Appendix

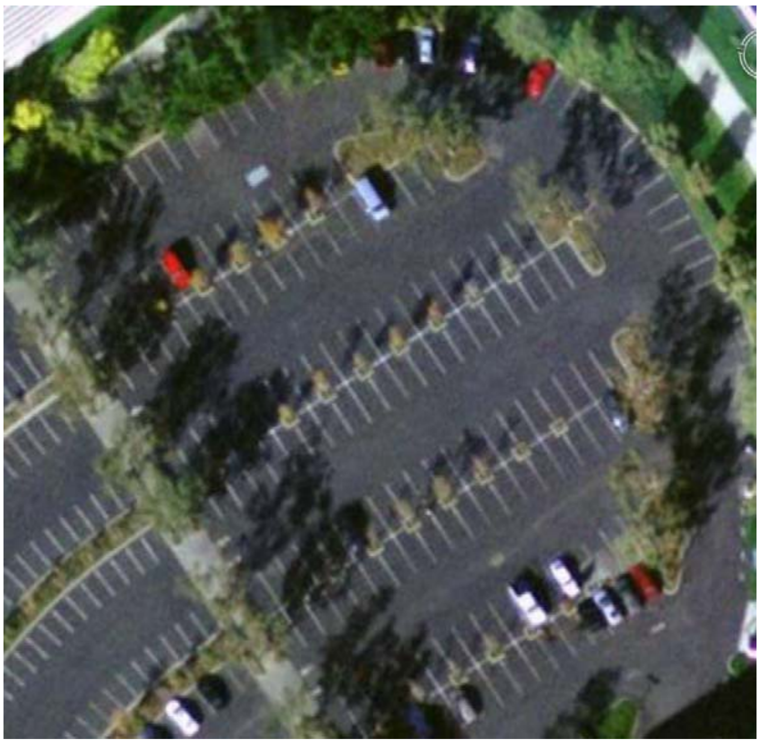
C

Example Scenarios and Spreadsheet Tools for Sizing Stormwater Treatment Measures

C.1 Parking Lot Example

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. This example demonstrates the use of the 4 percent standard for sizing bioretention areas.



Typical Parking Lot

Summary of Stormwater Controls

Site Design Measures

- Landscaped areas within one drainage management area is designed to function as a self-treating area, so that it bypasses the bioretention area, as described in Section 4.1 of this manual. A second landscaped area drains to 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 four percent standard described in Section 5.1.

The following shows sizing and calculations of the site and the treatment measures used.

Typical Bioretention Area

Procedure for sizing treatment measures using the 4 percent standard:

A1. Based on the topography of the site and configuration of buildings, divide the site into drainage management areas (DMAs), each of which will drain to an LID treatment measure. Implement Steps 2 through 5 for each DMA.

A2. To minimize the amount of landscaping or pervious pavement that will contribute runoff to the LID treatment measures, it was possible to design landscaping in Drainage Management Area B as a "self-treating area" (as described in Section 4.1), so that runoff from that landscaped area bypasses the treatment measure.

A3. List the area of impervious surfaces that drain to each treatment measure; include the area of pervious surface (landscaping) in Area A and multiply the pervious area by a factor of 0.1.

A4. For Area A, add the product obtained in Step A3 to the area of impervious surface, to obtain the area of "effective impervious surface."

A5. Multiply the impervious surface (or effective impervious surface in applicable DMAs) by a factor of 0.04. This is the required surface area of the LID treatment measure.

Steps 2 through 5 are shown in Table A-1.

Table A-1: Bioretention Sizing for Parking Lot Example (4% standard sizing approach)

DMA	Impervious Area (sf)	Pervious Area (sf)[1]	Pervious Area x 0.1	Effective Impervious Area (EIA) (sf)	EIA * 0.04 (sf)
A	6,788	7,868	786.8	7,575	303
B	24,491	0	0	24,491	980
Totals	31,279	7,868	786.8	32,066	1,283

[1] Include only the pervious area that drains to the treatment measure, not self-treating areas.

C.2 Podium Type Building Example

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. Flow-through planters in this example are sized using the combination flow and volume sizing approach.

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.

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. Because this value is less than 16.4 inches, the applicable rain gauge is the San Jose Airport gauge (MAP = 14.4 inches)

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.

City of Portland *2004 Stormwater Manual*

Typical Flow Through Planter

Procedure for sizing using combined flow and volume method:

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. 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 effective 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
Effective Impervious Area		**24,100 square feet**

B3. 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 (runoff coefficient of 1.0). The unit basin storage volume at the San Jose Airport gauge for a coefficient of 1.0 is **0.56 inches**. Adjust this volume based on the mean annual precipitation at the site (16 inches).

Adjusted unit basin storage volume = 0.56" * (16"/14.4") = 0.62".

B4. Calculate the Water Quality Design Volume. The water quality design volume is the area from Step B2 times the adjusted unit basin storage volume. (24,100 square feet * 0.62 inches * 1/12 feet per inch = **1,245 cubic feet**.)

B5. Use a constant surface loading rate of **5 inches per hour** through the soil as required by the Permit for use with treatment soils.

B6. 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). 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 0.62 inches, the rain event duration is 0.62 inches ÷ 0.2 inches/hour = **3.1 hours**.

B7. Compute Required Depth of Storage for a given treatment area. (Maximum Allowable Depth = 12 inches)

Start by calculating the bioretention area using the 4% standard sizing factor. For the effective impervious area calculated in Step B2 (24,100 square feet), the required bioretention surface area would be (0.04*24,100) = **964 square feet**. Then assume a bioretention area size that is 25% smaller than that calculated using the 4% standard. Using the example, 964 – (0.25 × 964) = **723 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 B6. For this example, for a bioretention treatment area of 723 square feet, with a surface loading rate of 5 inches per hour for a duration of 3.1 hours, the volume of treated runoff = 723 square feet × 5 inches/hour × (1 foot/12 inches) × 3.1 hours = **934 cubic feet**.

B8. The difference between the volume of runoff from Step B4 and the volume that flows through the planter for the storm duration from B7 is (1,245 cubic feet – 934 cubic feet) = **311 cubic feet**. If this volume is stored over a surface area of 723 square feet, the average ponding depth would be 311 cubic feet ÷ 723 square feet = **0.43 feet or 5.2 inches**.

B9. 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 B7 and B8 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 5.2 inches is less than the recommended range of 6 to 12 inches. A repetition of steps B7 and B8 with a bioretention area that is 30 percent smaller than the bioretention area calculated in Step B2 is provided below.

B.10 Repeat Step B7 with a bioretention area 30% smaller than the bioretention area in Step B2: 964 sq.ft. – (0.30 x 964) = 674 sq.ft. Calculate the volume treated during the rain event duration: 674 sq.ft. x 5 in/hr x 1 ft/12 in x 3.1 hours = **871 cubic feet**.

Repeat Step B9 for the smaller bioretention area to calculate the volume remaining in the ponded area: 1245 cu.ft. – 871 cu.ft. = 374 cubic feet. Calculate the average ponding depth: 374 cu.ft. ÷ 674 sq.ft. = **0.55 feet or 6.6 inches**.

Note: See worksheets on the following pages:

3.1 Worksheet for Calculating the Water Quality Design Volume (80 percent capture method)
3.2 Worksheet for Calculating the Combination Flow and Volume Method

The worksheets are available for download at www.cleanwaterprogram.org, included in Appendix C of the online C.3 Technical Guidance.