June 2017 C.3 Workshop – Sizing Example

Section II. Sizing for Volume-Based Treatment Measures

Section II.B — Sizing Volume-Based Treatment Measures based on the Adapted CASQA Stormwater BMP Handbook Approach

The equation that will be used to size the BMP is:

Design Volume = (Rain Gage Correction Factor) × (Unit Basin Storage Volume) × (Drainage Area)

Step 1. Determine the drainage area for the BMP, A = **0.80** acres

Step 2. Determine percent imperviousness of the drainage area:

a. Estimate the amount of impervious surface (rooftops, hardscape, streets, and sidewalks, etc.) in the area draining to the BMP: **0.80** acres

b. % impervious area = (amount of impervious area/drainage area for the BMP) × 100
% impervious area = **(Step 2.a/Step 1)** × 100
% impervious area = **100** %

Step 3. Find the mean annual precipitation at the site (MAP_{site}). To do so, estimate where the site is on Figure B-1 and estimate the mean annual precipitation in inches from the rain line (isopleth) nearest to the project site.[1] Interpolate between isopleths if necessary.

MAP_{site} = **15.0** inches

Step 4. Identify the reference rain gage closest to the project site from Table B-2b and record the MAP_{gage}:

MAP_{gage} = **13.9** inches

Table B-2b: Precipitation Data for Three Reference Gages

Reference Rain Gages	Mean Annual Precipitation (MAP_{gage}) (in)
San Jose Airport	13.9
Palo Alto	13.7
Morgan Hill	19.5

[1] Check with the local municipality to determine if more detailed maps are available for locating the site and estimating MAP.

Section II. Sizing for Volume-Based Treatment Measures, continued

Section II.B —Adapted CASQA Stormwater BMP Handbook Approach (continued)

Step 5 Determine the rain gage correction factor for the precipitation at the site using the information from **Step 3** and **Step 4**.

Correction Factor = MAP_{site} (**Step 3**)/MAP_{gage} (**Step 4**) = 15.0/13.9

Correction Factor = **1.08**

Step 6. Identify the representative soil type for the BMP drainage area.

a) Identify from Figure B-1 or from site soils data, the soil type that is representative of the pervious portion of the project shown here in order of increasing infiltration capability:

____ Clay (D) ____ Sandy Clay (D) ____ Clay Loam (D)

____ Silt Loam/Loam (B) _**X**_ Not Applicable (100% Impervious)

b) Does the site planning allow for protection of natural areas and associated vegetation and soils so that the soils outside the building footprint are not graded/compacted? **N** (Y/N)

If your answer is no, and the soil will be compacted during site preparation and grading, the soil's infiltration ability will be decreased. Modify your answer to a soil with a lower infiltration rate (e.g., Silt Loam to Clay Loam or Clay).

Modified soil type: ______

Step 7. Determine the average slope for the drainage area for the BMP: **1** %

Step 8. Determine the unit basin storage volume from sizing curves.

a) Slope ≤ 1%

Use the figure at the end of this Appendix entitled "Unit Basin Volume for 80% Capture, 1% Slope" corresponding to the nearest rain gage: Figure B-2, B-3, or B-4 for San Jose, Palo Alto, or Morgan Hill, respectively. Find the percent imperviousness of the drainage area (from **Step 2**) on the x-axis. From there, find the line corresponding to the soil type (from **Step 6**), and obtain the unit basin storage volume on the y-axis.

Unit Basin Storage for 1% slope ($UBS_{1\%}$) = **0.58** (inches)

b) Slope ≥ 15%

Use the figure at the end of this Appendix entitled "Unit Basin Volume for 80% Capture, 15% Slope" corresponding to the nearest rain gage: Figure B-5, B-6, or B-7 for San Jose, Palo Alto, or Morgan Hill, respectively. Find the percent imperviousness of the drainage area (from **Step 2**) on the x-axis. From there, find the line corresponding to the soil type (from **Step 6**), and obtain the unit basin storage volume on the y-axis.

Unit Basin Storage for 15% slope ($UBS_{15\%}$) = ______ (inches)

Section II. Sizing for Volume-Based Treatment Measures, continued

Section II.B. —Adapted CASQA Stormwater BMP Handbook Approach (continued)

c) Slope > 1% and < 15%

Find the unit basin volumes for 1% and 15% using the techniques in **Steps 8.a** and **8.b** and interpolate by applying a slope correction factor per the following formula:

UBS_x = $UBS_{1\%}$ + ($UBS_{15\%}$ - $UBS_{1\%}$) × (X%-1%) / (15% -1%)
= (**Step 8a**) + (**Step 8b**- **Step 8a**) × (X%-1%)/(15%-1%)

Where UBS_x = Unit Basin Storage volume for drainage area of intermediate slope, X %

Unit Basin Storage volume (UBS_x) = ____________(inches)
(corrected for slope of site)

Step 9. Determine the Adjusted Unit Basin Storage Volume for the site, using the following equation:

Adjusted UBS = Rain Gage Correction Factor × Unit Basin Storage Volume

Adjusted UBS = (**Step 5**) × (**Step 8**) = 1.08 × 0.58

Adjusted UBS = **0.63** inches

Step 10. Determine the BMP Design Volume, using the following equation:

Design Volume = Adjusted Unit Basin Storage Volume × Drainage Area

Design Volume = (**Step 9**) × (**Step 1**) × 1 ft/12 in = 0.63 × 0.8 × 1/12

Design Volume = **0.042** acre-feet × 43,560 square feet/acre = **1,819** cubic feet

Section IV. Sizing for Flow- and Volume- Based Treatment Measures (Combination Flow and Volume Approach)

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 treatment measure is mostly impervious. Contributing pervious surfaces can be converted to equivalent impervious surface using the procedure outlined in Step 1.

Step 1. **Contributing drainage area to the treatment measure:** **_35,000_ sq. ft.**

Is the contributing drainage area 100% impervious? __X__ Yes ____ No
If yes, skip to Step 2c and fill in the drainage area as the effective impervious area.

Step 2. Determine the effective impervious surface area draining to the treatment measure:

a. Impervious surface area draining to the treatment measure: _**35,000**_ sq. ft.

b. Pervious surface area draining to the treatment measure: ___**0**__ sq. ft.

For small grass or landscaped areas, multiply the pervious surface area by a runoff coefficient of 0.10 to compute the equivalent impervious surface area.

c. Effective impervious area = (pervious area × 0.10) + impervious area
Effective impervious area = (Step 2.b x 0.10) + Step 2.a
Effective impervious area = _**35,000**_ sq. ft.

Step 3. Determine the required treatment volume using Adapted CASQA Stormwater BMP Handbook Approach (Worksheet Section II.B, Steps 9 and 10). Copy the results here:

Adjusted Unit Basin Storage (UBS) Volume: **__0.63_ in.**

Water Quality Design (WQD) Volume: **_1,819_ cu. ft.**

Step 4. Determine the design rainfall intensity (Uniform Intensity Approach, Section III.C, Step 3):

Design Rainfall Intensity: **__0.2__ in/hr**

Step 5. Assume that the rain event that generates the Unit Basin Storage Volume of runoff occurs at the design rainfall intensity for the entire length of the storm. Calculate the duration of the storm by dividing the adjusted Unit Basin Storage Volume by the design rainfall intensity. In other words, determine the amount of time required for the Unit Basin Storage Volume to be achieved at the design intensity rate.

Duration = UBS Volume (inches) ÷ Rainfall Intensity (inches/hour)

Duration = (**Step 3**) ÷ 0.2 in/hr = **___3.15__ hrs.**

IV. Sizing for Flow- and Volume-Based Treatment Measures, continued

Step 6. 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 **0.03.**

Estimated Surface Area = Total Effective Impervious Area × 0.03

Estimated Surface Area = __**35,000**__ sq. ft. × 0.03 = __**1,050**__ **sq. ft.**
(**Step 2.c**)

Step 7. Calculate the volume of runoff that filters through the biotreatment soil at a rate of 5 inches per hour (the design surface loading rate for bioretention facilities), for the duration of the storm calculated in Step 5.

Volume of Treated Runoff = Estimated Surface Area × 5 in/hr × (1 ft/12 in) × Duration

Volume of Treated Runoff = __**1,050**__ sq. ft. × 5/12 × __**3.15**__ hrs. = __**1,378**__ **cu. ft.**
(**Step 6**) (**Step 5**)

Step 8. Calculate the portion of the water quality design (WQD) volume remaining after treatment is accomplished by filtering through the biotreatment soil. The result is the amount that must be stored in the ponding area above the bioretention surface area estimated in Step 6.

Volume in ponding area = WQD Volume – Volume of Treated Runoff

Volume in ponding area = __**1,819**__ cu. ft. – __**1,378**__ cu. ft. = __**441**__ **cu. ft.**
(**Step 3**) (**Step 7**)

Step 9. Calculate the depth of the volume in the ponding area by dividing this volume by the estimated surface area in Step 6.

Depth of ponding = Volume in Ponding Area ÷ Estimated Surface Area

Depth of ponding = __**441**__ cu. ft. ÷ __**1,050**__ sq. ft. = __**0.42**__ **ft. (5 in.)**
(**Step 8**) (**Step 6**)

Step 10. Check to see if the average ponding depth is between 0.5 and 1.0 feet (6 and 12 inches), which is the range of allowable ponding depths in a bioretention facility or flow-through planter (**0.5 feet is recommended**). If the ponding depth is less than 0.5 feet, the bioretention design can be optimized with a smaller surface area (i.e., repeat Steps 6 through 9 with a smaller surface area). If the ponding depth is greater than 1 foot, a larger surface area will be required (i.e., repeat Steps 6 through 9 with a larger surface area).

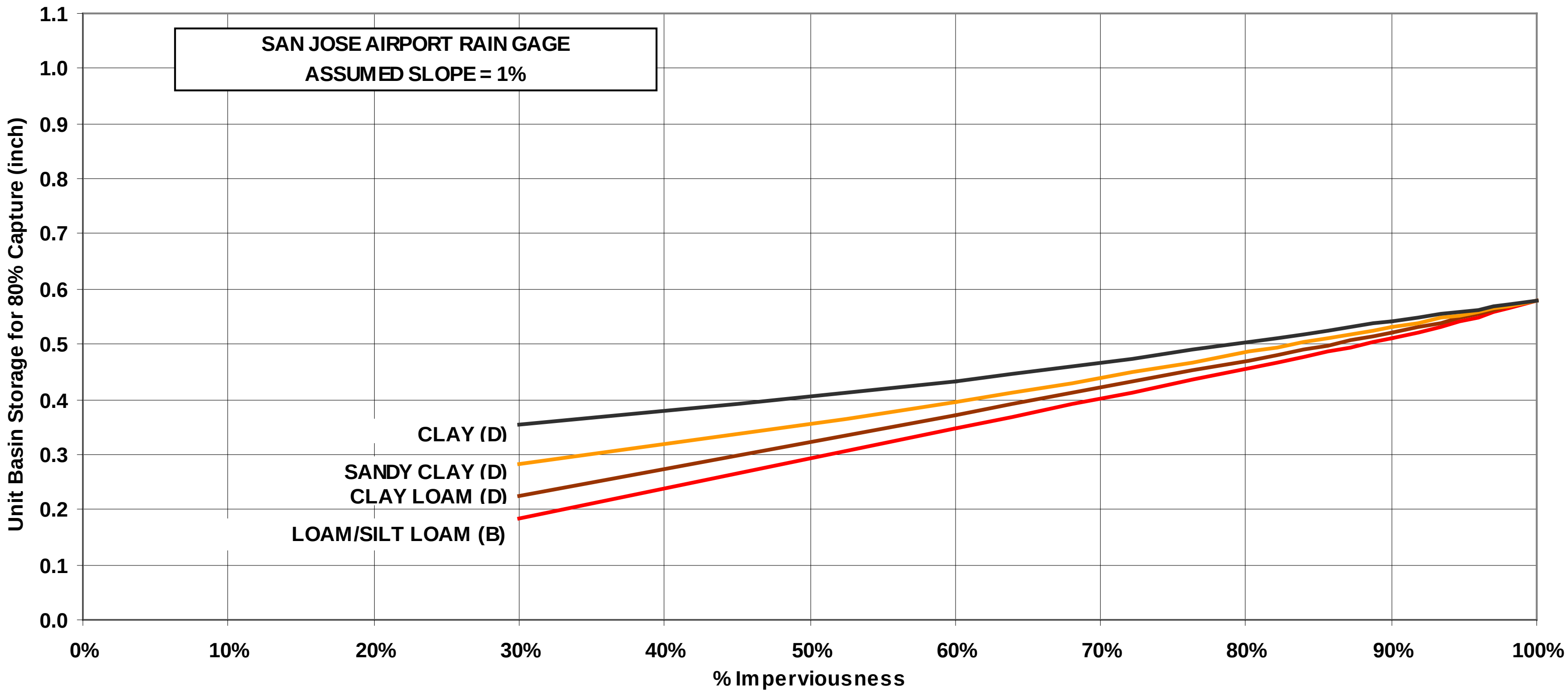

Figure B-2 Unit Basin Volume for 80% Capture - <u>San Jose Airport Rain Gage</u>