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Selection of Stormwater Treatment Facilities For Maximum Extent Practicable Treatment Effectiveness in Compliance with NPDES Provision C.3

The following types of facilities, if sized and designed as described in the *Stormwater C.3 Guidebook*, can meet the “maximum extent practicable” (MEP) standard for stormwater treatment effectiveness:

- Swales, planter boxes, bioretention areas, and other facilities using filtration through soil or sand (sized according to the flow-based criterion).
- Dry wells, infiltration trenches, infiltration basins, and other facilities using infiltration to native soils (sized according to the volume-based criterion).
- Extended detention basins, constructed wetlands or other facilities using settling (sized according to the volume-based criterion, with a detention time of 48 hours).

Lack of space, in itself, is not a suitable justification for using a less-effective treatment, because the uses of the site and the site design can be altered as needed to accommodate swales, planter boxes, or bioretention areas. In most cases, these effective facilities can be fit into required landscaping setbacks, easements, or other unbuildable areas.

Where possible, drainage to inlets, and drainage away from overflows and underdrains, should be by gravity. Where site topography makes it infeasible to accommodate gravity-fed facilities in the project design, the design flow may be captured in a vault or sump and pumped via force main to an effective facility.

The following situations sometimes present special challenges:

- Portions of sites which are not being developed or redeveloped, but which must be retrofit to meet treatment requirements in accordance with Provision C.3.c.i.3, which states: “Where a Significant Redevelopment project results in an increase of, or replacement of, more than fifty percent of the impervious surface of a previously existing development, and the existing development was not subject to stormwater treatment measures, the entire project must be included in the treatment measure design.”
- Sites smaller than one acre approved for “zero-lot-line” development or redevelopment as part of a municipality’s stated objective to preserve or enhance a pedestrian-oriented “smart-growth” type of urban design. Municipalities are encouraged to identify areas where this objective applies, based on General Plans or zoning.

In these special situations, the following types of facilities should each be evaluated in priority order (depending on the specific characteristics of the site and as determined by the municipal stormwater coordinator) until a feasible design is found. Additional guidance on facility selection and design is contained in the attached memo.

1. Swales, planter boxes, or bioretention areas fed by gravity.
2. Capture of the design flow in a vault or sump and pumping to swales, planter boxes, or bioretention areas.
3. A subsurface sand or media filter with a maximum design surface loading rate of 5 inches per hour and a minimum media depth of 18 inches. The sand surface must be made accessible for periodic inspection and maintenance (for example, via a removable grating).
4. A higher-rate surface biofilter, such as a tree-pit-style unit. The grading and drainage design should minimize the area draining to each unit and maximize the number of discrete drainage areas and units.
5. A higher-rate vault-based filtration unit.

Installations of all treatment facilities are subject to the Provision C.3.e requirements for operation and maintenance verification. Planned inspection and maintenance of facilities must be documented in a Stormwater Treatment Facilities Operation and Maintenance Plan prepared in accordance with Appendix F of the *Stormwater C.3 Guidebook*. Installations of vaults and other facilities which could hold water longer than 72 hours should be coordinated with the Contra Costa Mosquito and Vector Control District prior to final design.

Projects subject to flow-control (hydrograph modification management) requirements must also meet the standard in Appendix D of the *Stormwater C.3 Guidebook*. For most sites, treatment and flow control requirements can both be met most cost-effectively by using swales, planter boxes, or bioretention areas (or in highly permeable soils, dry wells, infiltration trenches, or infiltration basins) sized using the Program's Integrated Management Practice Sizing Calculator.

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To: **Contra Costa Clean Water Program
C.3 Implementation Work Group**

From: Dan Cloak

Subject: **Criteria for Selecting Stormwater Treatment Facilities**

Date: 21 March 2007

Introduction

The *Stormwater C.3 Guidebook*, Third Edition, lists a variety of facilities that can achieve “maximum extent practicable” treatment effectiveness:

- Swales, planter boxes, bioretention areas, and other facilities using filtration through soil or sand (sized according to the flow-based criterion).
- Dry wells, infiltration trenches, infiltration basins, and other facilities using infiltration to native soils (sized according to the volume-based criterion).
- Extended detention basins, constructed wetlands or other facilities using settling (sized according to the volume-based criterion, with a detention time of 48 hours).

The *Guidebook* provides critical design criteria for each of these types of facilities.

However, on some development sites and proposed projects it may be impracticable to use these preferred facilities and criteria.

This memorandum supports development of:

- Criteria for determining when it is impracticable to use the preferred types of facilities on a particular site.
- A procedure for selecting the appropriate “maximum extent practicable” type of treatment facility in these cases.

Regulatory Background

Provision C.3.c states:

Dischargers shall require Group 1 Projects to implement appropriate source control and site design measures and to design and implement stormwater treatment measures, to reduce the discharge of stormwater pollutants to the *maximum extent practicable* [emphasis added].

The Program’s November 2005 *Policy on the Use of Hydrodynamic Separators* states:

...“maximum extent practicable” means less-effective treatment may not be substituted when it is practicable to provide more effective treatment.

Last year the State Water Resources Control Board convened an expert Stormwater Panel on Numeric Limits (2006) to consider whether it was feasible to establish enforceable numeric effluent limits for stormwater discharges. The panel found:

It is not feasible at this time to set enforceable numeric effluent criteria for municipal BMPs and in particular urban discharges. However, it is possible to select and design them much more rigorously with respect to the physical, chemical and/or biological processes that take place within them, providing more confidence that the estimated mean concentrations of constituents in the effluents will be close to the design target.

In other words, to achieve “maximum extent practicable” it makes sense to specify criteria for facility design rather than for effluent quality or percent pollutant removal. The *Guidebook* approach is consistent with this finding.

Hydraulic Sizing Criteria

Provision C.3.d does specify hydraulic design criteria. Detention basins and other facilities which remove pollutants by settling must have a minimum volume. Flow-through facilities, including all types of filters, must treat the flow of runoff produced by a specified rainfall intensity.

The *Stormwater C.3 Guidebook* specifies 0.2 inches/hour as the design rainfall intensity for designing flow-based treatment facilities, including media filters (such as sand filters) and biofilters (such as swales, planter boxes, and bioretention areas) in Contra Costa.

The flow into a treatment facility can be calculated using the rational method:

$$Q = C * i * A_{\text{tributary}}$$

where

Q = design flow

C = runoff factor (conservatively set to 1.0 for impervious areas)

i = specified rainfall intensity (0.2 inches per hour)

A_{tributary} = tributary area draining to the facility.

Chapter 5 and Appendix C of the *Stormwater C.3 Guidebook* specify an 18-inch deep layer of sandy loam with a minimum sustained permeability of 5 inches per hour for stormwater planters, bioretention areas, and “dry” swales. *Guidebook* Chapter 5 states the loading rate of 5 inches per hour should also be applied to sand filters and other facilities which use media filtration.

The flow through the facility can be calculated by multiplying this rate times the surface area of the facility.

Using the continuity equation:

$$Q_{in} = Q_{out}$$

$$C * i * A_{tributary} = I * A_{facility}$$

which, upon rearrangement, yields a sizing factor $A_{facility}/A_{tributary}$ of 0.2 inches per hour/5 inches per hour or 0.04 (dimensionless).

These *Guidebook* criteria yield facility volumes comparable to what would result from using the design criteria in Claytor and Scheuler (1996), which are the basis for design standards used by stormwater programs in various states and cities throughout the U.S. The key Claytor and Scheuler (1996) design criterion is that the volume of pore spaces within the filter, plus the storage volume above the filter bed, plus the volume in a pretreatment settling basin (if used) should be at least $0.75 * [\text{Water Quality Volume (WQV)}]$.¹

The *Guidebook* sizing criteria address the following issues which are critical to sustained facility performance and achievement of “maximum extent practicable” pollutant removal:

- The capacity of the filter media to absorb and retain pollutants.
- Facilitation of biological processes within the filter, which provide multiple pathways for pollutant retention and processing.
- The filter’s ability to delay “breakthrough,” which may occur when pollutants migrate through the depth of the filter and are released into the filtrate.
- The capacity of the filter to absorb “shock” loadings of pollutants without deterioration of effluent quality.
- Continued effectiveness under adverse conditions such as unexpectedly high loadings and/or delayed maintenance.
- Visibility of the treatment facility and ease of inspection.
- Required maintenance frequency and cost of maintenance.
- Future availability and cost of materials needed to maintain the filter’s effectiveness.

¹ This criterion is incorporated into the Maryland Department of the Environment’s (MDE’s) *Stormwater Design Manual*. In the June 9, 2006 letter conditionally approving the use of the Filterra® system as a stand-alone BMP, MDE stated: “The storm event monitoring data and pollutant removal efficiency analyses support the high k factor that allows Filterra® units to be considerably smaller than typical filtering practices sized according to Design Manual specifications. However, MDE feels it imperative to hold fast to the remaining Design Manual sizing criteria of pretreating 25% of the water quality volume (WQV) and holding 75% of the WQV in the entire system.”

Characterizing Sites Where Preferred Facilities May be Impracticable

Swales, bioretention areas, and planter boxes are the preferred treatment facilities and can be equipped with underdrains in sites with low-permeability soils. By carefully considering drainage and stormwater treatment *before* sketching a site plan or subdivision of lots, land development engineers have successfully incorporated swales, planter boxes, and bioretention areas—sized using the 0.04 factor—into many types of developments in Contra Costa. Project examples include high-density residential development on steep, clayey hillsides, mixed-use residential/retail developments, multifamily residential developments, and sites smaller than one acre.

Based on their professional experience and judgment, participants in the C.3 Implementation Work Group have noted the following circumstances where incorporation of swales, planter boxes, or bioretention areas into a site plan is sometimes (but not always) particularly difficult.

- Sites where zoning specifies the location of site landscaping (for example, along the street frontage), and the site topography is such that the locations to be landscaped are at a higher elevation than the areas to be paved.
- Retrofit of existing paved areas which are drained by conventional catch basins and underground pipes and are not being substantially re-graded or repaved. These retrofits may be required under the following language from Provision C.3.c: “Where a Significant Redevelopment project results in an increase of, or replacement of, more than fifty percent of the impervious surface of a previously existing development, and the existing development was not subject to stormwater treatment measures, the entire project must be included in the treatment measure design.”
- Lots, including small lots in older urban areas which are being redeveloped, where the approved mode of development is to extend structures to the lot line in all directions (“zero-lot-line” development).

There may be other circumstances where the use of swales, planter boxes, and bioretention areas is infeasible. Municipal stormwater coordinators are encouraged, when these rare and unusual circumstances arise, to consult with each other through the Program’s committee’s and work groups, and with Program staff, to determine if a design solution incorporating swales, planter boxes, or bioretention areas has been found for a comparable circumstance in another municipality.

Next Best Practicable Alternatives

On sites where swales, planter boxes, and bioretention areas are not feasible, the most effective practicable alternative should be selected.

Selection should seek to achieve, as much as possible given site constraints, the same advantages provided by swales, planter boxes and bioretention areas. It is recommended that options be evaluated in the

following sequence, depending on the specific characteristics of the site and as determined by the municipal stormwater coordinator:

1. *Swales, planter boxes, and bioretention areas fed by gravity.*
2. *Capture of the design flow in a vault or sump and pumping via force main to swales, planter boxes, or bioretention areas.* This alternative can be used where site topography makes it infeasible to drain by gravity to paved areas to swales, planter boxes, and bioretention areas. The advantages of the LID IMPs are preserved, but the additional maintenance requirements of a vault and pump are added. For treatment-only IMPs, the vault can be fairly small (and should be smaller than the reservoir on the surface of the receiving IMP). The design pumping rate should be greater than the flow produced by 0.2 inches per hour rainfall. Care should be taken to ensure the vault minimizes standing water and is readily accessible for inspection and maintenance. When evaluating the feasibility of this option, consider the availability and reliability of electrical power (typically only 110V/120V is needed) as well as practicability of maintenance for the vault and pump.
3. *Subsurface sand or media filter* with a maximum design surface loading rate of 5 inches per hour and a minimum media depth of 18 inches. This provides detention volume and capacity for pollutant removal similar to that of the preferred swales, bioretention areas, and planter boxes. However, there will be less biological activity to assist with pollutant removal and to keep the media surface open and permeable. The sand surface must be made accessible for frequent inspection and maintenance (for example, via a removable grating).
4. *A higher-rate surface biofilter*, such as a Filterra® tree-pit-style unit. The grading and drainage design should minimize the area draining to each unit and maximize the number of discrete drainage areas and units. These facilities have good removal rates for pollutants, and are easy to maintain, but provide little detention, have less overall capacity for absorbing pollutants, and consequently have less capacity to absorb shock loadings or to perform under adverse conditions.
5. *A higher-rate vault-based filtration unit*, of either non-proprietary or proprietary design. The *California Stormwater BMP Handbook for New Development and Redevelopment* Fact Sheet TC-40 includes example non-proprietary designs. For proprietary designs, the manufacturer's recommended filtration surface area (or number of cartridges) should be doubled to increase the likelihood adequate performance will be maintained over time.

References Cited

Claytor, Richard and Thomas R. Schueler. 1996. *Design of Stormwater Filtering Systems*. Center for Watershed Protection, Ellicott City, Maryland.

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