomes excessively tall; when nuisance weeds and other vegetation start to take over.			Vegetation mowed per specifications or maintenance plan, or nuisance vegetation removed so that flow is not impeded. Vegetation should never be mowed lower than the design flow depth. Remove clippings from the buffer strip and dispose appropriately.
7. Excessive Shading	Growth of planted vegetation is poor because sunlight does not reach buffer strip.			Healthy growth of planted vegetation. If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
8. Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.			Material removed so that there is no clogging or blockage in the inlet and outlet areas.
9. Trash and Debris Accumulation	Trash and debris accumulated in the buffer strip.			Trash and debris removed from buffer strip. Dispose of trash and debris properly.
10. Erosion/ Scouring	Eroded or scoured buffer strip bottom due to flow channelization, or higher flows.			No erosion or scouring in buffer strip bottom. For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the buffer strip should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the buffer strip bottom at 8-inch intervals.
11. Miscellaneous	Any condition not covered above that needs attention in order for the vegetated buffer strip to function as designed.			Meet the design specifications.

Infiltration Trench Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets____

Assessor's Parcel No.: ________________________________

Property Owner: __________________________ Phone No.:__________________

Designated Contact: _______________________ Phone No.:__________________

Mailing Address:____

The property contains [[== insert number ==]] infiltration trench(es), located as described below and as shown in the attached site plan.

- **Infiltration Trench No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other infiltration trenches, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead to trench failure. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Infiltration Trenches

No.	Maintenance Task	Frequency of Task
1	Remove obstructions, debris and trash from infiltration trench and dispose of properly.	Monthly, or as needed after storm events
2	Inspect trench to ensure that it drains between storms, and within 5 days after rainfall. Check observation well 2-3 days after storm to confirm drainage.	Monthly during wet season, or as needed after storm events
3	Inspect filter fabric for sediment deposits by removing a small section of the top layer.	Annually
4	Monitor observation well to confirm that trench has drained during dry season.	Annually, during dry season
5	Mow and trim vegetation around the trench to maintain a neat and orderly appearance.	As needed
6	Remove any trash, grass clippings and other debris from the trench perimeter and dispose of properly.	As needed
7	Check for erosion at inflow or overflow structures.	As needed
8	Confirm that cap of observation well is sealed.	At every inspection
9	Inspect infiltration trench using the attached inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material

II. Prohibitions

Trees and other large vegetation shall be prevented from growing adjacent to the trench to prevent damage.

Standing water shall not remain in the treatment measures for more than five days, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Infiltration Trench Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Infiltration Trench
Inspection and Maintenance Checklist

Property Address: ____ Property Owner: ________________________________

Treatment Measure No.: ____________ Date of Inspection: ___________ Type of Inspection: Monthly Pre-Wet Season After heavy runoff End of Wet Season Other:__________________

Inspector(s): ____________________________________

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Results Expected When Maintenance Is Performed**
1. Standing Water	When water stands in the infiltration trench between storms and does not drain within 5 days after rainfall.			There should be no areas of standing water once inflow has ceased. Any of the following may apply: sediment or trash blockages removed, improved grade from head to foot of infiltration trench, removed clogging at check dams, or added underdrains.
2. Trash and Debris Accumulation	Trash and debris accumulated in the infiltration trench.			Trash and debris removed from infiltration trench and disposed of properly.
3. Sediment	Evidence of sedimentation in trench. Less than 50% storage volume remaining in sediment traps, forebays or pretreatment swales.			Material removed and disposed of properly so that there is no clogging or blockage.
4. Inlet/Outlet	Inlet/outlet areas clogged with sediment or debris, and/or eroded.			Material removed and disposed of properly so that there is no clogging or blockage in the inlet and outlet areas.
5. Overflow Spillway	Clogged with sediment or debris, and/or eroded.			Material removed and disposed of properly so that there is no clogging or blockage, and trench is restored to design condition.
6. Filter Fabric	Annual inspection, by removing a small section of the top layer, shows sediment accumulation that may lead to trench failure.			Replace filter fabric, as needed, to restore infiltration trench to design condition.
7. Observation Well	Routine monitoring of observation well indicates that trench is not draining within specified time or observation well cap is missing.			Restore trench to design conditions. Observation well cap is sealed.
8. Miscellaneous	Any condition not covered above that needs attention in order for the infiltration			Meet the design specifications.

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Results Expected When Maintenance Is Performed**
	trench to function as designed.			

Extended Detention Basin Maintenance Plan for [[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets____

Assessor's Parcel No.: ________________________________

Property Owner: _________________________ Phone No.:__________________

Designated Contact: ______________________ Phone No.:__________________

Mailing Address:____

The property contains [[== insert number ==]] extended detention basins, located as described below and as shown in the attached site plan.

- **Extended Detention Basin No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other extended detention basins, if applicable. ==]]
- [[==Identify Extended Detention Basin(s) designed for Hydromodification Management (HM).]]

I. Routine Maintenance Activities

Primary maintenance activities include vegetation management and sediment removal, although mosquito abatement is a concern if the extended detention basin is designed to include permanent pools of standing water. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Extended Detention Basins

No.	Maintenance Task	Frequency of Task
1	Conduct annual vegetation management during the summer, removing weeds and harvesting vegetation. Remove all grass cuttings and other green waste.	Once a year
2	Trim vegetation at beginning and end of wet season to prevent establishment of woody vegetation, and for aesthetics and mosquito control.	Twice a year (spring and fall)
3	Evaluate health of vegetation and remove and replace any dead or dying plants. Remove all green waste and dispose of properly.	Twice a year
4	If turf grass is included in basin design, conduct regular mowing and remove all grass cuttings. Avoid producing ruts when mowing.	[[== insert frequency, if applicable ==]]
5	Remove sediment from forebay when the sediment level reaches the level shown on the fixed vertical sediment marker and dispose of sediment properly.	As needed
6	Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of basin volume and dispose of sediment properly.	Every 10 years, or as needed [[to maintain 2 in. clearance below low-flow orifice for HM design]]
7	Remove accumulated trash and debris from the extended detention basin at the middle and end of the wet season and dispose of trash and debris properly.	Twice a year (January and April)
8	Irrigate during dry weather.	[[== insert frequency ==]]
9	Inspect extended detention basin using the attached inspection checklist.	Quarterly, or as needed

II. Prohibitions

The use of pesticides and quick release fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed:

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.
2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.
4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is preferable. Check with municipality for specific requirements.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer’s instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

Standing water shall not remain in the treatment and/or hydromodification management measures for more than five days, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Extended Detention Basin Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Extended Detention Basin
Inspection and Maintenance Checklist

Property Address: ____ Property Owner: _______________________________________

Treatment Measure No.: ____________ Date of Inspection: ___________ Type of Inspection: Monthly Pre-Wet Season After heavy runoff End of Wet Season Other:_________________

Inspector(s): ________________________________

Defect	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (Describe maintenance completed and if any needed maintenance was not conducted, note when it will be done.)	Results Expected When Maintenance Is Performed
General				
Trash & Debris	• Trash and debris accumulated in basin. • Visual evidence of dumping.			Trash and debris cleared from site and disposed of properly.
Poisonous Vegetation and noxious weeds	Poisonous or nuisance vegetation or noxious weeds, e.g., morning glory, English ivy, reed canary grass, Japanese knotweed, purple loosestrife, blackberry, Scotch broom, poison oak, stinging nettles, or devil's club.			Use Integrated Pest Management techniques to control noxious weeds or invasive species.
Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants.			No contaminants or pollutants present.
Rodent Holes	If facility acts as a dam or berm, any evidence of rodent holes, or any evidence of water piping through dam or berm via rodent holes.			The design specifications are not compromised by holes. Any rodent control activities are in accordance with applicable laws and do not affect any protected species.
Insects	Insects such as wasps and hornets interfere with maintenance activities.			Insects do not interfere with maintenance activities.

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if any needed maintenance was not conducted, note when it will be done.)	**Results Expected When Maintenance Is Performed**
Tree/Brush Growth and Hazard Trees	• Growth does not allow maintenance access or interferes with maintenance activity. • Dead, diseased, or dying trees.			• Trees do not hinder maintenance activities. • Remove hazard trees as approved by the City. (Use a certified Arborist to determine health of tree or removal requirements).
Drainage time	Standing water remains in basin more than five days.			Correct any circumstances that restrict the flow of water from the system. Restore drainage to design condition. If the problem cannot be corrected and problems with standing water recur, then mosquitoes should be controlled with larvicides, applied by a licensed pesticide applicator.
Outfall structure	Debris or silt build-up obstructs an outfall structure.			Remove debris and/or silt build-up and dispose of properly.
Side Slopes				
Erosion	• Eroded over 2 in. deep where cause of damage is still present or where there is potential for continued erosion. • Any erosion on a compacted berm embankment.			Cause of erosion is managed appropriately. Side slopes or berm are restored to design specifications, as needed.
Storage Area				
Sediment	Accumulated sediment >10% of designed basin depth or affects inletting or outletting condition of the facility.			Sediment cleaned out to designed basin shape and depth; basin reseeded if necessary to control erosion. Sediment disposed of properly.
Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.			Liner repaired or replaced. Liner is fully covered.
Emergency Overflow/ Spillway and Berms				
Settlement	Berm settlement 4 inches lower than the design elevation.			Dike is built back to the design elevation.

Defect	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (Describe maintenance completed and if any needed maintenance was not conducted, note when it will be done.)	Results Expected When Maintenance Is Performed
Tree Growth	Tree growth on berms or emergency spillway >4 ft in height or covering more than 10% of spillway.			• Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. • A civil engineer should be consulted for proper berm/spillway restoration.
Emergency Overflow/ Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.			Rocks and pad depth are restored to design standards.
Debris Barriers (e.g., Trash Racks)				
Trash and Debris	Trash or debris is plugging openings in the barrier.			Trash or debris is removed and disposed of properly.
Damaged/ Missing Bars	Bars are missing, loose, bent out of shape, or deteriorating due to excessive rust.			Bars are repaired or replaced to allow proper functioning of trash rack.
Inlet/Outlet Pipe	Debris barrier is missing or not attached to pipe.			Debris barrier is repaired or replaced to allow proper functioning of trash rack.
Fencing and Gates				
Missing or broken parts	Any defect in or damage to the fence or gate that permits easy entry to a facility.			Fencing and gate are restored to design specifications.
Deteriorating Paint or Protective Coating	Part or parts that have a rusting or scaling condition that has affected structural adequacy.			Paint or protective coating is sufficient to protect structural adequacy of fence or gate.
Flow Duration Control Outlet (if included in design to meet Hydromodification Management Standard) [[==refer to any attachments with additional provisions==]]				
Risers, orifices and screens	Any debris or clogging			Restore unobstructed flow through discharge structure; to meet original design; dispose of debris properly.
Miscellaneous				
Miscellan-ous	Any condition not covered above that needs attention to restore extended detention basin to design conditions.			Meets the design specifications.

Media Filter Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets____

Assessor's Parcel No.: ________________________________

Property Owner: __________________________ Phone No.:__________________

Designated Contact: _______________________ Phone No.:__________________

Mailing Address:____

The property contains [[== insert number ==]] media filter(s), located as described below and as shown in the attached site plan[1].

- **Media Filter No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other media filters, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead to Media Filter failure. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Media Filters

No.	Maintenance Task	Frequency of Task
1	Inspect for standing water, sediment, trash and debris.	Monthly during rainy season
2	Remove sediment, trash and debris from sedimentation basin, riser pipe and filter bed. Dispose of sediment, trash and debris properly.	As needed
3	Ensure that media filter drains completely within five days.	After major storm events and as needed.
4	For media filters with a filter bed, inspect media depth to ensure proper drainage.	Monthly during rainy season, or as needed after storm events
5	For manufactured media filter, follow manufacturer's guidelines for maintenance and cartridge replacement.	As per manufacturer's specifications.
6	Inspect Media Filter using the attached inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material

II. Prohibitions

Trees and other large vegetation shall be prevented from growing adjacent to the media filter to prevent damage.

Standing water shall not remain in the treatment measures for more than five days, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

[1] Attached site plan must match the site plan exhibit to Maintenance Agreement.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

III. Inspections

The attached Media Filter Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Media Filter
Inspection and Maintenance Checklist

Property Address: ____ Property Owner: _____________________________

Treatment Measure No.: ___________ Date of Inspection: __________ Type of Inspection: Monthly Pre-Wet Season

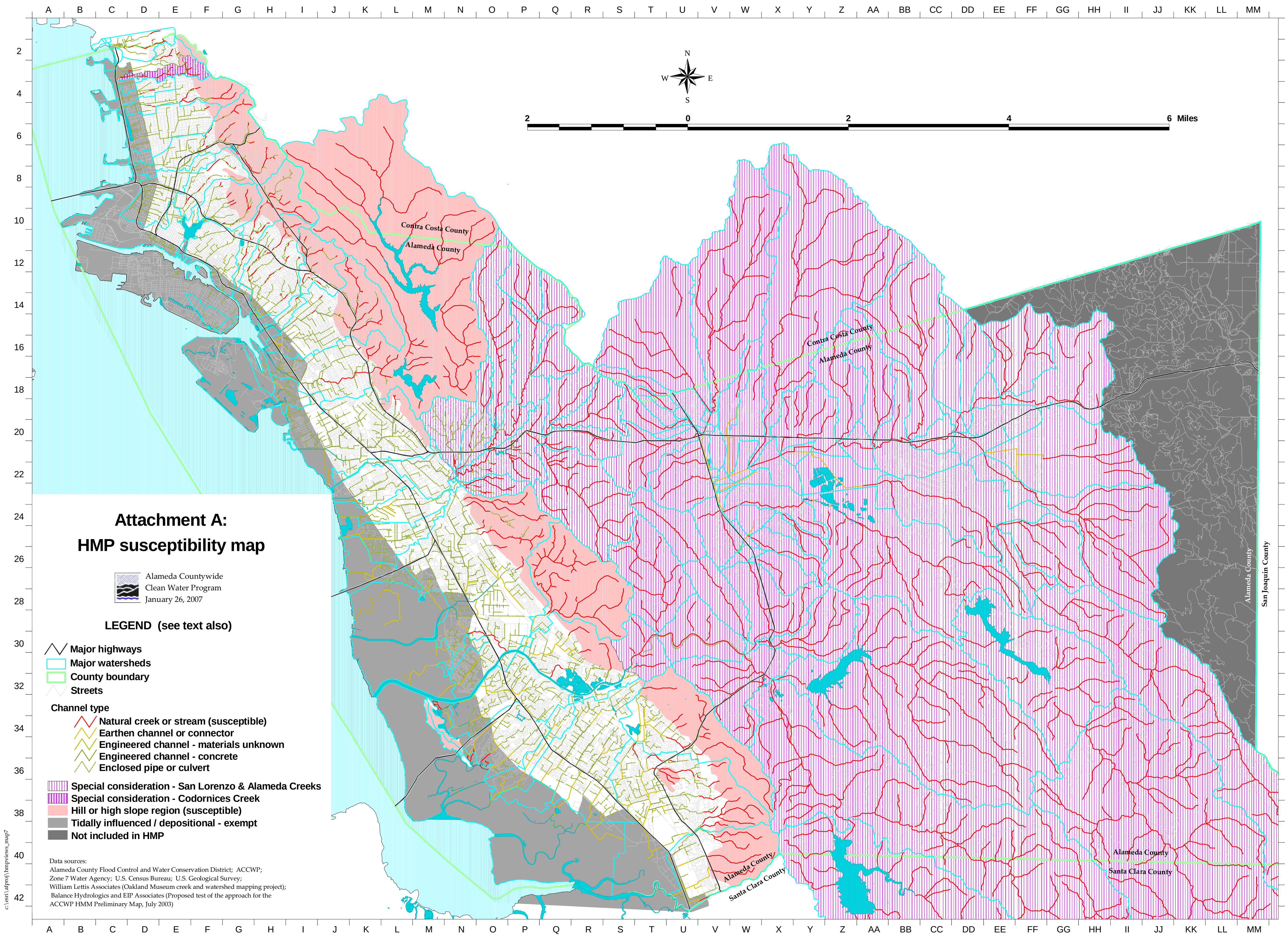
After heavy runoff End of Wet Season

Inspector(s): ________________________________ Other:________________

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Results Expected When Maintenance Is Performed**
1. Sediment, trash and debris accumulation	Sediment, trash and debris accumulated in the sedimentation basin, riser pipe and filter bed. Filter does not drain as specified.			Sediment, trash and debris removed from sedimentation basin, riser pipe and filter bed and disposed of properly. Filter drains per design specifications.
2. Standing water	Media filter does not drain within five days after rainfall.			Clogs removed from sedimentation basin, riser pipe and filter bed. Filter drains per design specifications.
3. Mosquitoes	Evidence of mosquito larvae in media filter.			Clogs removed from sedimentation basin, riser pipe and filter bed. Filter drains per design specifications.
4. Filter bed	Overall media depth 300 millimeters (12 inches) or less.			Media depth restored to 450 millimeters (18 inches).
5. Miscellaneous	Any condition not covered above that needs attention in order for the media filter to function as designed.			Meet the design specifications.

Hydromodification Management Susceptibility Map

This map in this appendix shows a portion of the Hydromodification Management Susceptibility Map included in the Municipal Regional Stormwater Permit (MRP). This map is available for download in a format that enables zooming to a closer view of the project vicinity with local streets. A link for downloading this map is anticipated to be available on Development page of the Clean Water Program's website (www.cleanwaterprogram.org, click on "Businesses", then click on "Development Related Issues"). Until the map is uploaded to that site, you can contact the Clean Water Program to obtain the map file by going to www.cleanwaterprogram.org, clicking on the "Contact Us" tab and filling out your contact information.


Attachment A:
HMP susceptibility map
Alameda Countywide
Clean Water Program
January 26, 2007
LEGEND (see text also)
Major highways
Major watersheds
County boundary
Streets
Channel type
Natural creek or stream (susceptible)
Earthen channel or connector
Engineered channel - materials unknown
Engineered channel - concrete
Enclosed pipe or culvert
Special consideration - San Lorenzo & Alameda Creeks
Special consideration - Codornices Creek
Hill or high slope region (susceptible)
Tidally influenced / depositional - exempt
Not included in HMP
Data sources:
Alameda County Flood Control and Water Conservation District; ACCWP;
Zone 7 Water Agency; U.S. Census Bureau; U.S. Geological Survey;
William Lettis Associates (Oakland Museum creek and watershed mapping project);
Balance Hydrologics and EIP Associates (Proposed test of the approach for the
ACCWP HMM Preliminary Map, July 2003)
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Appendix

J

Feasibility Evaluation: Infiltration and Rainwater Harvesting/Use

The purpose of this guidance is to assist project applicants and agency staff in determining whether it is feasible or infeasible for individual projects to treat the full water quality design flow or volume of stormwater runoff, as specified in MRP Provision C.3.d, using infiltration or rainwater harvesting and use[1]. Where this is infeasible, biotreatment will be allowed. The information presented in this guidance is based on the "Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report" (referred to as the "Feasibility Report") prepared by the Bay Area Stormwater Management Agencies Association (BASMAA) and submitted to the Regional Water Board in 2011[2]. The guidance also assists project applicants and agency staff in evaluating whether a project qualifies as a "Special Project" that is eligible for LID treatment reduction credits, and if so, what credits will apply.

Table of Contents

J.1 General Approach

BASMAA's member agencies have collaborated to develop worksheets to assist project applicants and municipal staff in evaluating the feasibility and infeasibility of infiltration or rainwater harvesting and use, and determining the project's eligibility for Special Project LID

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[1] Provision C.3.c of the MRP requires that the C.3.d amount or runoff be treated with infiltration, evapotranspiration, or harvesting and use, or, where this is infeasible, biotreatment. Evapotranspiration will occur in all landscape-based treatment and was incorporated in modeling of infiltration and rainwater harvesting/use conducted for the Feasibility Report.

[2] This report is available on the Clean Water Program's website (www.cleanwaterprogram.org – click on "Businesses", then "Development Resources" and scroll to "Feasibility Infeasibility Criteria Report").

treatment reduction credits. The steps in this process are shown in the flow chart (Figure J-1) and listed below:

- ***Step 1:*** Complete the Infiltration/Harvesting and Use Feasibility Screening worksheet (screening worksheet), to evaluate whether the project may potentially fall into one of the following categories:
    a. Is it potentially a Special Project? (If so, complete the Special Projects Worksheet in Step 2)
    b. Is it infeasible to infiltrate the full C.3.d amount of runoff? (If not, complete the Infiltration Feasibility Worksheet in Step 2.)
    c. Is it infeasible to harvest and use the full C.3.d amount of runoff? (If not, complete the Rainwater Harvesting Feasibility Worksheet in Step 2.)
- ***Step 2:*** Either complete the applicable worksheet(s) or, if no further analysis is needed, go to Step 3d.
- ***Step 3:*** Depending on which additional worksheet(s) is/are completed, any of the following outcomes may result:
    a. If the project is a Special Project that receives 100 percent LID treatment reduction, up to 100 percent of the C.3.d amount of stormwater runoff may be treated with media filters and/or manufactured tree well filters.
    b. If infiltration of the C.3.d amount of runoff (or the remainder after deducting any Special Projects LID treatment reduction credit) is found to be feasible, then the project must infiltrate the required amount of runoff, unless it is harvested and used.
    c. If rainwater harvesting and use of the C.3.d amount of runoff (or the remainder after deducting any Special Projects LID treatment reduction credit) is found to be feasible, then the project must harvest and use the required amount of runoff, unless it is infiltrated.
    d. If the required amount of runoff cannot be infiltrated or harvested and used, implement biotreatment, except for any Special Project LID treatment reduction that may be allowed. Where conditions allow, the biotreatment measures should maximize infiltration.

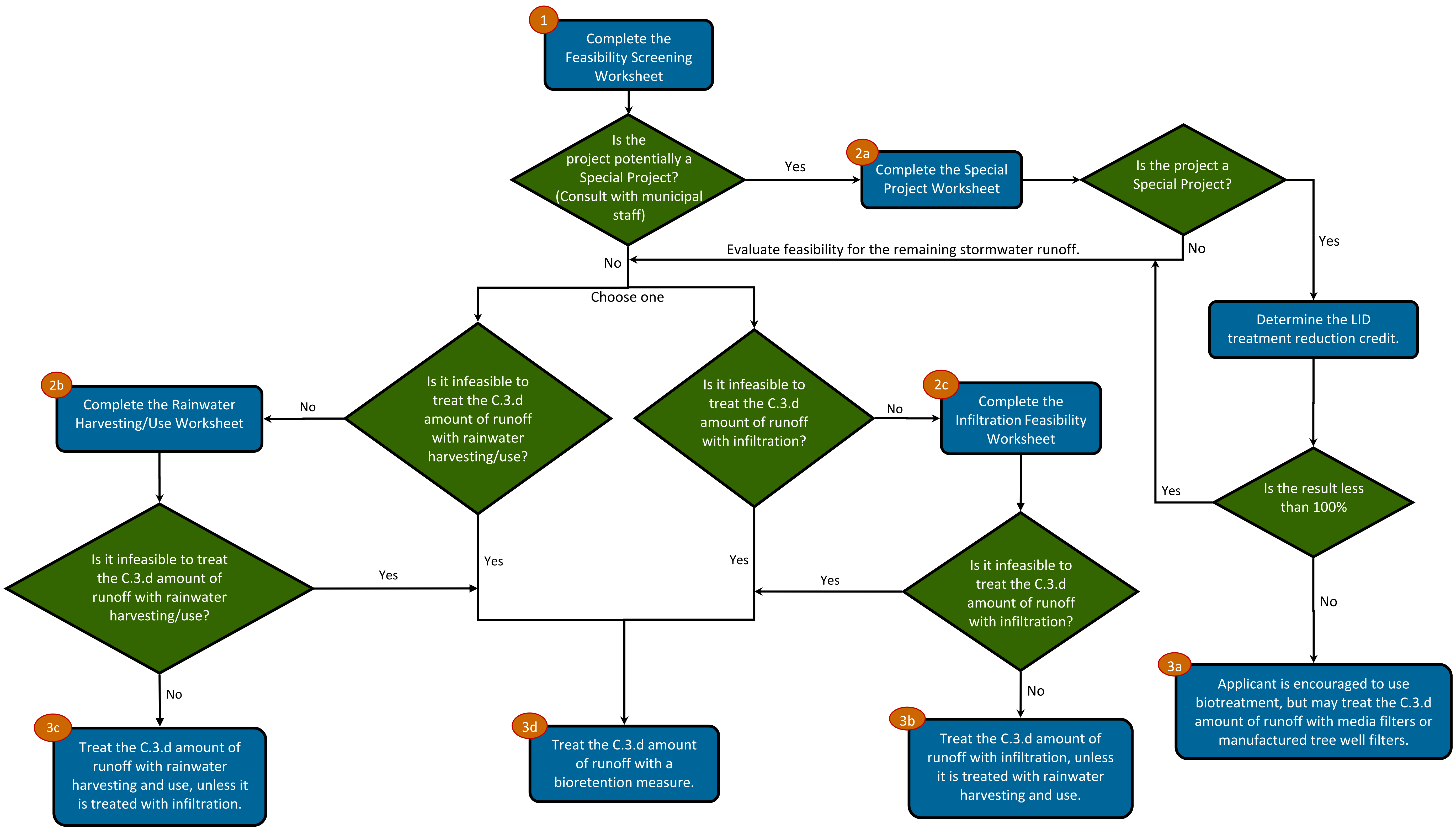

Figure J-1: Flow chart of feasibility and infeasibility evaluation process

J.2 Infiltration/Rainwater Harvesting and Use Feasibility Screening Worksheet Guidance

Many projects will complete only the screening worksheet, and will not have to complete the other worksheets related to feasibility. This worksheet screens out from further evaluation projects that clearly cannot infiltrate or harvest and use the C.3.d amount of runoff. The worksheet is organized around the following topics:

- Special Projects pre-screening,
- Feasibility screening for infiltration,
- Recycled water use,
- Calculate the potential rainwater capture area,
- Feasibility screening for rainwater harvest and use,
- Use of biotreatment, and
- Results of Screening Analysis

Special Projects Pre-Screening

The instructions under the worksheet title on page 1 instruct the applicant to contact municipal staff to determine whether the project meets the criteria for Special Projects. To make this determination, municipal staff may use the Special Projects Worksheet (download from www.cleanwaterprogram.org, click on "Businesses", then "Development Related Issues") and refer to the Special Projects criteria in Appendix K. If the project qualifies as a Special Project LID treatment may be required for a specified percentage of the C.3.d amount of stormwater runoff from the project. The following guidance applies if the project is found to be a Special Project:

- If the Special Project receives 100 percent LID treatment reduction, the project is allowed to treat the entire C.3.d amount of stormwater runoff with high flow-rate tree box filters or high flow rate media filters. There is no need to fill out the screening form.
- If the Special Project receives less than 100 percent LID reduction, the project must evaluate the feasibility of infiltrating or harvesting and using the remaining C.3.d amount of stormwater runoff. To do this, complete Sections 1, 2, 3 and 7 of the screening form to evaluate infiltration feasibility and identify any use of recycled water. Then fill out the Rainwater Harvesting and Use Feasibility Worksheet to evaluate the feasibility of treating the remaining percentage of the C.3.d amount of runoff with harvesting and use. Information about using these forms is provided below.
- As required in Provision C.3.e.vi(2), a narrative discussion must be provided of the feasibility or infeasibility of 100 percent LID treatment.

Screening Worksheet Section 2: Feasibility Screening for Infiltration

This question is based on the how efficiently soils at the project site can infiltrate water. Where possible, base your response on information in a project-specific soils report.

- If the soils report includes the saturated hydraulic conductivity (Ksat) for onsite soils, use this as the basis for determining feasibility of infiltration. The Feasibility Report found that infiltration of the C.3.d amount of runoff is infeasible where soils have a Ksat of less than 1.6 inches/hour.

- If the site-specific soil report does not include the Ksat, but does include the soil type, then base the feasibility determination on soil type. If the soils at the project site consist of Type C or Type D, then infiltration of the C.3.d amount of runoff is infeasible.
- If the above information is unavailable for the project site, then base the feasibility determination on the Ksat value shown on the map included in Attachment 3. You can also obtain Natural Resource Conservation Service soil survey data (the basis for the attached maps) at the following website: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm. Where possible, this information should be confirmed with site-specific data.

Screening Worksheet Section 3: Recycled Water Use

If the project will install and use a recycled water system for non-potable water use, then rainwater harvesting is considered to be infeasible, and you can skip to Section 6 of this form. It would not be cost effective for a project to be required to install two plumbing systems for non-potable water. Recycled water is given priority over rainwater for non-potable water use because of the year-round availability and consistent quality of recycled water, the municipalities' investments in recycled water infrastructure, and the requirement for wastewater treatment facilities to find reliable uses for recycled water.

Screening Worksheet Section 4: Potential Rainwater Capture Area

If a recycled water system is not used, further evaluation of rainwater harvesting/use feasibility is based on whether there is sufficient demand for the amount of rainwater that would potentially be captured by the project. The first step in this evaluation is to identify the potential rainwater capture area for the entire project area. Please note that this section, and Section 5, should not be completed for Special Projects that receive less than 100 percent LID treatment reduction. This form is not designed to take Special Projects treatment reductions into account. The Rainwater Harvesting and Use Feasibility Form does account for these reductions and should be used to evaluate the feasibility of harvest and use based on demand.

After the worksheet is completed for the entire project, if rainwater harvesting and use is infeasible, AND, if the project includes one or more buildings with a roof area of 10,000 square feet or more, then Sections 4 and 5 should be completed for each individual roof that has an area of 10,000 square feet or more.[3]

- ***Table 1: Calculation of the Potential Rainwater Capture Area.*** The purpose of completing this table is to identify the area from which rainwater could potentially be captured and stored for use.

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[3] The Feasibility Report indicated that rainwater harvesting/use feasibility would be determined on a drainage management area (DMA) basis. BASMAA has identified roofs of this size as the appropriate level of analysis for determining rainwater harvesting feasibility on a DMA basis.

- ***Question 4.2: "50 Percent Rule."*** When evaluating the entire project, indicate whether the amount of any impervious surface that is replaced by the project is at least 50 percent, but less than 100 percent, of the existing impervious surface at the project site.
  - If the area of impervious surface to be replaced is at least 50 percent but less than 100 percent of the existing impervious surface, then the stormwater runoff from all the existing impervious surface will be included in the Potential Rainwater Capture Area. (This is referred to as "the 50 percent rule.")
  - If the amount to be replaced is less than 50 percent of the existing impervious surface, then only the stormwater runoff from the new and/or replaced impervious surface will need to be treated.

- ***Questions 4.3 and 4.4: Potential Rainwater Capture Area:*** After taking the "50 percent rule" into consideration, enter the total area (in square feet) that will need to receive stormwater treatment. This is the potential rainwater capture area. This result then needs to be converted to acres, since some criteria that will be used to evaluate rainwater harvesting feasibility are per acre of impervious surface.

Screening Worksheet Section 5: Screening for Rainwater Harvest/Use

- ***Question 5.1: Feasibility of Irrigation use.*** Respond to this question if the project includes landscaping. This is based on a screening criterion derived from Table 11 in the Feasibility Report (included in Attachment 3 of this guidance), which presents ratios of "Effective Irrigated Area to Impervious Area" (EIATIA) for each of the rain gauge areas that were evaluated in the report. The multiplier shown in the Question 5.1 applies to areas of turf landscaping in the San Jose rain gauge area, which is the lowest EIATIA for the county.

- ***Question 5.2a: Residential toilet flushing.*** Answer this question only for projects that consist entirely of residential use, and for the residential portion of mixed use projects that include some residential use. This question is based on a screening criterion derived from Attachment 2: Toilet-Flushing Demand for Harvested Rainwater. The threshold number of dwelling units per acre shown in Question 5.2a specifically applies to toilet flushing demand in the San Jose rain gauge area, which is the lowest demand threshold for residential toilet flushing feasibility in the county.

- ***Question 5.2b: Commercial/Institutional/Industrial Toilet Flushing.*** Answer this question only for projects that consist entirely of commercial and/or institutional and/or industrial use, and for the commercial portion of mixed commercial and residential use projects. This question is based on screening criteria derived from California Plumbing Code building occupancy load factors and Table 10 in the Feasibility Report, which identifies the required toilet flushing demand based on employees per impervious acre (Table 10 is included in Attachment 3). The feasibility threshold in Question 5.2b is provided in terms of square feet of interior floor area per acre of impervious surface. This threshold indicates that, at this ratio of interior floor area to impervious surface, rainwater harvesting and use for non-residential and non-school toilet flushing is feasible in the San Jose rain gauge area. The San Jose rain gauge threshold is the lowest demand threshold for non-residential and non-school toilet flushing feasibility in the county.

- ***Question 5.2c: School Toilet Flushing.*** Answer this question only for school projects. This question is based on screening criteria derived from California Plumbing Code building occupancy load factors and Table 10 in the Feasibility Report (see Attachment 3), which identifies the required toilet flushing demand based on employees per impervious acre. The feasibility threshold in Question 5.2c is provided in terms of square feet of interior floor area per acre of impervious surface. This threshold indicates that, at this ratio of interior floor area to impervious surface, rainwater harvesting and use for school toilet flushing is feasible in the San Jose rain gauge area. The San Jose rain gauge threshold is the lowest demand threshold for school toilet flushing feasibility in the county.

- ***Item 5.2d: Mixed Commercial and Residential Use Projects.*** This item provides instructions to separately evaluate the commercial and residential portions of a mixed use project, as described above under Questions 5.2a and 5.2b.

- ***Question 5.2e: Industrial Projects.*** Answer this question only for industrial projects. If the project will include an industrial processing use for non-potable water, identify the demand for this use. This question is based on the required cistern volume and demand, for the maximum allowable drawdown time, to capture the C.3.d amount of runoff shown in Table 9 of the Feasibility Report (see Attachment 3). The required demand in gallons per day per acre of impervious area in Question 5.2d applies to the required demand in the San Jose rain gauge area, the lowest industrial non-potable water demand threshold for harvesting and use feasibility in the county.

  If the project's industrial non-potable water demand is MORE than 2,400 gallons a day, refer to the curves from Appendix F of the Feasibility Report (see Attachment 3) to evaluate the feasibility of harvesting and using the C.3.d amount of runoff for industrial use. Find the page that shows curves corresponding to the closest rain gauge to your project. The applicant can select any combination of drawdown time and cistern size that achieves at least 80 percent capture of runoff on the Y-axis of the graphs. The required demand in gallons per day per impervious acre is calculated by dividing the cistern volume by the drawdown time (converted to days).

Screening Worksheet Section 6: Biotreatment

Section 6 of the worksheet indicates whether, based on results of the screening evaluation, the project is allowed to implement biotreatment.

Screening Worksheet Section 7: Results of Screening Analysis

Section 7 of the screening worksheet lists the possible outcomes that may result from the screening analysis. If the project is allowed to implement biotreatment, check the biotreatment box only. If further analysis is required, check all boxes that apply, based on the results of evaluations in the previous sections.

J.3 Infiltration Feasibility Worksheet Guidance

Fill out this worksheet if soils at the project site have a Ksat of 1.6 or greater, or are Type A or B soils. This worksheet will help determine if conditions at the site would prohibit infiltration.

Feasibility of Infiltration Facilities

A "yes" answer to any of the questions from 2.1 through 2.3 indicates that site conditions prohibit the use of both infiltration measures (indirect infiltration, including unlined bioretention areas and infiltration trenches that are wider than they are deep) and infiltration devices (direct infiltration, including infiltration trenches and basins that are deeper than they are wide). A "yes" answer to any of these questions means that infiltration must be avoided altogether. In these situations, appropriate biotreatment systems may consist of a concrete-lined flow through planter, or a bioretention area with a waterproof liner. As soon as you answer "yes" to any of these questions, stop filling out the form, and indicate in Section 3 that infiltration is infeasible. If the answers to Questions 2.1 through 2.3 are all "no", then the use of infiltration measures (indirect infiltration) is feasible. Continue filling out the form to determine whether the use of infiltration devices (direct infiltration) is feasible.

Feasibility of Infiltration Devices

A "yes" answer to any of the questions from 2.4 through 2.8 indicates that the use of infiltration devices (direct infiltration) is infeasible. Examples of infiltration devices include any infiltration trench or basin, dry welll, or French drain that is deeper than it is wide. Requirements for infiltration devices (direct infiltration) are more stringent, because the design of infiltration devices causes stormwater runoff to bypass surface soils. This means that groundwater resources are more vulnerable to contamination than would be the case if infiltration measures (indirect infiltration) were used.

A "yes" answer for any question from 2.4 through 2.8 would not change the feasibility of infiltration measures (indirect infiltration); it would mean only that the use of infiltration devices (direct infiltration) is prohibited.

J.4 Rainwater Harvesting/Use Feasibility Worksheet Guidance

Complete this worksheet if the project's feasibility screening worksheet indicated that further analysis of rainwater harvesting and use is needed. Section 7 of the screening worksheet will indicate whether further analysis is needed for the entire project, or just one or more roofs that each individually have an area of 10,000 square feet or more. Fill out the rainwater harvesting and use worksheet separately for either the entire project, or for just one roof. The worksheet is organized around the following topics:

- Enter project data;
- Calculate area of self-treating areas, self-retaining areas, and areas contributing to self-retaining areas;
- Subtract credit for self-treating/self-retaining areas from area requiring treatment;
- Determine feasibility of use for toilet flushing based on demand;
- Determine feasibility of harvesting and use based on factors other than demand; and
- Results of feasibility determination.

The worksheet is provided in Excel, with pre-set formulas that perform various calculations automatically. The open cells shaded in blue are for you to enter data. Open cells without shading include the pre-set formulas.

RWH Feasibility Worksheet Section 1: Enter Project Data

The following data must be entered in this section and will form the basis for evaluating the feasibility of using the full C.3.d amount of runoff for toilet flushing:

- Project type,
- Number of dwelling units (for a residential or mixed use project),
- Square footage of non-residential interior floor area (for a non-residential or mixed use project), and
- Potential rain capture area (obtain from the screening worksheet).

If you are filling out this form for a project with a potential non-potable use of stormwater other than toilet flushing, skip sections 2 through 4, and go directly to Section 5.

RWH Feasibility Section 2: Calculate self-treating and self-retaining areas

You may exclude the following from the calculation of the potential rain capture area: 1) runoff from self-treating areas; 2) runoff from self-retaining areas; 3) the areas of impervious surface that drain to self-retaining areas. This is because, if the project includes such areas, they have been designed to infiltrate the C.3.d amount of runoff. In Section 2 of the form, enter the area (in square feet) of the project that consists of self-treating or self-retaining areas, and the impervious surface area that drains to self-retaining areas.

RWH Feasibility Section 3: Subtract self-treating and self-retaining areas

This section includes pre-set formulas that will automatically subtract from the area that is being evaluated (adjusted to account for any Special Project LID treatment reduction) the total square footage of self-treating and self-retaining areas, as well the square footage of impervious surface that drain to self-retaining areas. The result is the potential rainwater capture area. A pre-set formula then converts the potential rainwater capture area from square feet to acres.

RWH Feasibility Section 4: Feasibility of use for toilet flushing based on demand

- ***Steps 4.1 and 4.2: Identify project density:*** In these steps, you will identify (for residential projects) the dwelling units per acre of potential rainwater capture area. For non-residential projects, you will identify the non-residential interior floor area (in square feet) per acre of potential rain capture area. These ratios will be used to represent the anticipated toilet flushing demand for the project. The worksheet includes pre-set formulas to help you do this. Please note: ***If you are evaluating a mixed use project***, do not use these pre-set formulas. For mixed use projects, evaluate the residential toilet flushing demand based on the dwelling units per acre for the residential portion of the project (using a prorated acreage, based on the percentage of the project dedicated to residential use). Then evaluate the commercial toilet flushing demand per acre for the commercial portion of the project (using a prorated acreage, based on the percentage of the project dedicated to commercial use).

- ***Steps 4.3 and 4.4: Identify applicable density thresholds.*** In these steps, you will identify the project density thresholds at which there is sufficient toilet flushing demand to use the full C.3.d amount of stormwater runoff. Refer to the tables in Attachment 2 to locate the applicable density threshold for the rain gauge that is located nearest to your project. The density threshold for residential projects is in terms of dwelling units per impervious acre. The density threshold for non-residential projects is in terms of interior floor area (in square feet) per acre of impervious surface.
- ***Steps 4.5 and 4.6: Feasibility of use based on toilet flushing demand.*** In these steps, you will compare the project density(ies) from steps 4.1 and/or 4.2 with the density thresholds from steps 4.3 and 4.4. If the project density(ies) LESS than the threshold(s), then there is sufficient demand to harvest and use the C.3.d amount of runoff for toilet flushing. If the answer to the applicable question(s) is yes, then rainwater harvesting and use is infeasible, and you can skip to Section 6. If either question results in a "no" answer, then continue to Section 5 to see if there are other constraints that would make it infeasible.

RWH Feasibility Worksheet: Section 5: Factors other than demand

Complete this section if there was a "yes" answer to Questions 4.5 and/or 4.6, or if you are evaluating non-toilet flushing uses of rainwater. The questions in this section will help you determine whether there are site-specific factors, such as steep slope or lack of available space for a cistern, which would make rainwater harvesting and use infeasible.

J.5 Worksheets and Attachments

To download electronic versions of the following worksheets, visit www.cleanwaterprogram.org, click on "Businesses", then "Development Related Issues":

- Screening Worksheet
- Infiltration Feasibility Worksheet
- Rainwater Harvesting and Use Feasibility Worksheet
- Special Projects Worksheet

The following pages include the attachments listed below.

- Attachment 1: Glossary
- Attachment 2: Toilet-Flushing Demand for Harvested Rainwater
- Attachment 3: Excerpts from the Feasibility Report (Map of Soil Hydraulic Conductivity and Rain Gauge Areas, Tables 8 through 11 and curves from the report's Appendix F)

Feasibility Worksheets
Attachment 1: Glossary

Bioinfiltration Area

A type of low development treatment measure designed to have a surface ponding area that allows for evapotranspiration, and to filter water through 18 inches of engineered biotreatment soil. After the water filters through the engineered soil, it encounters a 12-inch layer of rock in which an underdrain is typically installed. If the underlying soils have a saturated hydraulic conductivity rate of 1.6" per hour or greater, then the C.3.d amount of runoff is treated by evapotranspiration and infiltration. If the soils have a lower hydraulic conductivity rate, then the bioinfiltration area treats stormwater with evapotranspiration, some infiltration, and the remaining amount of the C.3.d amount of runoff is filtered and released into the underdrain. The difference between a bioinfiltration area and a bioretention area is that the bioinfiltration area is never lined with an impermeable layer; whereas, a bioretention area may be lined or unlined.

Bioretention Area

A type of low development treatment measure designed to have a surface ponding area that allows for evapotranspiration, and to filter water through 18 inches of engineered biotreatment soil. After the water filters through the engineered soil, it encounters a 12-inch layer of rock in which an underdrain is typically installed. If the underlying soils have a saturated hydraulic conductivity rate of 1.6" per hour or greater, then the C.3.d amount of runoff is treated by evapotranspiration and infiltration. If the soils have a lower hydraulic conductivity rate, or if infiltration is prohibited and the bioretention area is lined with an impermeable layer, then the bioretention area treats stormwater with evapotranspiration, some or no infiltration, and the remaining amount of the C.3.d amount of runoff is filtered and released into the underdrain. The difference between a bioinfiltration area and a bioretention area is that the bioinfiltration area is never lined with an impermeable layer; whereas, a bioretention area may be lined or unlined.

Biotreatment

A type of low impact development treatment allowed under Provision C.3.c of the ***MRP****, if infiltration, evapotranspiration and rainwater harvesting and use are infeasible. As required by Provision C.3.c.i(2)(vi), biotreatment systems shall be designed to have a surface area no smaller than what is required to accommodate a 5 inches/hour stormwater runoff surface loading rate and shall use biotreatment soil as specified in the biotreatment soil specifications approved by the Regional Water Board, or equivalent.

C.3 Regulated Projects:

Development projects as defined by Provision C.3.b.ii of the ***MRP****. This includes public and private projects that create and/or replace 10,000 square feet or more of impervious surface, and restaurants, retail gasoline outlets, auto service facilities, and uncovered parking lots (stand-alone or part of another use) that create and/or replace 5,000 square feet or more of impervious surface. Single family homes that are not part of a larger plan of development are specifically excluded.

C.3.d Amount of Runoff

The amount of stormwater runoff from C.3 Regulated Projects that must receive stormwater treatment, as described by hydraulic sizing criteria in Provision C.3.d of the ***MRP****.

Heritage Tree

An individual tree of any size or species given the 'heritage tree' designation as defined by the municipality's tree ordinance or other section of the municipal code.

Infiltration Devices

Infiltration facilities that are deeper that they are wide and designed to infiltrate stormwater runoff into the subsurface and, as designed, bypass the natural groundwater protection afforded by surface soil. These devices include dry wells, injection wells and infiltration trenches (includes French drains).

Infiltration Facilities

A term that refers to both infiltration devices and measures.

Infiltration Measures

Infiltration facilities that are wider than they are deep (e.g., bioinfiltration, infiltration basins and shallow wide infiltration trenches and dry wells).

Low Impact Development (LID) Treatment

Removal of pollutants from stormwater runoff using the following types of stormwater treatment measures: rainwater harvesting and use, infiltration, evapotranspiration, or, where these are infeasible, biotreatment.

Municipal Regional Stormwater Permit (MRP)

The municipal stormwater NPDES permit under which discharges are permitted from municipal separate storm sewer systems throughout Alameda County and the other NPDES Phase I jurisdictions within the San Francisco Bay Region.

Potential Rainwater Capture Area

The impervious area from which rainwater may be potentially be captured, if rainwater harvesting and use were implemented for a project. If the entire site is evaluated for rainwater harvesting and use feasibility, this consists of the impervious area of the proposed project; for redevelopment projects that replace 50% or more of the existing impervious surface, it also includes the areas of existing impervious surface that are not modified by the project. If only a roof area is evaluated for rainwater harvesting and use feasibility, the potential rainwater capture area consists only of the applicable roof area.

Screening Density

A threshold of density (e.g., number of units or interior floor area) per acre of impervious surface, associated with a certain potential demand for non-potable water, for C.3 regulated projects. The screening density varies according to location (see Attachment 2.) If the screening density is met or exceeded, the Rainwater Harvesting and Use Feasibility Worksheet must be completed for the project.

Self-Retaining Area

A portion of a development site designed to retain the first one inch of rainfall (by ponding and infiltration and/or evapotranspiration) without producing stormwater runoff. Self-retaining areas must have at least a 2:1 ratio of contributing area to a self-retaining area and a 3" ponding depth. Self-retaining areas may include graded depressions with landscaping or pervious pavement. **Areas that Contribute Runoff to Self-Retaining Areas** are impervious or partially pervious areas that drain to self-retaining areas.

Self-Treating Area

A portion of a development site in which infiltration, evapotranspiration and other natural processes remove pollutants from stormwater. Self-treating areas may include conserved natural open areas, areas of landscaping, green roofs and pervious pavement. Self-treating areas treat only the rain falling on them and do not receive stormwater runoff from other areas.

Special Projects

Certain types of smart growth, high density and transit oriented development projects that are allowed, under Provision C.3.e.ii of the MRP, to receive LID treatment reductions. The specific development project types will be described in an amendment to the MRP, anticipated in Fall 2011.

Total Project Cost

Total project cost includes the construction (labor) and materials cost of the physical improvements proposed; however, it does not include land, transactions, financing, permitting, demolition, or off-site mitigation costs.

Feasibility Worksheets
Attachment 2: Toilet-Flushing Demand Required for Rainwater Harvesting Feasibility per Impervious Acre (IA) [1,2]

Table 1 - Alameda County:

Rain Gauge[3]	Required Demand (gal/day/IA)[4]	Residential		Office/Retail[5]		Schools[6]	
		No. of residents per IA[7]	Dwelling Units per IA[8]	Employees per IA[9]	Interior Floor Area (sq.ft./IA)[10]	Employees[11] per IA	Interior Floor Area (sq.ft./IA)[12]
Berkeley 5,900		690	255	860	172,000	170	51,000
Dublin 4,100		480	177	590	118,000	120	36,000
Hayward 4,800		560	207	700	140,000	140	42,000
Palo Alto	2,900	340	125	420	84,000	90	27,000
San Jose	2,400	280	103	350	70,000	70	21,000

Notes:

1. Demand thresholds obtained from the “Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report” (LID Feasibility Report) submitted to the Regional Water Board on May 1, 2011.
2. Toilet flushing demands assume use of low flow toilets per the California Green Building Code.
3. See Attachment 3 to identify the rain gauge that corresponds to the project site.
4. Required demand per acre of impervious area to achieve 80% capture of the C.3.d runoff volume with the maximum allowable drawdown time for cistern of 50,000 gallons or less, from Table 9 of the LID Feasibility Report.
5. “Office/Retail” includes the following land uses: office or public buildings, hospitals, health care facilities, retail or wholesale stores, and congregate residences.
6. “Schools” includes day care, elementary and secondary schools, colleges, universities, and adult centers.
7. Residential toilet flushing demand identified in Table 10 of the LID Feasibility Report.
8. Residential toilet flushing demand divided by the countywide average number of persons per household (US Census data reported on www.abag.org), as follows: Alameda County: 2.71 persons per household.
9. Office/retail employee toilet flushing demand identified in Table 10 of the LID Feasibility Report.
10. Interior floor area required for rainwater harvest and use feasibility per acre of impervious area is based on the number of employees in Column 5 multiplied by an occupant load factor of 200 square feet per employee (reference: 2010 California Plumbing Code, Chapter 4, Plumbing Fixtures and Fitting Fixtures, Table A, page 62.)
11. School employee toilet flushing demand identified in Table 10 of the LID Feasibility Report. Each school employee represents 1 employee and 5 “visitors” (students and others).
12. Interior floor area required for rainwater harvest and use feasibility per acre of impervious area is based on the number of employees in Column 7 multiplied by 6 to account for visitors, then multiplied by an occupant load factor of 50 square feet per employee (reference: 2010 California Plumbing Code).

LID Feasibility Worksheet

Attachment 3:

Excerpts from BASMAA's
Feasibility/Infeasibility Criteria Report

- Figure A6: Saturated Hydraulic Conductivity (Ksat) and Precipitation Polygons, Alameda County, CA
- Table 8: Required Cistern Volume and Demand per Acre of Impervious Area to Achieve 80% Capture with a 48-hour Drawdown Time
- Table 9: Required Cistern Volume and Demand per Acre of Impervious Area to Achieve 80% Capture with the Longer Drawdown Time Allowable (Minimum Demand) for Cistern of 50,000 Gallons or Less
- Table 10: TUTIA Ratios for Typical Land Uses for Rain Gauges Analyzed
- Table 11: EIATIA Ratios for Rain Gauges Analyzed
- Figure F1: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1 Acre, 100% Impervious Tributary Area: Berkeley
- Figure F3: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1 Acre, 100% Impervious Tributary Area: Dublin
- Figure F4: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1 Acre, 100% Impervious Tributary Area: Hayward
- Figure F8: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1 Acre, 100% Impervious Tributary Area: Palo Alto
- Figure F11: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1 Acre, 100% Impervious Tributary Area: San Jose

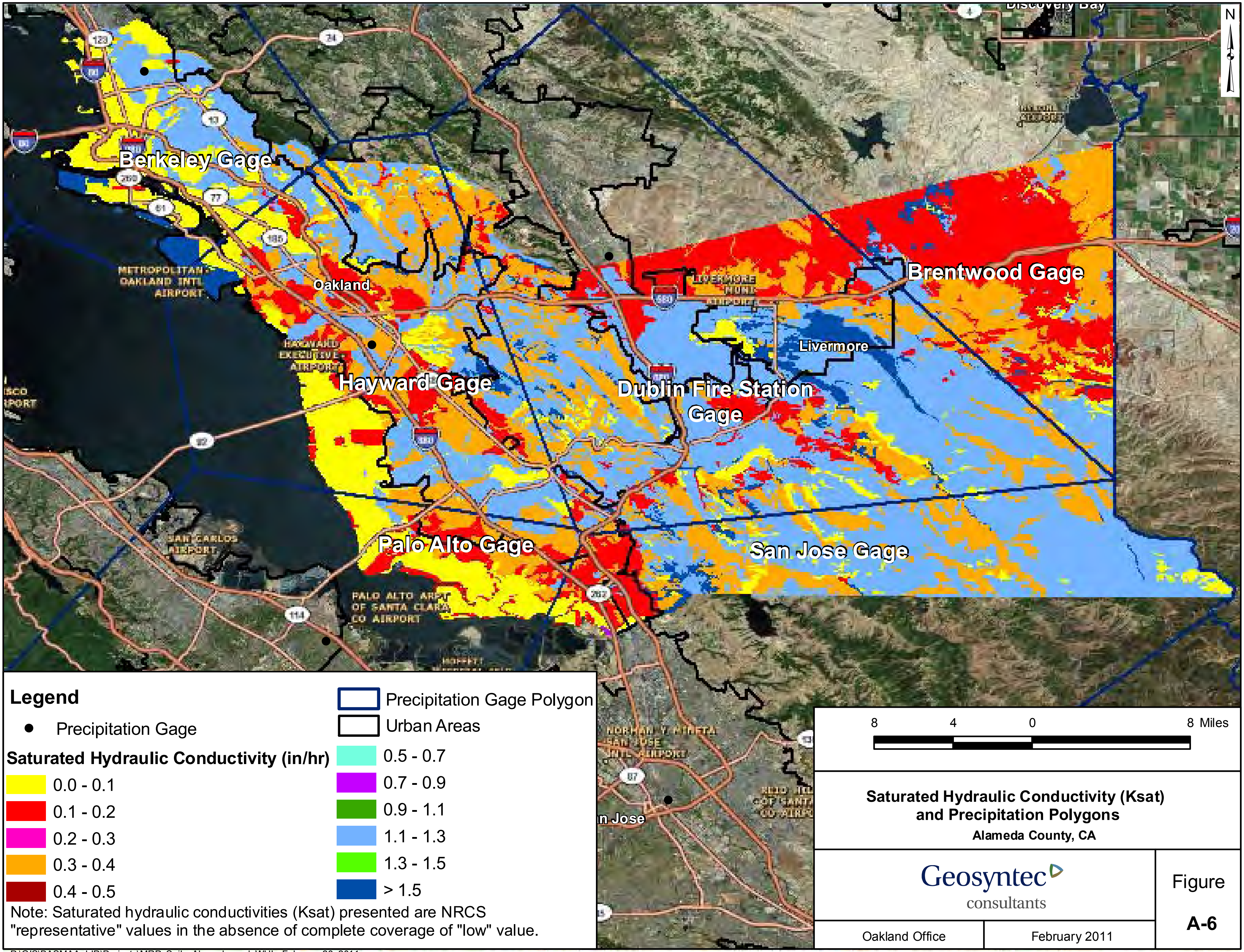

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Table 8: Required Cistern Volume and Demand per Acre of Impervious Area to Achieve 80% Capture with a 48-hour Drawdown Time

Rain Gauge	Drawdown Time (hr.)	Required Cistern Size (gallons)	Required Demand (gal/day)
Berkeley	48	23,000	11,500
Brentwood	48	19,000	9,500
Dublin	48	21,000	10,500
Hayward	48	23,500	11,750
Lake Solano	48	29,000	14,500
Martinez	48	23,000	11,500
Morgan Hill	48	25,500	12,750
Palo Alto	48	16,500	8,250
San Francisco	48	20,000	10,000
San Francisco Oceanside	48	19,000	9,500
San Jose	48	15,000	7,500

If a longer drawdown time (and lower minimum demand) is desired, Table 9 includes the maximum drawdown time allowable to achieve 80 percent capture for a cistern sized at 50,000 gallons or less per acre of impervious area, along with the required cistern sizes and daily demands.

Table 9: Required Cistern Volume and Demand per Acre of Impervious Area to Achieve 80% Capture with the Longer Drawdown Time Allowable (Minimum Demand) for Cistern of 50,000 Gallons or Less

Rain Gauge	Drawdown Time (hr.)	Required Cistern Size (gallons)	Required Demand (gal/day)
Berkeley	180	44,000	5,900
Brentwood	240	42,000	4,200
Dublin	240	41,000	4,100
Hayward	240	47,500	4,800
Lake Solano	120	45,000	9,000
Martinez	180	44,000	5,900
Morgan Hill	180	49,000	6,500
Palo Alto	360	44,000	2,900
San Francisco	240	45,500	4,600
San Francisco Oceanside	240	43,000	4,300
San Jose	480	48,000	2,400

Table 10: TUTIA Ratios for Typical Land Uses for Rain Gauges Analyzed

Rain Gauge	Required Demand[1] (gal/day)	Toilet Users per Impervious Acre (TUTIA)[2]							
		Residential		Office/Retail		Schools		Industrial	
		Current	CGBC[3]	Current	CGBC	Current	CGBC	Current	CGBC
Assumed Per Capita Use per Day (gal/day)[4]		18	8.6	14	6.9	66	34	11	5.4
Berkeley	5,900	320	690	420	860	90	170	540	1,090
Brentwood	4,200	230	490	300	610	60	120	380	780
Dublin	4,100	220	480	290	590	60	120	370	760
Hayward	4,800	260	560	340	700	70	140	440	890
Lake Solano	9,000	490	1050	640	1,300	140	270	820	1,670
Martinez	5,900	320	690	420	860	90	170	540	1090
Morgan Hill	6,500	350	760	460	940	100	190	590	1,200
Palo Alto	2,900	160	340	210	420	40	90	260	540
San Francisco	4,600	250	530	330	670	70	140	420	850
San Francisco Oceanside	4,300	230	500	310	620	70	130	390	800
San Jose	2,400	130	280	170	350	40	70	220	440

Footnotes:
[1] For a 50,000 or less gallon tank to achieve 80 percent capture within maximum allowable drawdown time (Table 9).
[2] The TUTIA ratios are based on employee toilet users per impervious acre. These ratios were calculated using the daily toilet and urinal water usage from Table 5, which are per employee and encompass usage by visitors and students within the daily demand (assumes about 5 students per school employee).
[3] CGBC = California Green Building Code Requirements water usage accounting for water conservation.
[4] From Table 5, Toilet and Urinal Water Usage per Resident or Employee.

EIATA Ratios

Comparing the required daily demands for rainwater harvesting systems for both 48-hour drawdown times and maximum drawdown times to daily demands per irrigated acre, it becomes evident that the required demands are many times larger than irrigation demands. This can be translated into an ‘Effective Irrigated Area to Impervious Area’ (EIATIA) ratio by dividing the required rainwater harvesting system demand by the daily irrigation demand (shown in Table 7). Since both demands are calculated on a per acre basis, the EIATIA ratio represents the number of acres of irrigated area needed per acre of impervious surface to meet the demand needed for 80 percent capture. EIATIA ratios were analyzed for the rain gauges used for analysis and the evapotranspiration data listed in Table F-1. These ratios, as well as the required total imperviousness (assuming a project includes the impervious tributary area and the irrigated area only) are included in Table 11.

Table 11: EIATIA Ratios for Rain Gauges Analyzed

Rain Gauge	Required Daily Demand[1] (gal/day)	ET Data Location[2]	Conservation Landscaping			Turf Areas		
			Demand per Irrigated Acre[3]	EIATIA	Resultant Imper-viousness (%)	Demand per Irrigated Acre[3]	EIATIA	Resultant Imper-viousness (%)
Berkeley	5,900	Oakland	420	14.0	7%	850	6.9	13%
Brentwood	4,200	Brentwood	420	10.0	9%	850	4.9	17%
Dublin	4,100	Pleasanton	430	9.5	9%	850	4.8	17%
Hayward	4,800	Fremont	520	9.2	10%	1,040	4.6	18%
Lake Solano	9,000	Fairfield	420	21.4	4%	840	10.7	9%
Martinez	5,900	Martinez	380	15.5	6%	760	7.8	11%
Morgan Hill	6,500	Morgan Hill	500	13.0	7%	1,000	6.5	13%
Palo Alto	2,900	Redwood City	450	6.4	13%	900	3.2	24%
San Francisco	4,600	San Francisco	360	12.8	7%	720	6.4	14%
San Francisco Oceanside	4,300	San Francisco	360	11.9	8%	720	6.0	14%
San Jose	2,400	San Jose	470	5.1	16%	940	2.6	28%

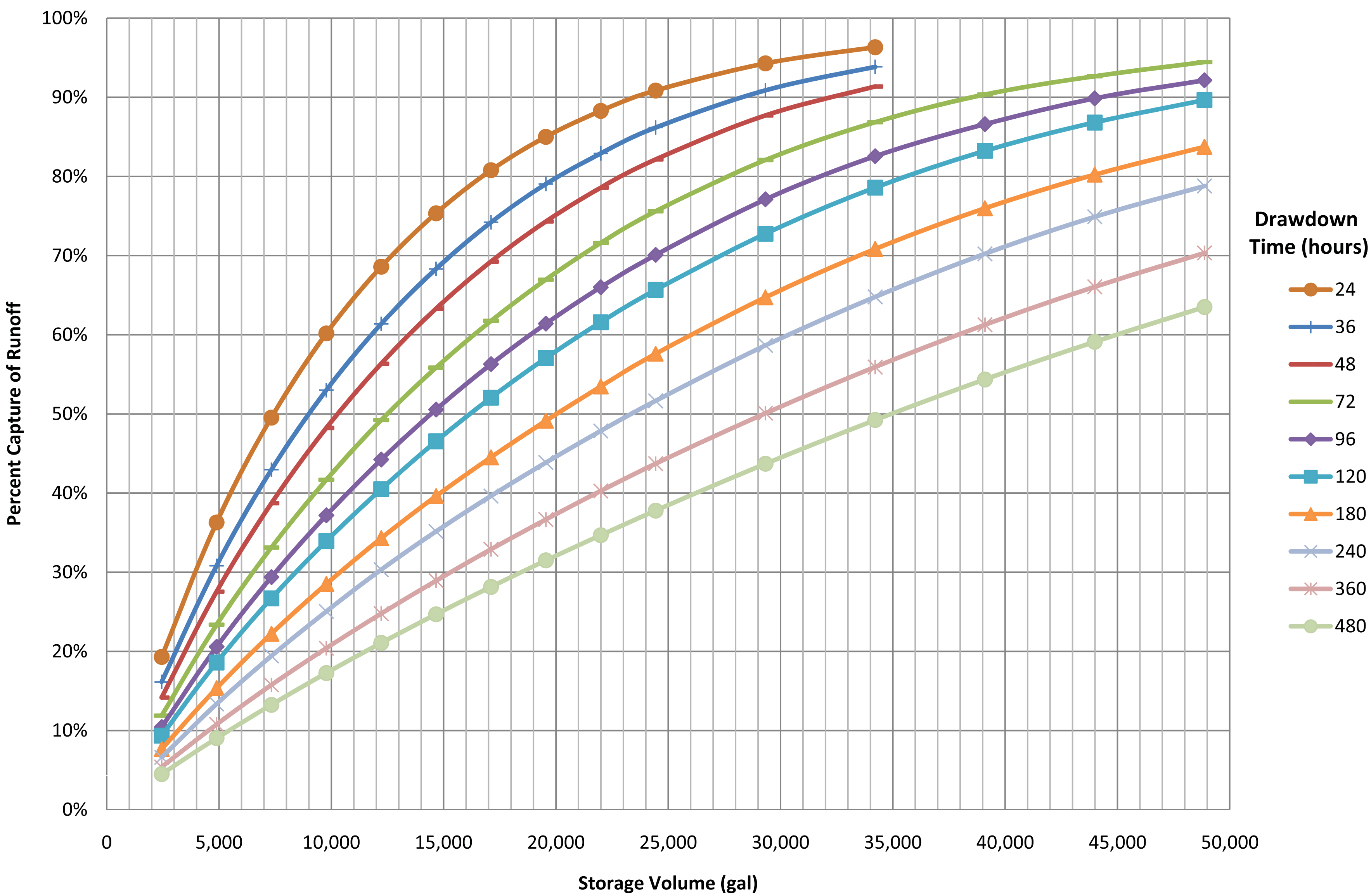
Footnotes:
[1] To achieve 80 percent capture within maximum allowable drawdown time (Table 9).
[2] Closest location selected, from Table F-1.
[3] From Table 7.

3.3.3 Summary

In summary, TUTIA ratios indicate that dense land uses would be required to provide the needed demand to make rainwater harvesting feasible in the MRP area. A project must have sufficiently high toilet flushing uses to achieve 80 percent capture within the maximum allowable drawdown time (see Table 9 for maximum allowable drawdown time for a 50,000 gallon tank or less). For instance, approximately 280 to 1,050 residential toilet users (roughly 90 – 130 dwelling units per acre[5]) are required, depending on location, per impervious acre to meet the demand needed for 80 percent capture with the maximum allowable drawdown time and CA Green Building Code flush requirements. Meeting the demand requirements would entail a very dense housing

[5] Assuming three residents per dwelling unit.

Figure F-1: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1-Acre, 100% Impervious Tributary Area - Berkeley



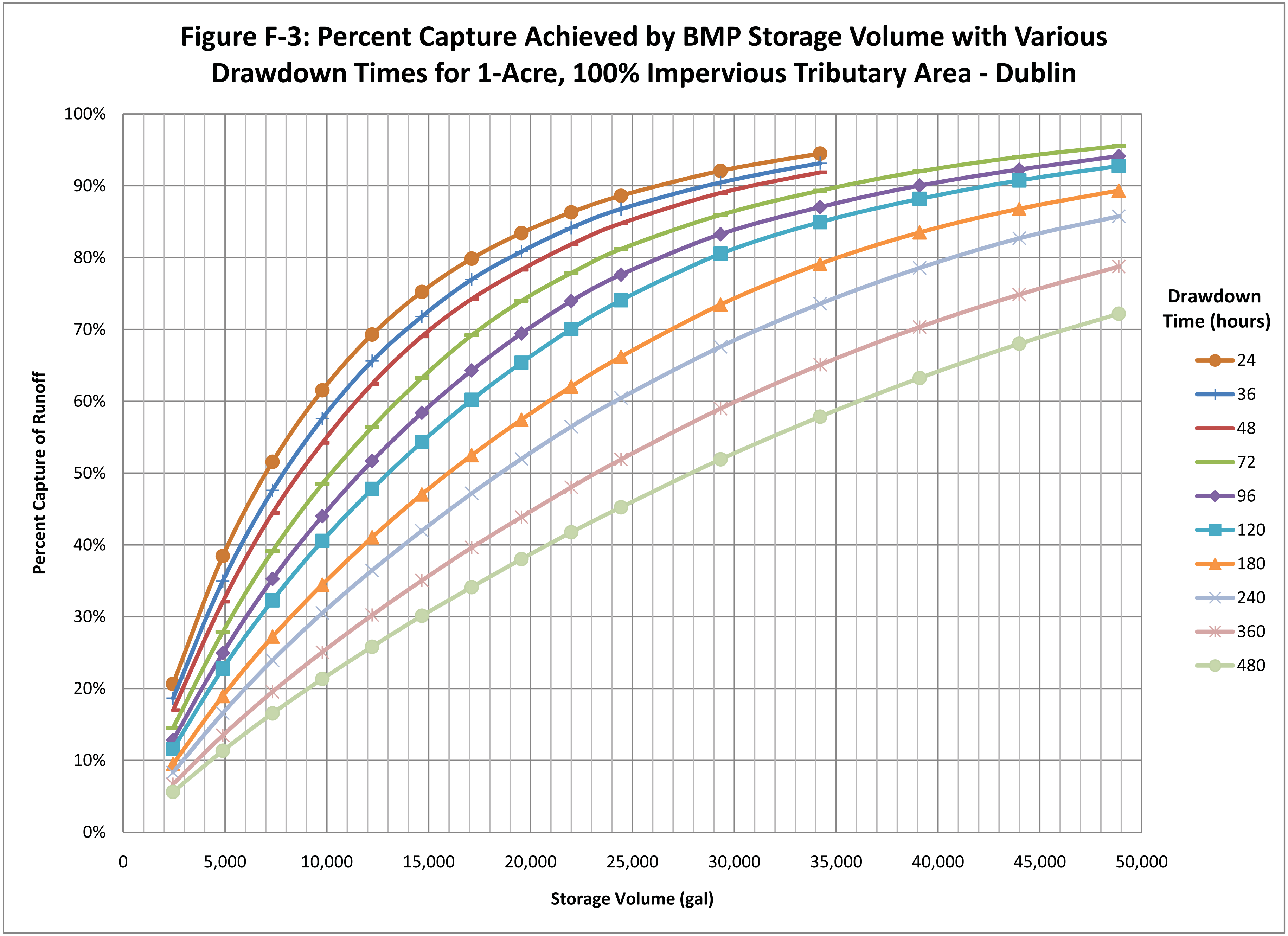


Figure F-3: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1-Acre, 100% Impervious Tributary Area - Dublin
Percent Capture of Runoff
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
50,000
Storage Volume (gal)
Drawdown Time (hours)
24
36
48
72
96
120
180
240
360
480

Figure F-4: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1-Acre, 100% Impervious Tributary Area - Hayward

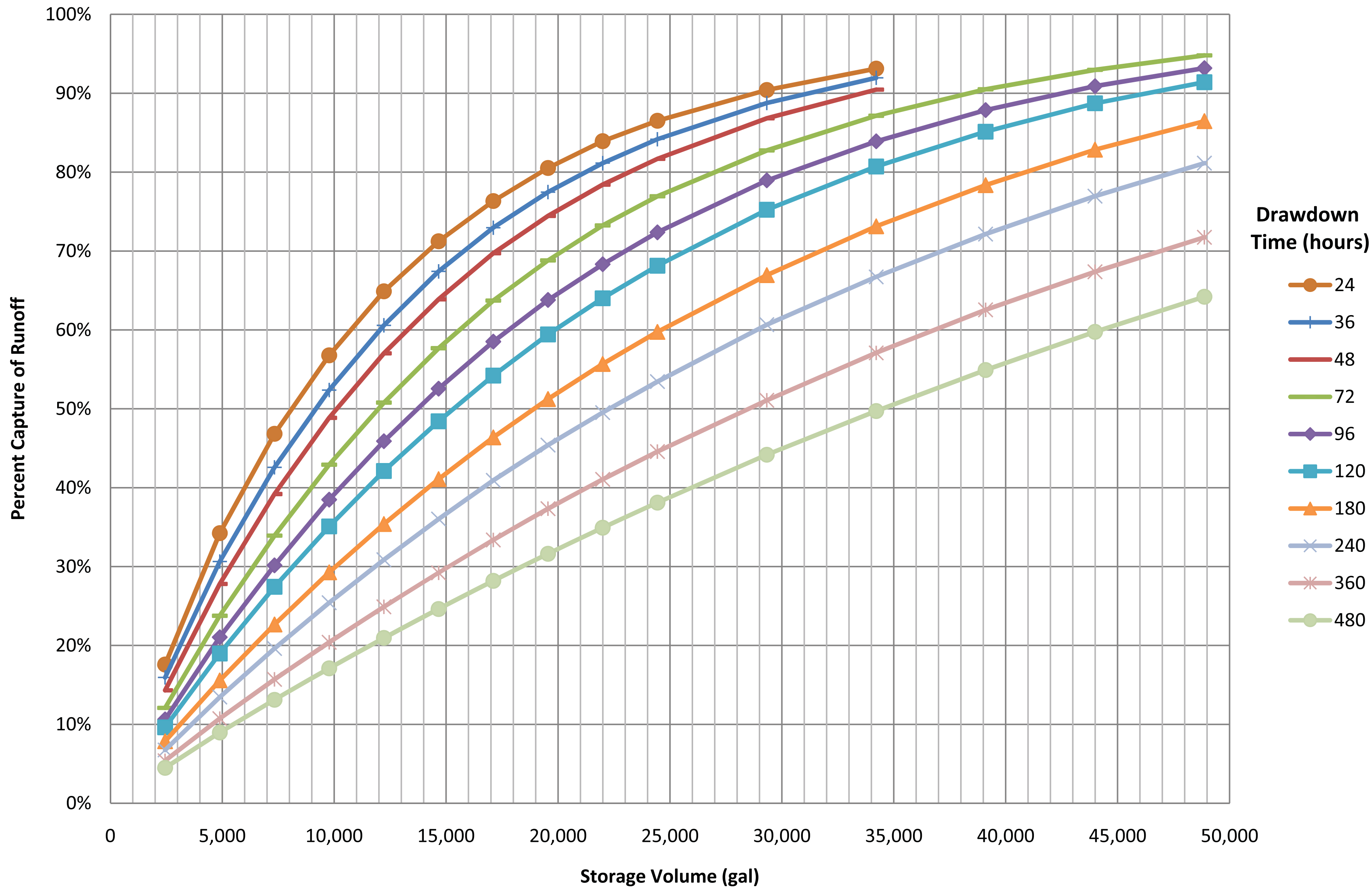


Figure F-8: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1-Acre, 100% Impervious Tributary Area - Palo Alto

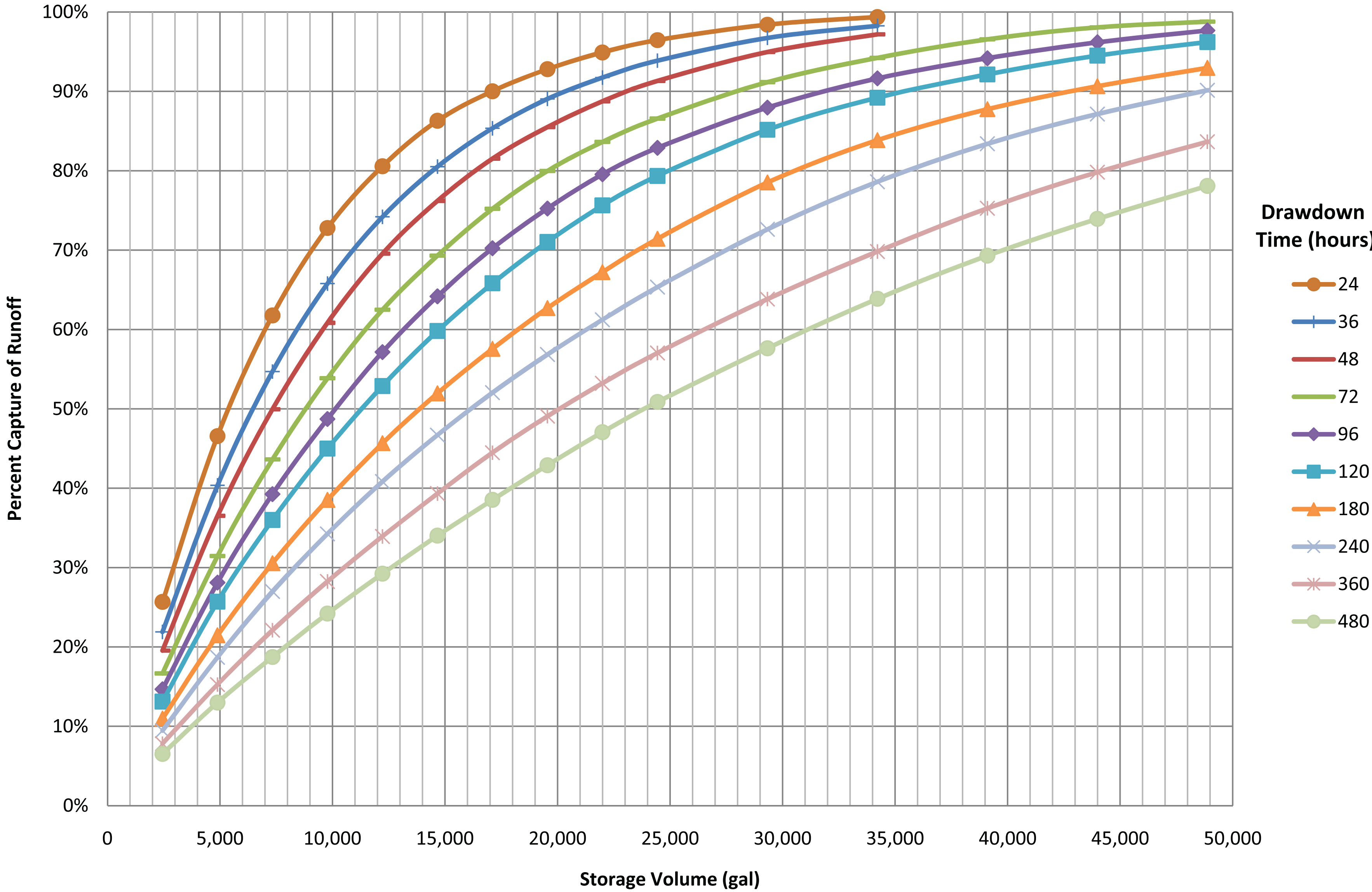
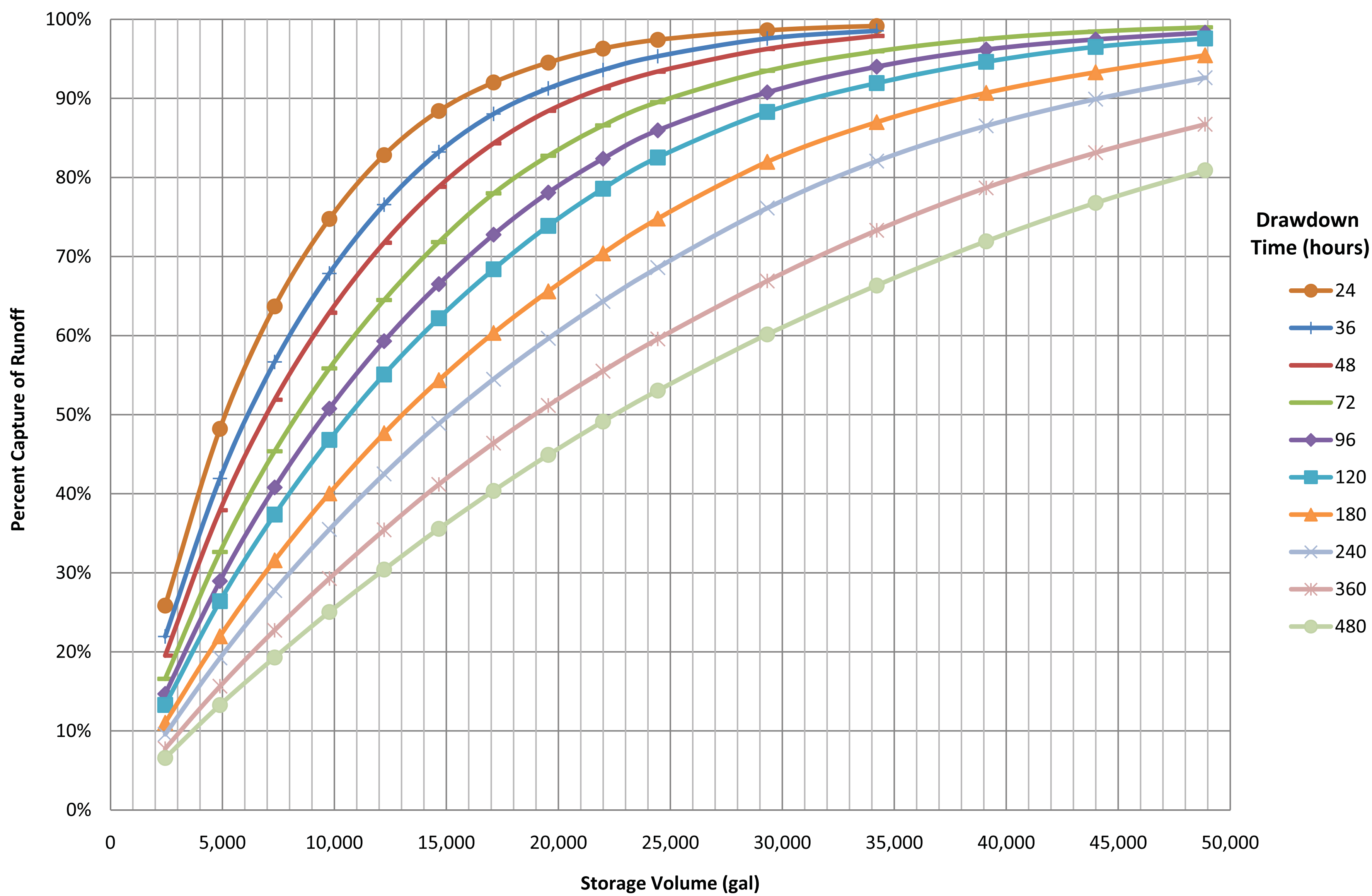


Figure F-11: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1-Acre, 100% Impervious Tributary Area - San Jose



Appendix

K

Special Projects

Table of Contents

K.1 Introduction

On November 28, 2011, the San Francisco Bay Regional Water Quality Control Board (Water Board) amended the MRP to allow LID treatment reduction credits for three categories of smart growth, high density and transit oriented development project, described below. Projects that receive LID treatment reduction credits are allowed to use specific types of non-LID treatment, if the use of LID treatment is first evaluated and determined to be infeasible. As described in Section K.5, documentation must be provided to discuss the feasibility and infeasibility of using 100 percent LID treatment onsite and offsite.

The types of non-LID treatment that may be used are:

- High flow-rate media filters, and
- High flow-rate tree well filters (also called high flow-rate tree box filters).

The three categories of Special Projects are:

- Category A: Small Infill Projects ($\leq$ ½ acre of impervious surface)
- Category B: Larger Infill Projects ($\leq$ 2 acres of impervious surface)
- Category C: Transit-Oriented Development

Any Regulated Project that meets all the criteria for more than one Special Project Category (such as a Regulated Project that may be characterized as a Category B or C Special Project) may only use the LID Treatment Reduction Credit allowed under one of the categories. For example, a Regulated Project that may be characterized as a Category B or C Special Project may use the LID Treatment Reduction Credit allowed under Category B or Category C, but not the sum of both.

K.2 Category A: Small Infill Projects

The defining criteria and LID treatment reduction credits for Category A projects are described below.

CRITERIA FOR CATEGORY A (SMALL INFILL) SPECIAL PROJECTS

To be considered a Category A Special Project, a Provision C.3 Regulated Project must meet all of the following criteria:

1. Be built as part of the municipality’s stated objective to preserve or enhance a pedestrian-oriented type of urban design.
2. Be located in the 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.
3. Create and/or replace one half acre or less of impervious surface area.
4. Include no surface parking, except for incidental surface parking. Incidental surface parking is allowed only for emergency vehicle access, Americans with Disabilities Act (ADA) accessibility, and passenger and freight loading zones.
5. Have at least 85% coverage for the entire project site by permanent structures. The remaining 15% portion of the site is to be used for safety access, parking structure entrances, trash and recycling service, utility access, pedestrian connections, public uses, landscaping, and stormwater treatment.

LID TREATMENT REDUCTION FOR CATEGORY A (SMALL INFILL) SPECIAL PROJECTS

Any Category A Special Project may qualify for 100% LID Treatment Reduction Credit, which would allow the Category A Special Project to treat up to 100% of the amount of stormwater runoff specified by Provision C.3.d with either one or a combination of the two types of non-LID treatment systems identified in Section K.1. Prior to receiving the LID treatment reduction credits, the applicant must demonstrate, to the satisfaction of municipal staff, that LID treatment is infeasible, as described in Section K.5.

K.3 Category B: Larger Infill Projects

The defining criteria and LID treatment reduction credits for Category B projects are described below.

CRITERIA FOR CATEGORY B (LARGER INFILL) SPECIAL PROJECTS

To be considered a Category B Special Project, a Provision C.3 Regulated Project must meet all of the following criteria:

1. Be built as part of the municipality's stated objective to preserve or enhance a pedestrian-oriented type of urban design.
2. Be located in a Permittee'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.
3. Create and/or replace greater than one-half acre but no more than 2 acres of impervious surface area.
4. Include no surface parking, except for incidental surface parking. Incidental surface parking is allowed only for emergency vehicle access, ADA accessibility, and passenger and freight loading zones.
5. Have at least 85% coverage for the entire project site by permanent structures. The remaining 15% portion of the site is to be used for safety access, parking structure entrances, trash and recycling service, utility access, pedestrian connections, public uses, landscaping, and stormwater treatment.

LID TREATMENT REDUCTION FOR CATEGORY B (LARGER INFILL) SPECIAL PROJECTS

For Category B Special Projects, the maximum LID treatment reduction credit allowed varies depending upon the density achieved by the project in accordance with the criteria shown in Table K-1. Density is expressed in Floor Area Ratios (FARs) for commercial and mixed-use development projects and in Dwelling Units per Acre (DU/Ac) for residential development projects. The credits are expressed in percentages of the amount of stormwater runoff specified by Provision C.3.d for the Project's drainage area. The Special Project may treat the percentage of the C.3.d amount of runoff that corresponds to the project's density using either one or a combination of the two types of non-LID treatment systems listed in Section K.1. To be eligible to receive the LID treatment reduction credits, the applicant must demonstrate, to the satisfaction of municipal staff, that LID treatment is infeasible, as described in Section K.5. Any remaining amount of stormwater runoff must be treated with LID treatment measures.

Table K-1
Category B LID Treatment Reduction Credits, Based on the Density of Development

% of the C.3.d Amount of Runoff that May Receive Non-LID Treatment	Land Use Type	Density Required to Obtain the LID Treatment Reduction Credit
50%	Commercial or Mixed Use	Floor Area Ratio 2:1
50%	Residential	50 dwelling units/acre
75%	Commercial or Mixed Use	Floor Area Ratio 3:1
75%	Residential	75 dwelling units/acre
100%	Commercial or Mixed Use	Floor Area Ratio 4:1
100%	Residential	100 dwelling units/acre

K.4 Category C: Transit-Oriented Development

The defining criteria and LID treatment reduction credits for Category C projects are described below.

CRITERIA FOR CATEGORY C (TRANSIT ORIENTED DEVELOPMENT) SPECIAL PROJECTS

To be considered a Category C Special Project, a Provision C.3 Regulated Project must meet all of the following criteria:

1. Be characterized as a non auto-related land use project. That is, Category C specifically excludes any Regulated Project that is a stand-alone surface parking lot; car dealership; auto and truck rental facility with onsite surface storage; fast-food restaurant, bank or pharmacy with drive-through lanes; gas station, car wash, auto repair and service facility; or other auto-related project unrelated to the concept of Transit-Oriented Development.
2. If a commercial or mixed-use development project, achieve at least an FAR of 2:1.
3. If a residential development project, achieve at least a density of 25 DU/Ac.

LID TREATMENT REDUCTION FOR CATEGORY C (TRANSIT-ORIENTED DEVELOPMENT)

For Category C Special Projects, the total maximum LID treatment reduction credit allowed is the sum of three different types of credits for which the Category C Special Project qualifies. These credits are categorized as follows:

- Location Credits,
- Density Credits, and

- Minimized Surface Parking Credits.

The Special Project may use either one or a combination of the two types of non-LID treatment systems listed in Section K.1 to treat the total percentage of the C.3.d amount of stormwater runoff that results from adding together the Location, Density and Minimized Surface Parking credits that the project is eligible for. In addition, to be eligible to receive the LID treatment reduction credits, the applicant must demonstrate, to the satisfaction of municipal staff, that LID treatment is infeasible, as described in Section K.5. Any remaining amount of stormwater runoff must be treated with LID treatment measures.

Location Credits (Transit-Oriented Development)

Location credits are based on the project site's proximity to a transit hub[1], or its location within a planned Priority Development Area (PDA)[2]. Only one Location Credit may be used by an individual Category C Special Project, even if the project qualifies for multiple Location Credits. In order to qualify for a Location Credit, at least 50 percent or more of a Category C Special Project's site must be located within the ¼ or ½ mile radius of an existing or planned transit hub, or 100 percent of the site must be located within a PDA. The Location Credits, presented in Table K-2, are expressed in percentages of the amount of stormwater runoff specified by Provision C.3.d for the project's drainage area.

Table K-2
Location Credits for Category C, Transit Oriented Development
(Only one Location Credit may be used.)

% of the C.3.d Amount of Runoff that May Receive Non-LID	Project Site Location
50%	50% or more of the site is located within a ¼ or ½ mile radius of an existing or planned transit hub
25%	50% or more of the site is located within a ½ mile radius of an existing or planned transit hub
25%	100% of the site is located within a PDA

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1 Transit hub is defined as a rail, light rail, or commuter rail station, ferry terminal, or bus transfer station served by three or more bus routes (i.e., a bus stop with no supporting services does not qualify). A planned transit hub is a station on the MTC's Regional Transit Expansion Program list, per MTC's Resolution 3434 (revised April 2006), which is a regional priority funding plan for future transit stations in the San Francisco Bay Area.

2 A planned Priority Development Area (PDA) is an infill development area formally designated by the Association of Bay Area Government's / Metropolitan Transportation Commission's FOCUS regional planning program. FOCUS is a regional incentive-based development and conservation strategy for the

Density Credits (Transit-Oriented Development)

To qualify for any Density Credits, a Category C Special Project must first qualify for one of the Location Credits listed above. The Density Credits are based on the density achieved by the project in accordance with the criteria shown in Table K-4. Density is expressed in Floor Area Ratios (FARs) for commercial and mixed-use development projects and in Dwelling Units per Acre (DU/Ac) for residential development projects. The credits are expressed in percentages of the amount of stormwater runoff specified in Provision C.3.d. Commercial and mixed-use Category C projects do not qualify for Density Credits based on DU/Ac, and residential Category C Projects do not qualify for Density Credits based on FAR. Only one Density Credit may be used by an individual Category C Special Project, even if the project qualifies for multiple Density Credits.

Table K-3
Density Credits for Category C, Transit Oriented Development
(Only one Density Credit may be used.)

% of the C.3.d Amount of Runoff that May Receive Non-LID Treatment	Land Use Type	Density Required to Obtain the Density Credit
10%	Commercial or Mixed Use	Floor Area Ratio 2:1
10%	Residential	30 dwelling units/acre
20%	Commercial or Mixed Use	Floor Area Ratio 4:1
20%	Residential	60 dwelling units/acre
30%	Commercial or Mixed Use	Floor Area Ratio 6:1
30%	Residential	100 dwelling units/acre

Minimized Surface Parking Credits (Transit-Oriented Development)

To qualify for any Minimized Surface Parking Credits, a Category C Special Project must first qualify for one of the Location Credits listed above. The LID treatment reduction credit is based on the amount of post-project impervious surface area that is dedicated to at-grade surface parking, in accordance with the criteria shown in Table K-3. The credits are expressed in percentages of the amount of stormwater runoff specified in Provision C.3.d. The at-grade surface parking must be treated with LID treatment measures. Only one Minimized Surface Parking Credit may be used by an individual Category C Special Project, even if the project qualifies for multiple Minimized Surface Parking Credits.

Table K-4 **Minimized Surface Parking Credits for Category C, Transit Oriented Development** (Only one Minimized Surface Parking Credit may be used.)	
% of the C.3.d Amount of Runoff that May Receive Non-LID	**Percentage of the Total Post-Project Impervious Surface Dedicated to At-Grade, Surface Parking**
10%	10% or less
20%	0% (except for emergency vehicle access, ADA accessibility and passenger and freight loading zones)

K.5 LID Infeasibility Requirement for Special Projects

In order to be considered a Special Project, in addition to documenting that all applicable criteria for one of the above-described Special Project categories have been met, the applicant must provide a narrative discussion of the feasibility or infeasibility of using 100 percent LID treatment onsite and offsite. Both technical and economic feasibility or infeasibility shall be discussed, as applicable. The discussion shall contain enough technical and/or economic detail to document the basis of any infeasibility that is determined.

K.6 Select Non-LID Treatment Measures Certified by a Government Agency

MRP Provision C.3.e.vi.(3)(i) requires municipalities to report to the Regional Water Board, for each non-LID treatment measure that the municipality approves, "whether the treatment system either meets minimum design criteria published by a government agency or received certification issued by a government agency, and reference the applicable criteria or certification."

For Special Projects that are allowed to use non-LID treatment measures, applicants are advised to use treatment measures that have been certified by the Washington State Department of Ecology's Technical Assessment Protocol – Ecology (TAPE), under General Use Level Designation (GULD) for Basic Treatment.[3] You can identify proprietary media filters and high flow rate or biofilters currently holding this certification at the following link: www.ecy.wa.gov/programs/wq/stormwater/newtech/basic.html.

[3] "General Use" is distinguished from a pilot or conditional use designation. "Basic Treatment" is distinguished from treatment effectiveness for phosphorus removal. Basic treatment is intended to achieve 80 percent removal of total suspended solids (TSS) for influent concentrations from 100 mg/L to 200 mg/L TSS and achieve 20 mg/L TSS for less heavily loaded influents.

The municipality may require that any non-LID treatment measures used in a Special Project be TAPE-certified, or the municipality may allow the use of non-LID treatment measures certified by another governmental program.

If the TAPE system is used, treatment measures should be sized based on the hydraulic sizing criteria specified in MRP Provision C.3.d and the design operating rate for which the product received TAPE GULD certification for Basic Treatment. If a different certification program is used, specify the design operating rate for which the product received the relevant certification.

Appendix L

Soil Specifications

The regional biotreatment soil specifications, approved by the Regional Water Board on November 28, 2011, are provided on the following pages. The soil specifications are included in Attachment L of the Municipal Regional Stormwater Permit (MRP), as amended. Effective December 1, 2011, stormwater biotreatment measures are required to use the Water Board-approved specifications. Alternative biotreatment mixes that achieve a long-term infiltration rate of 5 to 10 inches per hour, and are suitable for plant health, may be used in accordance with the requirements described in the specifications, under the heading "Verification of Alternative Bioretention Soil Mixes".

ATTACHMENT L

Provision C.3.c.i.(1)(b)(vi)

Specification of soils for Biotreatment or Bioretention Facilities

Soils for biotreatment or bioretention areas shall meet two objectives:

- Be sufficiently permeable to infiltrate runoff at a minimum rate of 5" per hour during the life of the facility, and
- Have sufficient moisture retention to support healthy vegetation.

Achieving both objectives with an engineered soil mix requires careful specification of soil gradations and a substantial component of organic material (typically compost).

Local soil products suppliers have expressed interest in developing 'brand-name' mixes that meet these specifications. 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 delivery date of the bioretention soil to the project site.

Batch-specific test results and certification shall be required for projects installing more than 100 cubic yards of bioretention soil.

SOIL SPECIFICATIONS

Bioretention soils shall meet the following criteria. "Applicant" refers to the entity proposing the soil mixture for approval by a Permittee.

1. General Requirements – Bioretention soil shall:
   a. Achieve a long-term, in-place infiltration rate of at least 5 inches per hour.
   b. Support vigorous plant growth.
   c. Consist of the following mixture of fine sand and compost, measured on a volume basis:

      60%-70% Sand

      30%-40% Compost

2. Submittal Requirements – The applicant shall submit to the Permittee for approval:
   a. A sample of mixed bioretention soil.
   b. Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this guideline specification.
   c. Grain size analysis results of the fine sand component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
   d. Quality analysis results for compost performed in accordance with Seal of Testing Assurance (STA) standards, as specified in 4.

e. Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with by Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, “Loss-On-Ignition Organic Matter Method”.

f. Grain size analysis results of compost component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.

g. A description of the equipment and methods used to mix the sand and compost to produce Bioretention Soil.

h. Provide the name of the testing laboratory(s) and the following information:

(1) Contact person(s)

(2) Address(s)

(3) Phone contact(s)

(4) E-mail address(s)

(5) Qualifications of laboratory(s), and personnel including date of current certification by STA, ASTM, or approved equal

3. <u>Sand for Bioretention Soil</u>

a. Sand shall be free of wood, waste, coating such as clay, stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size shall be nonplastic.

b. Sand for Bioretention Soils shall be analyzed by an accredited lab using #200, #100, #40, #30, #16. #8, #4, and 3/8 inch sieves (ASTM D 422 or as approved by municipality), and meet the following gradation:

Sieve Size	**Percent Passing (by weight)** *Min*	*Max*
3/8 inch	100	100
No. 4	90	100
No. 8	70	100
No. 16	40	95
No. 30	15	70
No. 40	5	55
No. 100	0	15
No. 200	0	5

Note: all sands complying with ASTM C33 for fine aggregate comply with the above gradation requirements.

4. <u>Composted Material</u>

Compost shall be a well decomposed, stable, weed free organic matter source derived from waste materials including yard debris, wood wastes or other organic materials not including manure or biosolids meeting the standards developed by the US Composting Council (USCC). The product shall be certified through the USCC Seal of Testing Assurance (STA) Program (a compost testing and information disclosure program).

a. <u>Compost Quality Analysis</u> – Before delivery of the soil, the supplier shall submit a copy of lab analysis performed by a laboratory that is enrolled in the US Composting Council's Compost Analysis Proficiency (CAP) program and using approved Test Methods for the Evaluation of Composting and Compost (TMECC). The lab report shall verify:

(1) Feedstock Materials shall be specified and include one or more of the following: landscape/yard trimmings, grass clippings, food scraps, and agricultural crop residues.

(2) Organic Matter Content: 35% - 75% by dry wt.

(3) Carbon and Nitrogen Ratio: C:N < 25:1 and C:N >15:1

(4) Maturity/Stability: shall have a dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or is hot (120F) upon delivery or rewetting is not acceptable. In addition any one of the following is required to indicate stability:

(i) Oxygen Test < 1.3 O2 /unit TS /hr

(ii) Specific oxy. Test < 1.5 O2 / unit BVS /

(iii) Respiration test < 8 C / unit VS / day

(iv) Dewar test < 20 Temp. rise (°C) e.

(v) Solvita® > 5 Index value

(5) Toxicity: any one of the following measures is sufficient to indicate non-toxicity.

(i) NH4- : NO3-N < 3

(ii) Ammonium < 500 ppm, dry basis

(iii) Seed Germination > 80 % of control

(iv) Plant Trials > 80% of control

(v) Solvita® > 5 Index value

(6) Nutrient Content: provide analysis detailing nutrient content including N-P-K, Ca, Na, Mg, S, and B.

(i) Total Nitrogen content 0.9% or above preferred.

(ii) Boron: Total shall be <80 ppm; Soluble shall be <2.5 ppm

(7) Salinity: Must be reported; < 6.0 mmhos/cm

(8) pH shall be between 6.5 and 8. May vary with plant species.

b. Compost for Bioretention Soil Texture – Compost for bioretention soils shall be analyzed by an accredited lab using #200, 1/4 inch, 1/2 inch, and 1 inch sieves ASTM D 422 or as approved by municipality), and meet the following gradation:

Sieve Size	**Percent Passing (by weight)** *Min*	*Max*
1 inch	99	100
1/2 inch	90	100
1/4 inch	40	90
No. 200	2	10

c. Bulk density shall be between 500 and 1100 dry lbs/cubic yard

d. Moisture content shall be between 30% - 55% of dry solids.

e. Inerts – compost shall be relatively free of inert ingredients, including glass, plastic and paper, < 1 % by weight or volume.

f. Weed seed/pathogen destruction – provide proof of process to further reduce pathogens (PFRP). For example, turned windrows must reach min. 55C for 15 days with at least 5 turnings during that period.

g. Select Pathogens – Salmonella <3 MPN/4grams of TS, or Coliform Bacteria <10000 MPN/gram.

h. Trace Contaminants Metals (Lead, Mercury, Etc.) – Product must meet US EPA, 40 CFR 503 regulations.

i. Compost Testing – The compost supplier will test all compost products within 120 calendar days prior to application. Samples will be taken using the STA sample collection protocol. (The sample collection protocol can be obtained from the U.S. Composting Council, 4250 Veterans Memorial Highway, Suite 275, Holbrook, NY 11741 Phone: 631-737-4931, www.compostingcouncil.org). The sample shall be sent to an independent STA Program approved lab. The compost supplier will pay for the test.

VERIFICATION OF ALTERNATIVE BIORETENTION SOIL MIXES

Bioretention soils not meeting the above criteria shall be evaluated on a case by case basis. Alternative bioretention soil shall meet the following specification: “Soils for bioretention facilities shall be sufficiently permeable to infiltrate runoff at a minimum rate of 5 inches per hour during the life of the facility, and provide sufficient retention of moisture and nutrients to support healthy vegetation.”

The following steps shall be followed by municipalities to verify that alternative soil mixes meet the specification:

1. General Requirements – Bioretention soil shall achieve a long-term, in-place infiltration rate of at least 5 inches per hour. Bioretention soil shall also support vigorous plant growth. The applicant refers to the entity proposing the soil mixture for approval.

   a. Submittals – The applicant must submit to the municipality for approval:

      (1) A sample of mixed bioretention soil.

      (2) Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this guideline specification.

      (3) Certification from an accredited geotechnical testing laboratory that the Bioretention Soil has an infiltration rate between 5 and 12 inches per hour as tested according to Section 1.b.(2)(ii).

      (4) Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with by Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".

      (5) Grain size analysis results of mixed bioretention soil performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.

      (6) A description of the equipment and methods used to mix the sand and compost to produce Bioretention Soil.

      (7) The name of the testing laboratory(s) and the following information:

         (i) contact person(s)

         (ii) address(s)

         (iii) phone contact(s)

         (iv) e-mail address(s)

         (v) qualifications of laboratory(s), and personnel including date of current certification by STA, ASTM, or approved equal

   b. Bioretention Soil

      (1) Bioretention Soil Texture

      Bioretention Soils shall be analyzed by an accredited lab using #200, and 1/2" inch sieves (ASTM D 422 or as approved by municipality), and meet the following gradation:

Sieve Size	**Percent Passing (by weight)**	
	Min	***Max***
1/2 inch	97	100
No. 200	2	5

      (2) Bioretention Soil Permeability testing

      Bioretention Soils shall be analyzed by an accredited geotechnical lab for the following tests:

(i) Moisture – density relationships (compaction tests) shall be conducted on bioretention soil. Bioretention soil for the permeability test shall be compacted to 85 to 90 percent of the maximum dry density (ASTM D1557).

(ii) Constant head permeability testing in accordance with ASTM D2434 shall be conducted on a minimum of two samples with a 6-inch mold and vacuum saturation.

MULCH FOR BIORETENTION FACILITIES

Mulch is recommended for the purpose of retaining moisture, preventing erosion and minimizing weed growth. Projects subject to the State's Model Water Efficiency Landscaping Ordinance (or comparable local ordinance) will be required to provide at least two inches of mulch. Aged mulch, also called compost mulch, reduces the ability of weeds to establish, keeps soil moist, and replenishes soil nutrients. Aged mulch can be obtained through soil suppliers or directly from commercial recycling yards. It is recommended to apply 1" to 2" of composted mulch, once a YUear, preferably in June following weeding.

Appendix

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BMP Specifications for Small Projects

This is a placeholder for a new appendix that will be added after specifications have been developed for lot-scale site design and treatment measures for projects that create and/or replace at least 2,500 but less than 10,000 square feet of impervious surface, per Provision C.3.i of the MRP. The implementation date for this new requirement is December 1, 2012.