



Stormwater Treatment Measure Sizing and Design Guidance

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April 25, 2023

Santa Clara Valley
Urban Runoff
Pollution Prevention Program

EOA inc.

Presentation Overview

- Sizing/Design of Self-Treating and Self-Retaining Areas
- Sizing/Design of Treatment Measures
  - Determining the Water Quality Design Flow and Volume
  - Bioretention and Flow-Through Planters
  - Pervious Pavement and Infiltration Trenches
  - High-Rate Media Filters
  - Rainwater Harvesting Cisterns

Site Design Measures to Reduce Runoff Requiring Treatment

- Self-Treating Areas
- Self-Retaining Areas
- ~~Interceptor Tree Credits~~

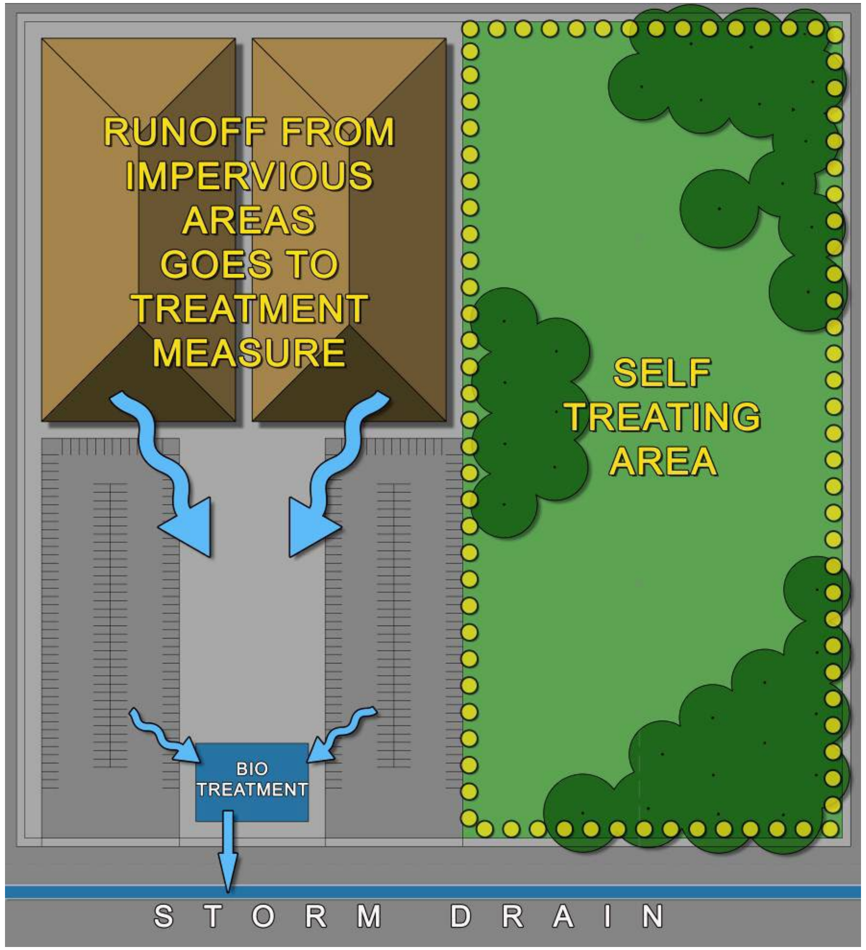
Self-Treating Area

- Pervious area that treats rain falling on itself only, via ponding, infiltration and/or evapotranspiration
  - Landscaping
  - Green roof
  - Pervious pavement
  - Artificial turf (if properly constructed)

- Landscaped areas must retain approximately 1” of rain
- Pervious pavement and artificial turf must be designed to store and infiltrate the C.3.d amount of runoff in order to qualify as self-treating areas

Self-Treating Areas Reduce the Area Requiring Treatment

- Runoff from **pervious** portions of the project (after infiltrating 1") can flow directly to the storm drain (if no mixing with runoff from impervious areas)
- Runoff from **impervious** areas flows to smaller treatment measure

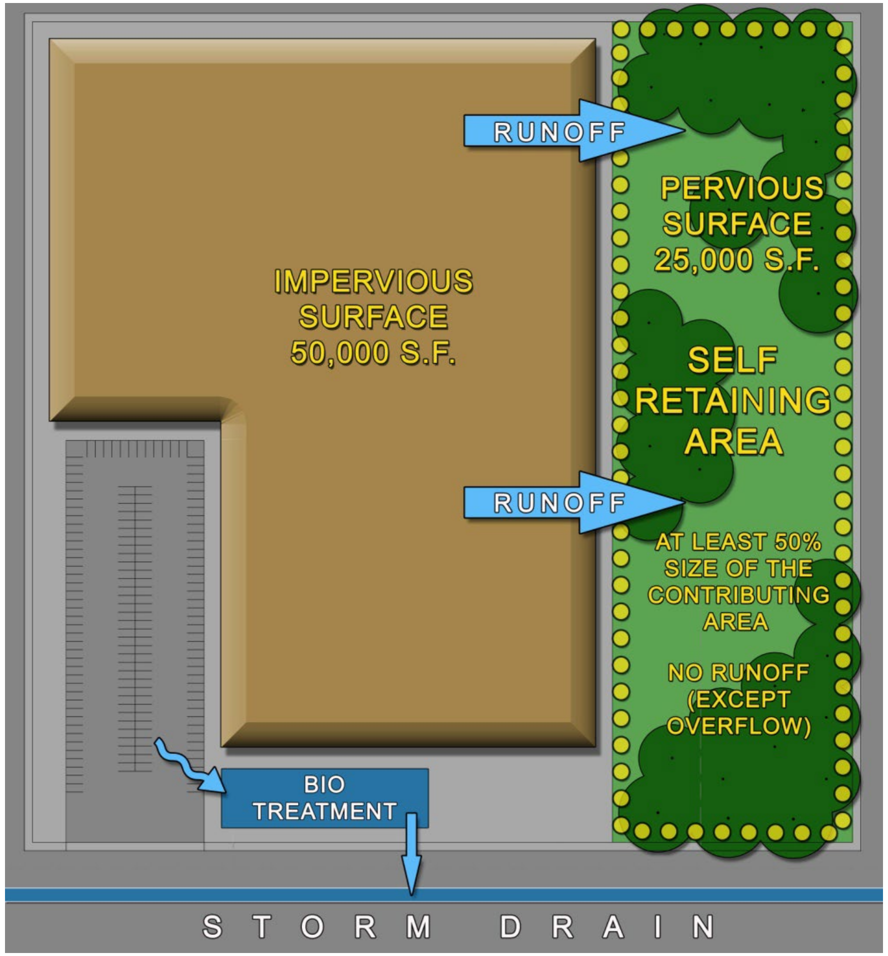


Self-Retaining Area

- Pervious area that retains first 1" of rainfall on itself and runoff from adjacent impervious area, up to a 2:1 ratio (impervious:pervious)
  - Roof runoff dispersion to depressed landscaped area
  - Partial green roofs
  - Pervious pavement (with adequate storage)
- No special soils required
- Area must be able to retain up to 3" of ponding

Self-Retaining Areas Reduce the Area that Requires Treatment

- Runoff from **impervious** portions of the project can flow directly to a **pervious** area that is at least 50% of the size of the contributing area
- Runoff from other impervious areas flows to smaller treatment measure



Design of Self-Retaining Areas

- Landscaped areas
  - Plan sheet should indicate a relatively flat, concave, landscaped surface with ponding depth as follows:
    - **Depth = 1 inch + [(Imperv Area ÷ Perv Area) X 1 inch]**
  - Elevation of any area drains should be set at top of ponding depth
- Partial green roofs and pervious pavement
  - Calculate depth of water quality volume using equation above
  - Determine depth of media/aggregate require to store the water quality volume

Sizing/Design of Treatment Measures

- MRP Provision C.3.d allows three approaches, depending on the type of treatment measure:
  - Volume-based
  - Flow-based
  - Combination flow/volume

Flow- or Volume-Based Sizing for Treatment Measures?

Flow and Volume Based Treatment Measure Sizing Criteria		
Type of Treatment Measure	**LID?**	**Hydraulic Sizing Criteria**
Bioretention area	Yes	Flow- or volume-based or combination
Flow-through planter	Yes	Flow- or volume-based or combination
Tree well filter (biotreatment soil)	Yes	Flow-based
Infiltration trench	Yes	Volume-based
Subsurface infiltration system	Yes	Volume-based
Rainwater harvesting and use	Yes	Volume-based
Pervious pavement	Yes	Volume-based
High flow rate media filter or tree well filter	No	Flow-based

C.3.d Sizing Criteria

- Volume-based sizing criteria:
  - URQM Method - use formula and volume capture coefficients in "Urban Runoff Quality Management", WEF/ASCE MOP No. 23 (1998), pages 175-178
  - CASQA BMP Handbook Method - Determine volume equal to 80% of the annual runoff, using methodology in Appendix D of the CASQA BMP Handbook (2003) using local rainfall data
    - **Sizing curves specific to Santa Clara Valley provided in Appendix B of the SCVURPPP C.3 Handbook**

C.3.d Sizing Criteria

- Flow-based sizing criteria:
  - Factored Flood Flow - 10% of the 50-year peak flow rate, determined using Intensity-Duration-Frequency curves from local flood control agency – **NOT USED**
  - Percentile Rainfall Intensity - Flow of runoff produced by a rain event equal to two times the 85th percentile hourly rainfall intensity
    - **Data for Santa Clara Valley rain gages in Sizing Worksheets (Appendix B of C.3 Handbook)**
  - **Uniform Intensity - Flow of runoff resulting from a rain event equal to 0.2 inches per hour intensity**

C.3.d Sizing Criteria

- 85th Percentile Rainfall Intensity Data:

Reference Rain Gages	85th Percentile Hourly Rainfall Intensity (in/hr)	Design Rainfall Intensity (in/hr)*
San Jose Airport	0.087	0.17
Palo Alto	0.096	0.19
Morgan Hill	0.12	0.24

*Design rainfall intensity = 2 X 85th percentile hourly rainfall intensity

- Need to translate rain gage values to site value using ratio of mean annual precipitation (MAP)

C.3.d Sizing Criteria

- Flow-based sizing criteria:
  - Simplified Sizing Method – Variation of Uniform Intensity Method (0.2 in/hr)
    - Surface area of biotreatment measure is sized to be 4% of the contributing impervious area
    - Based on runoff inflow of 0.2 in/hr (assume equal to rainfall intensity), with an infiltration rate through the biotreatment soil of 5 in/hr

      $$(0.2 \text{ in/hr} \div 5 \text{ in/hr} = 0.04)$$

    - Conservative approach because does not account for surface ponding – good for planning purposes

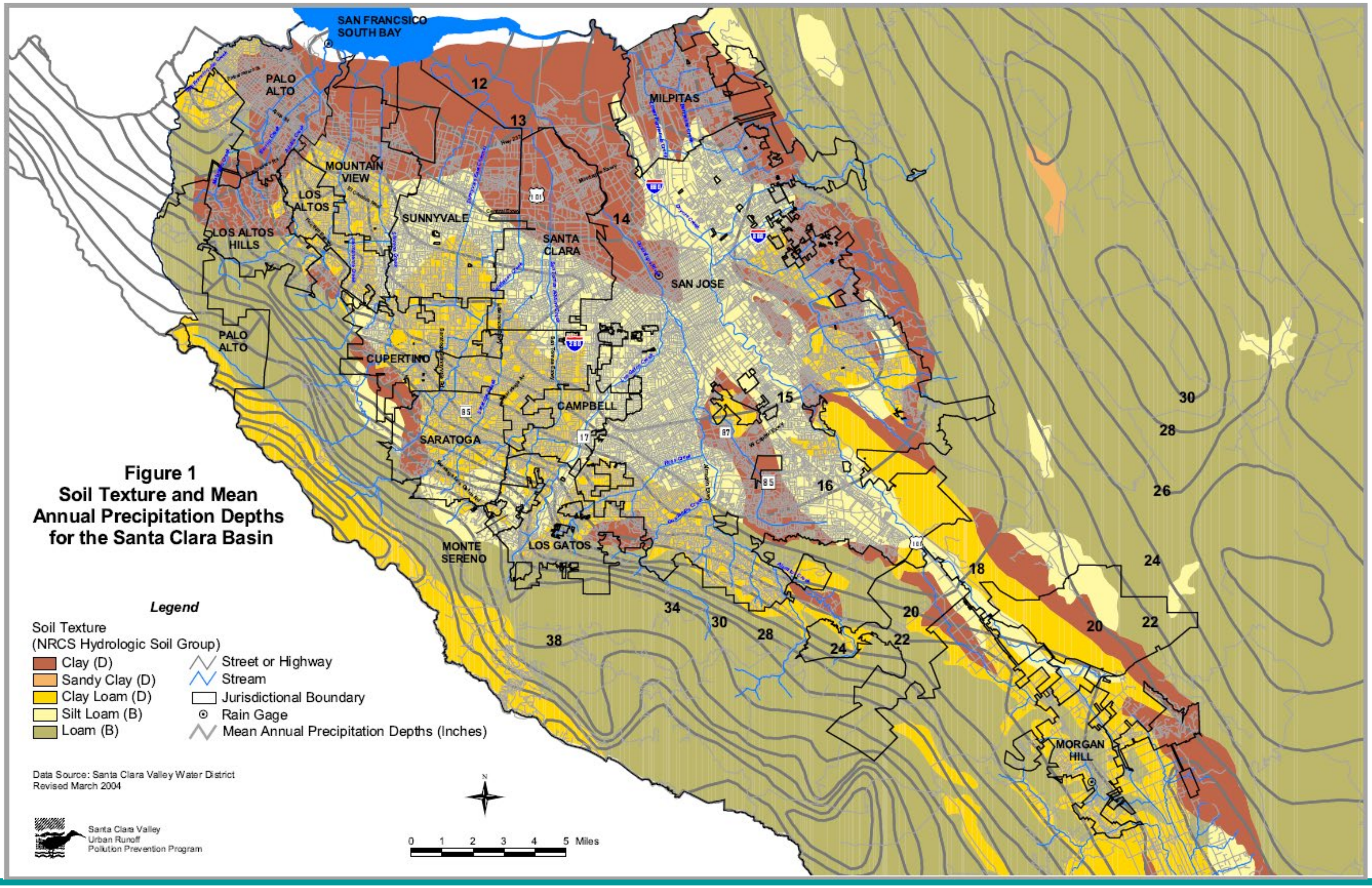
C.3.d Sizing Criteria

- Combination Flow & Volume Design Basis:
  - Treatment systems can be sized to treat “at least 80% of total runoff over the life of the project”
  - Option 1: Use a continuous simulation hydrologic model (typically not done for on-site treatment measures)
  - Option 2: Show how treatment measure sizing meets both flow and volume-based criteria
    - Used for bioretention and flow-through planters
    - Appropriate where drainage area is mostly impervious
    - **See guidance in Appendix B of C.3 Handbook**

Sizing Guidance

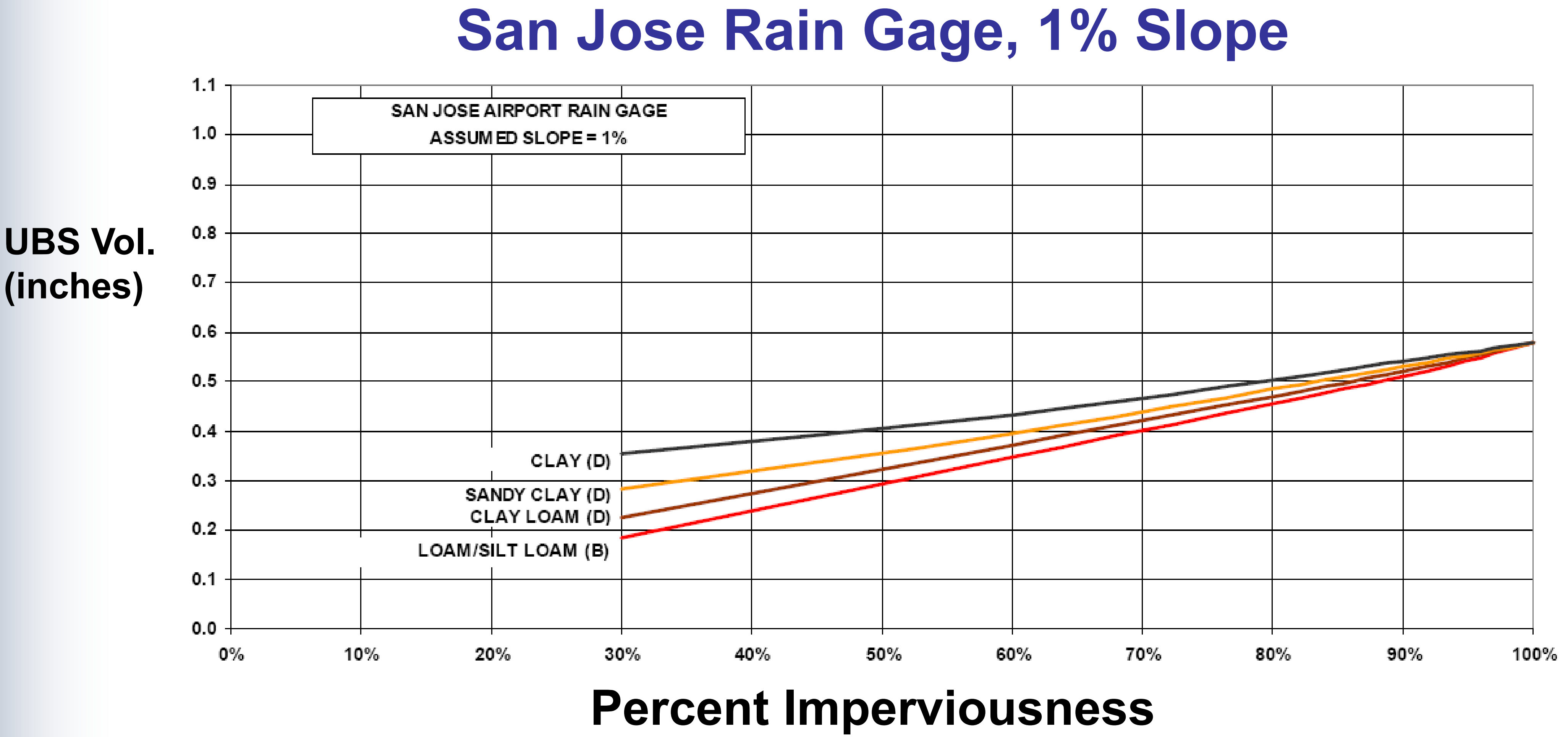
- Appendix B of SCVURPPP C.3 Handbook
  - Worksheets for determining water quality design flow, volume, and combination flow/volume
  - Figure B-1: Soil Texture and Mean Annual Precipitation (MAP) Depths
  - Figures B-2 – B-7: Unit Basin Storage Volume for 80% Capture (3 gages, 1% and 15% slopes)
  - Sizing examples
- Excel-format Sizing Worksheets now available

Figure B-1: Soil Texture and Mean Annual Precipitation (MAP) Depth



Unit Basin Storage Volumes for 80% Capture

(for San Jose, Palo Alto, and Morgan Hill gages, 1% and 15% slopes)

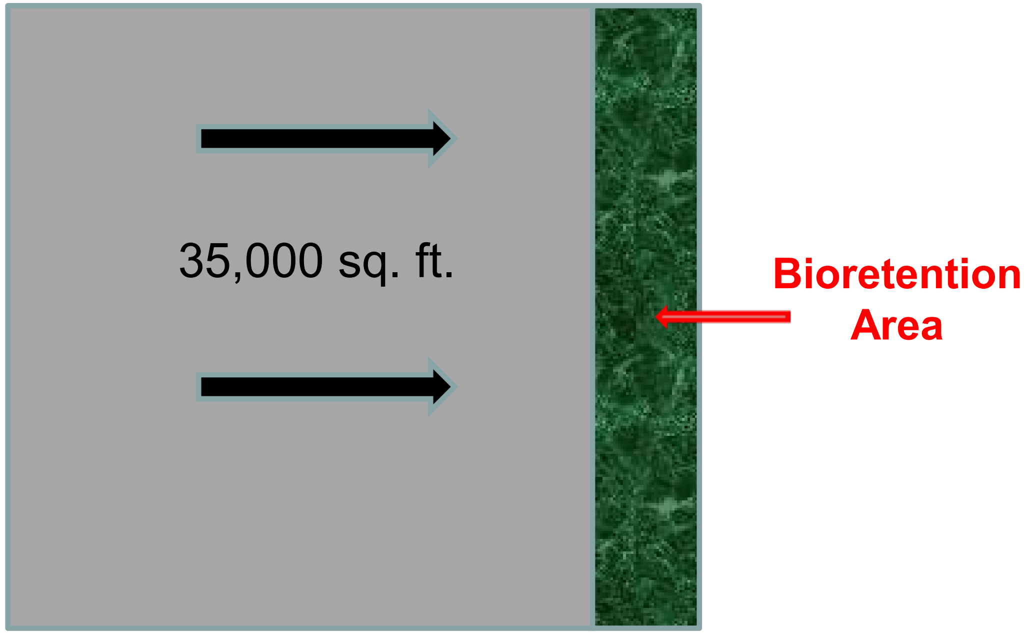


Sizing Bioretention Facilities

- Simplified Sizing (Flow-Based) Method
  - Surface area (top of BSM) is 4% of contributing impervious area
  - Does not consider storage in surface ponding area
- Volume Based Method
  - Store $\mathbf{V}_{\mathbf{WQ}}$ in just surface ponding area
  - Store $\mathbf{V}_{\mathbf{WQ}}$ in ponding area, soil media & drain rock
- Combination Flow and Volume Method
  - Compute both $\mathbf{Q}_{\mathbf{WQ}}$ and $\mathbf{V}_{\mathbf{WQ}}$
  - "Route" through facility, allowing ponding

Sizing Example #1: Simplified Method

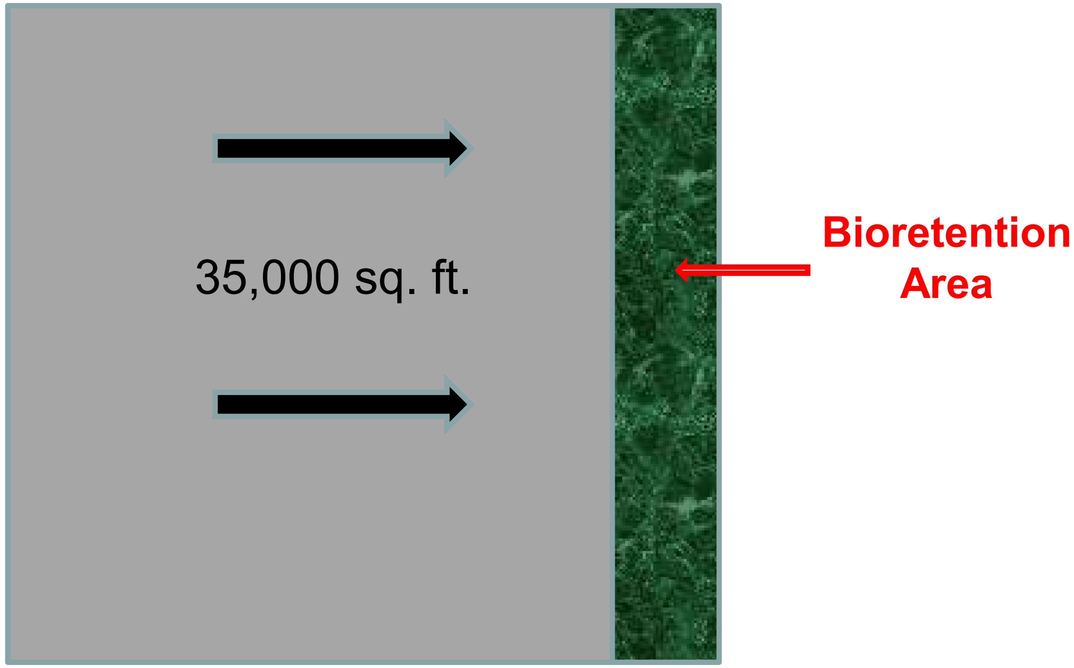
- Parking lot in Santa Clara
  - Area = 35,000 sq. ft. (~0.80 acres)
  - 100% impervious
  - Slope and MAP – not needed
  - Uniform intensity = 0.2 in/hr



- Surface area of bioretention:
  - **35,000 X 0.04 = 1,400 sq. ft.**
  - Note: if drainage area contains pervious area, multiply pervious area by 0.1 and add to impervious area to get "equivalent impervious area"

Sizing Example #1: Volume Method

- Parking lot in Santa Clara
  - Area = 35,000 sq. ft. (~0.80 acres)
  - 100% impervious
  - Slope = 1%
  - Mean annual precipitation (MAP) = 15 inches
- Use the sizing worksheets to determine water quality design volume $\mathbf{V_{WQ}}$



C.3 Sizing Worksheet – Volume

Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Worksheet for Sizing Volume-Based Treatment Measures based on the Adapted CASQA Stormwater BMP Handbook Approach (Method 2.b)

Santa Clara Valley
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Stormwater Treament Measure: **Bioretention area**

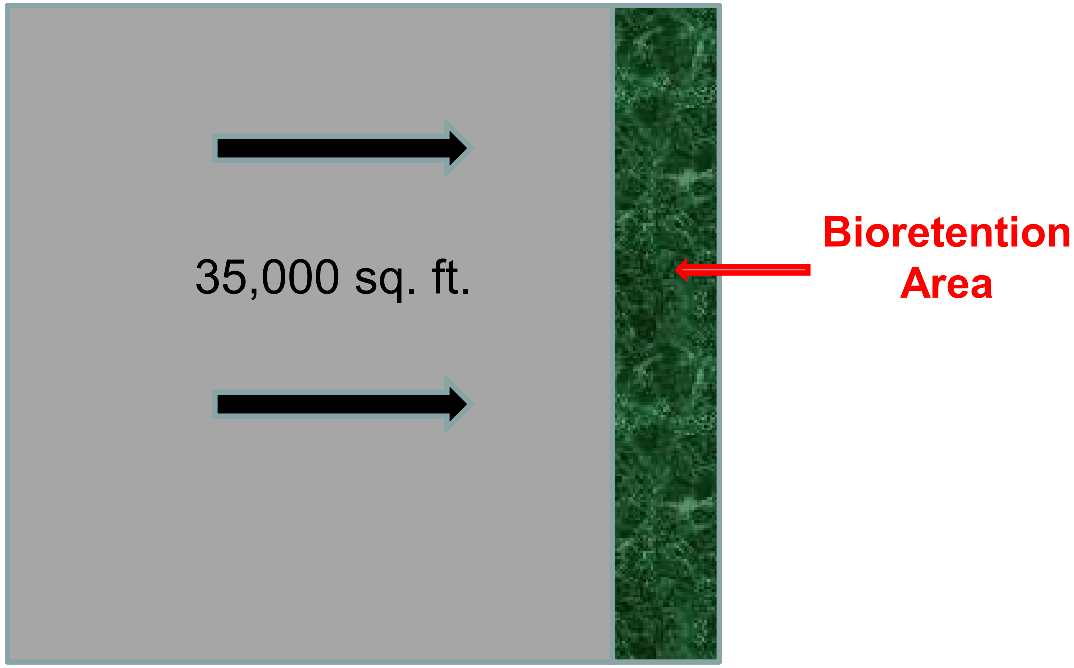
The equation that will be used to size the BMP is:

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

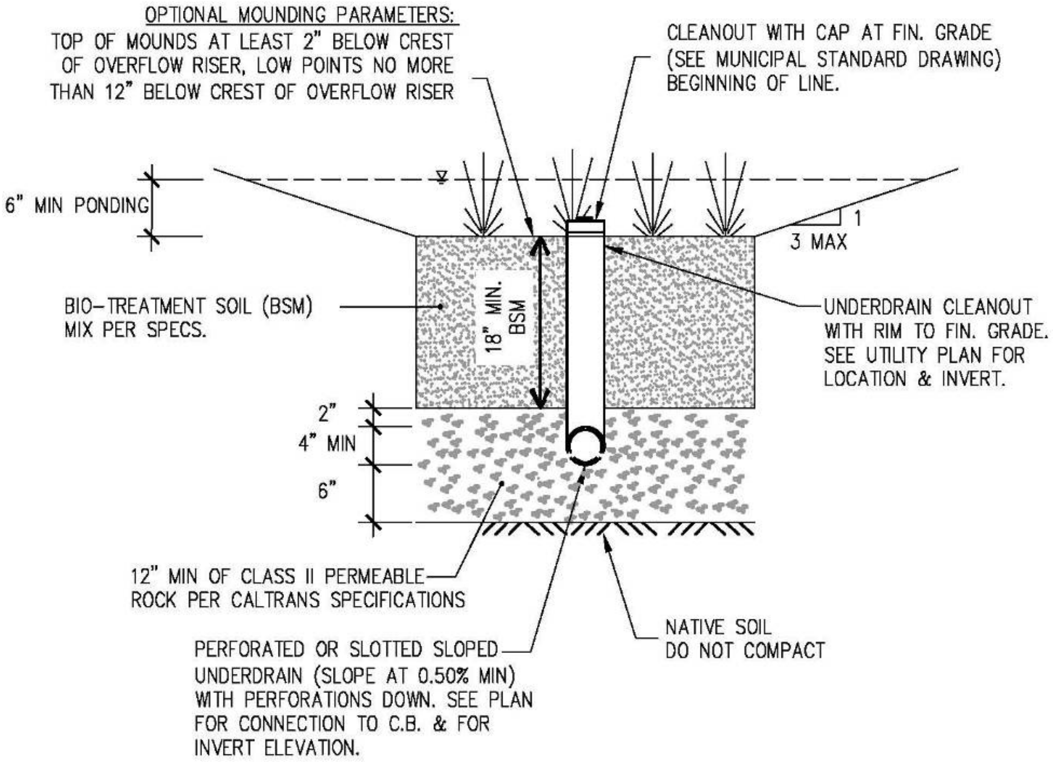
Step 1	Determine the drainage area for the treatment measure			
	Drainage Area =	**35000**	**square feet**	
Step 2	Determine the Percent Imperviousness of the drainage area			
	Enter the amount of **surface** area draining to the BMP:			
	Impervious Area =	**35000**	**square feet**	*Includes rooftops, hardscape, streets, and sidewalks, etc.*
	Pervious Area =	**0**	**square feet**	
	% Impervious Area =	**100**	**%**	
Step 3	Find the mean annual precipitation at the site (MAPsite).			
	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.			
	Interpolate between isopleths if necessary.	Click here for map (Figure B-1)		
	MAP_{site} =	**15**	*Site Mean Annual Precipitation*	
Step 4	Identify the reference rain gage closest to the project site (San Jose Airport, Palo Alto, or Morgan Hill)			
	Closest Reference Rain Gage:	**San Jose Airport**		
	MAP_{gage} =	**13.9**	**inches**	*Reference Gage Mean Annual Precipitation*
Step 5	Determine the rain gage correction factor for the precipitation at the site from Step 3 and Step 4.			
	MAP correction factor =	**1.08**	*Correction factor = MAP site/MAPgage*	
Step 6	Identify the representative soil type for the 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 (listed in the dropdown menu			
	in order of increasing infiltration capability.	Click here for map (Figure B-1)		
	Site Soil Type =	**Clay (D)**	*(if soil will be compacted during site preparation and grading, the soil's infiltration abilit*	
			will be decreased. Modify your answer to a soil with a lower infiltration rate)	
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?	**Yes**		
Step 7	Determine the average slope for the drainage area:			
	Average Slope (%) =	**1**		
Step 8	Determine the unit basin storage volume from sizing curves			
	Unit Basin Storage (UBS) =	**0.58**	**Inches**	*Unit basin storage volume from Figure B-2, B-3, or B-4, based on slope*
Step 9	Determine the Adjusted Unit Basin Storage Volume for the site			
	Adjusted UBS =	**0.63**	**Inches**	*Adjusted UBS = Rain Gage Correction Factor x Unit Basin Storage Volun*
Step 10	Determine the Design Volume			
	Design Volume =	**1,825**	**cubic feet**	*Design Volume = Adjusted Unit Basin Storage Volume x Total Drainage*

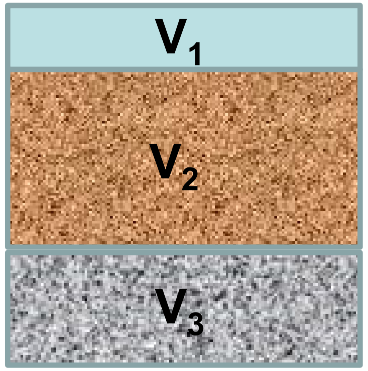
Sizing Example #1: Volume Method

- Parking lot in Santa Clara
  - Area = 35,000 sq. ft. (0.80 acres)
  - 100% impervious
  - Slope = 1%
  - Mean annual precipitation (MAP) = 15 inches
- Use the sizing worksheets to determine $\mathbf{V_{WQ}}$
- **Answer: $\mathbf{V_{WQ}}$ = 1,825 cu. ft.**



Sizing Bioretention Facilities: Volume-Based Method





Sizing Bioretention Facilities: Volume Method

Method 1: Store entire volume in surface ponding area

V_1

Depth (ft)	Porosity	Volume per sq. ft. (cubic feet)
0.5	1.0	0.5

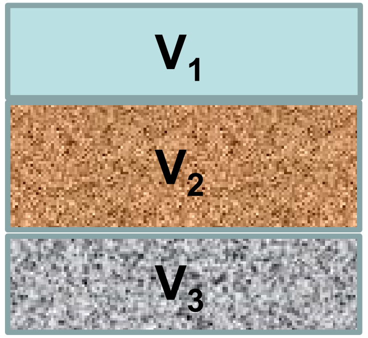
Surface Area = $\mathbf{V_{WQ}}$ (cu.ft.) ÷ 0.5 cu.ft./sq.ft.

Sizing Example:

- **1,825 cu.ft. ÷ 0.5 cu.ft./sq.ft. = 3,650 sq.ft.**

Sizing Bioretention Facilities: Volume-Based Method

Method 2: Store volume in ponding area and media



Depth (ft)	Porosity	Volume per sq. ft. (cubic feet)
0.5	1.0	0.5
1.5	0.30	0.45
0.5*	0.40	0.20
	Total	1.15

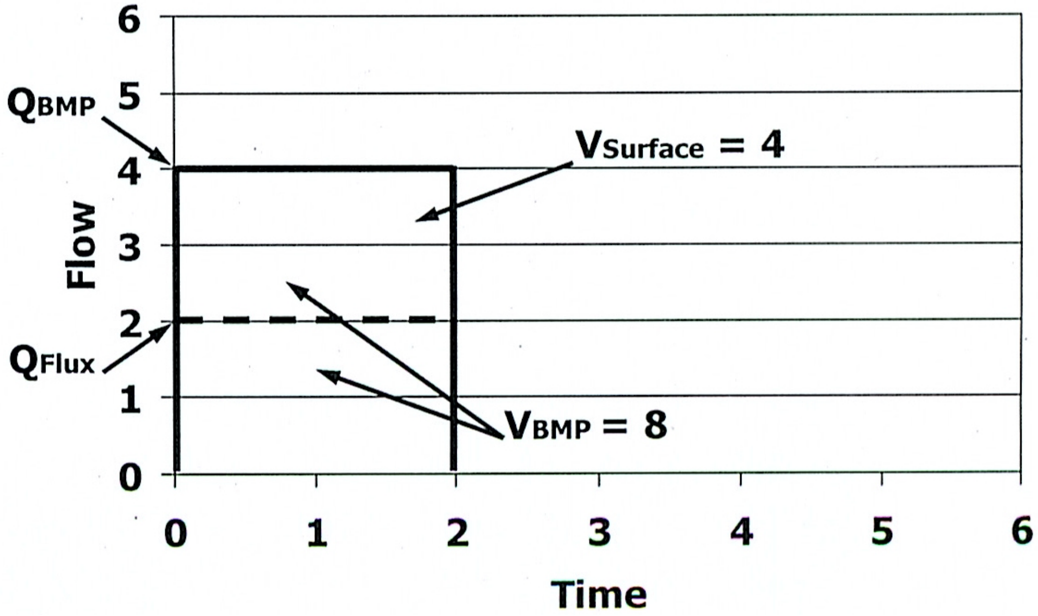
*Depth below underdrain at 6” above bottom

Surface Area = $\mathbf{V_{WQ}}$ (cu.ft.) ÷ 1.15 cu.ft./sq.ft.

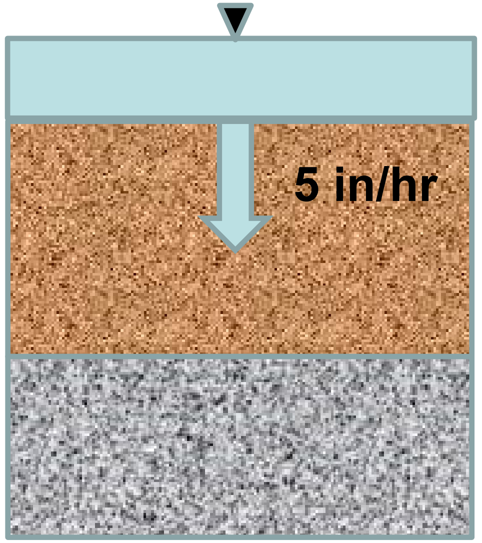
Sizing example: 1,825 cu.ft. ÷ 1.15 cu.ft./sq.ft. = 1,587 sq.ft.

Sizing Bioretention Facilities: Combination Flow & Volume Method

- "Hydrograph Approach"
  - Runoff is "routed" through the treatment measure
  - Assume rectangular hydrograph that meets both flow and volume criteria

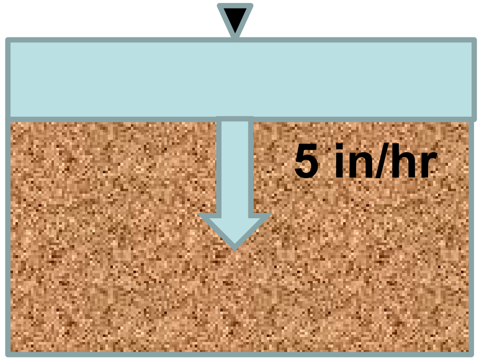


Sizing Bioretention Facilities: Combination Flow & Volume Method



- Determine $\mathbf{V_{WQ}}$
- Assume constant rainfall intensity of 0.2 in/hr continues throughout the storm (rectangular hydrograph)
- Calculate the duration of the storm by dividing the Unit Basin Storage by the rainfall intensity
- Calculate the volume of runoff that filters through the biotreatment soil at 5 in/hr over the storm duration
- Calculate the volume that remains on the surface and ponding depth

Sizing Bioretention Facilities: Combination Flow & Volume Method



- To start the calculation, you have to assume a surface area "$\mathbf{A_S}$" -- use 3% of the contributing impervious area as a first guess

- Determine volume of treated water "$\mathbf{V_T}$" during storm:

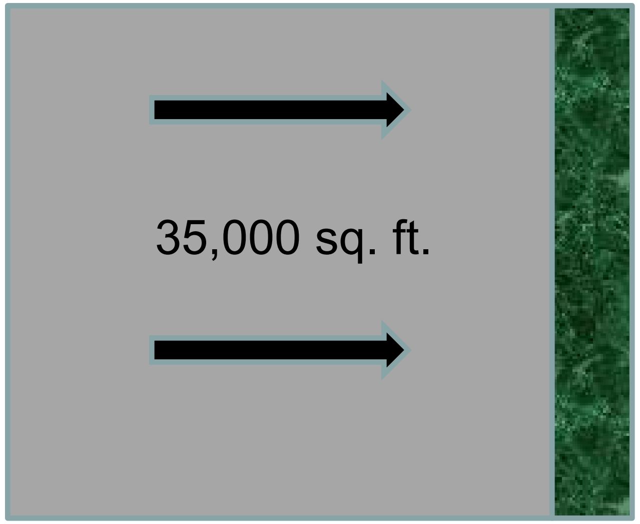
  $\mathbf{V_T} = \mathbf{A_S} \times 5$ in/hr x duration (hrs) x 1 in/12 ft
- Determine volume remaining on the surface "$\mathbf{V_S}$":

  $\mathbf{V_S = V_{WQ} - V_T}$
- Determine depth "**D**" of ponding on the surface:

  $\mathbf{D = V_S \div A_S}$
- Repeat until depth is approximately 6 inches

Sizing Example #1: Combo Method

- Parking lot in Santa Clara
  - Area = 35,000 sq. ft. (~0.8 acres)
  - 100% impervious
  - $\mathbf{V}_{\mathbf{WQ}}$ = 1,825 cu. ft.
  - UBS Volume = 0.63 in.
- Use the combination flow and volume sizing worksheet to determine the bioretention surface area



C.3 Sizing Worksheet – Combo Method Part 1

Santa Clara Valley Urban Runoff Pollution Prevention Program

Worksheet for Sizing Flow- and Volume-Based Treatment Measures (Combination Flow and Volume Approach)

Santa Clara Valley Urban Runoff Pollution Prevention Program

Stormwater Treament Measure: Bioretention area

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.

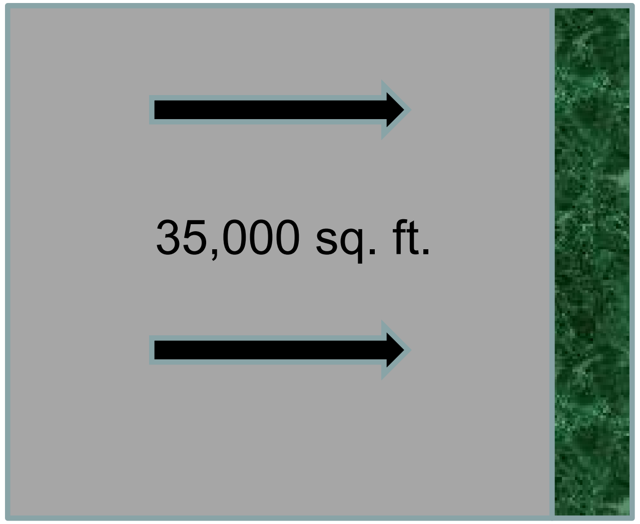
Step 1	Determine the contributing drainage area to the treatment measure			
	Drainage Area =	35000	square feet	
Step 2	Determine the Percent Imperviousness of the drainage area			
	Enter the amount of **surface** area draining to the BMP:			
a	**Impervious Area =**	35000	square feet	*Includes rooftops, hardscape, streets, and sidewalks, etc.*
b	**Pervious Area =**	0	square feet	
	% Impervious =	100	%	
Step 3	Determine the required treatment volume (using Adapted CASQA Stormwater BMP Handbook Approach)			
a	Find the mean annual precipitation at the site (MAPsite).			
	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.			
	Interpolate between isopleths if necessary.	Click here for map (Figure B-1)		
	MAP_{site} =	15	*Site Mean Annual Precipitation*	
b	Identify the reference rain gage closest to the project site (San Jose Airport, Palo Alto, or Morgan Hill)			
	Closest Reference Rain Gage:	San Jose Airport		
	MAP_{gage} =	13.9	inches	*Reference Gage Mean Annual Precipitation*
c	Determine the rain gage correction factor for the precipitation at the site from Step 3 and Step 4.			
	MAP correction factor =	1.08	*Correction factor = MAP site/MAPgage*	
d	Identify the representative soil type for the drainage area			
	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	Click here for map (Figure B-1)		
	Site Soil Type =	Clay (D)	*(if 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)*	
	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?	Yes		
e	Determine the average slope for the drainage area:			
	Average Slope (%) =	1		
f	Determine the unit basin storage volume from sizing curves			
	Unit Basin Storage (UBS) =	0.58	Inches	*Unit basin storage volume from Figure B-2, B-3, or B-4, based on slope*
g	Determine the Adjusted Unit Basin Storage Volume for the site			
	Adjusted UBS =	0.63	Inches	*Adjusted UBS = Rain Gage Correction Factor x Unit Basin Storage Volun*
h	Determine the Design Volume			
	Design Volume =	1,825	cubic feet	*Design Volume = Adjusted Unit Basin Storage Volume x Total Drainage*

C.3 Sizing Worksheet – Combo Method Part 2

h	Determine the Design Volume			
	Design Volume =	**1,825**	**cubic feet**	*Design Volume = Adjusted Unit Basin Storage Volume x Total Drainage*
Step 4	Determine the design rainfall intensity (Uniform Intensity Approach, Section III.C, Step 3) which is 0.2 in/hr:			
	Design Rainfall Intensity =	**0.20**	**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 =	**3.13**	**hours**	*Adjusted UBS ÷ Design Rainfall Intensity*
Step 6	Make a preliminary estimate of the surface area of the treatment measure			
	Try a preliminary surface area estimate =	1050	Square feet	*3% of total drainage area*
	BMP Surface Area =	**1,000**	**Square feet**	
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 =	**1,305**	**cubic feet**	*Surface Area x Duration*
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 =	**520**		
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 =	**6**	**Inches**	
	The average ponding depth is acceptable			
	The range of allowable ponding depths in a bioretention facility or flow-through planter is between 0.5 and 1.0 feet (6 and 12 inches)			
	0.5 feet is recommended			

Sizing Example #1: Combo Method

- Parking lot in Santa Clara
  - Area = 35,000 sq. ft. (~0.8 acres)
  - 100% impervious
  - $\mathbf{V}_{\mathbf{WQ}}$ = 1,825 cu. ft.
  - UBS Volume = 0.63 in.
- Use the combination flow and volume sizing worksheet to determine the bioretention surface area
- **Answer: 1,000 sq. ft. (with depth = 0.5 ft.)**



Sizing Bioretention Facilities: Comparison of Methods

Example: 35,000 sq. ft. parking lot in Santa Clara
MAP= 15 inches, 100% impervious, 1% slope
$\mathbf{V_{BMP}}$ = 1,825 cu. ft. (80% of annual runoff)

Sizing Method	Surface Area (sq. ft.)
Simplified Method (flow-based)	1,400 ☆
Volume ponded on surface	3,650
Volume stored in unit ($V_1+V_2+V_3$)	1,587
Combination flow & volume	1,000 ☆

Sizing Pervious Pavement and Infiltration Trenches

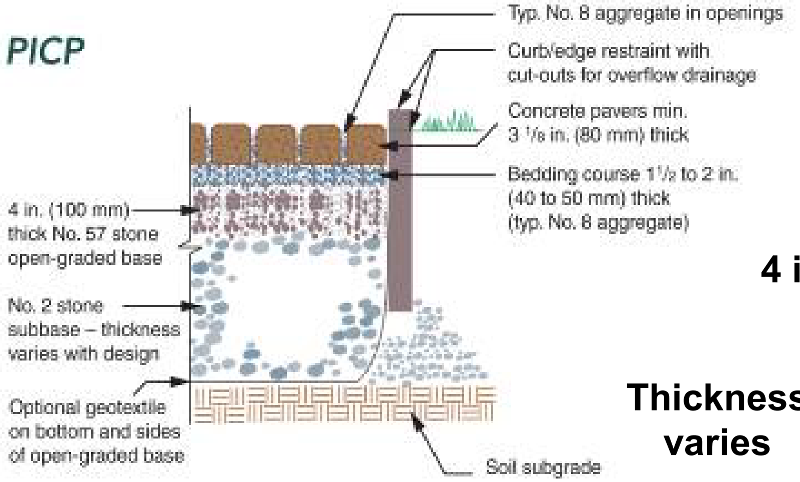
- General Principles
  - Store the $\mathbf{V_{WQ}}$ in void space of stone base/subbase and infiltrate into subgrade
  - Surface allows water to infiltrate at a high rate
  - Any underdrains must be placed above the void space needed to store and infiltrate the $\mathbf{V_{WQ}}$

Sizing Pervious Pavement and Infiltration Trenches

- Pervious Pavement
  - May be self-treating area or self-retaining area (accept runoff from other areas)
  - Can only be considered a "pervious area" if stone base/subbase designed to store and infiltrate the $\mathbf{V_{WQ}}$
  - Can work where native soils have low infiltration rates (stored water depths are relatively small)
  - Surface area is usually predetermined
  - Base and subbase thickness usually determined by expected traffic load and saturated soil strength
  - Slope should be $\leq$ 3% (or use check dams/trenches)

Pervious Pavement

Typical Section



- Base and subbase layers available for water storage
- Both typically have 40% void space

Pervious Pavement

- Approach to Sizing Pervious Pavement
  - Self-Treating
    - Check the depth of the $\mathbf{V_{WQ}}$ in base/subbase:
      UBS volume (in.) ÷ 0.40 = Depth (in.)

      Example: UBS volume = 1.0 in., depth = 2.5 in.
      (Minimum depth for vehicular traffic is 10 in.)
    - Check the time required for stored water to drain:
      UBS Vol. (in.) ÷ Infiltration rate (in/hr) = Drain time (hrs)
      (recommend < 48 hrs)

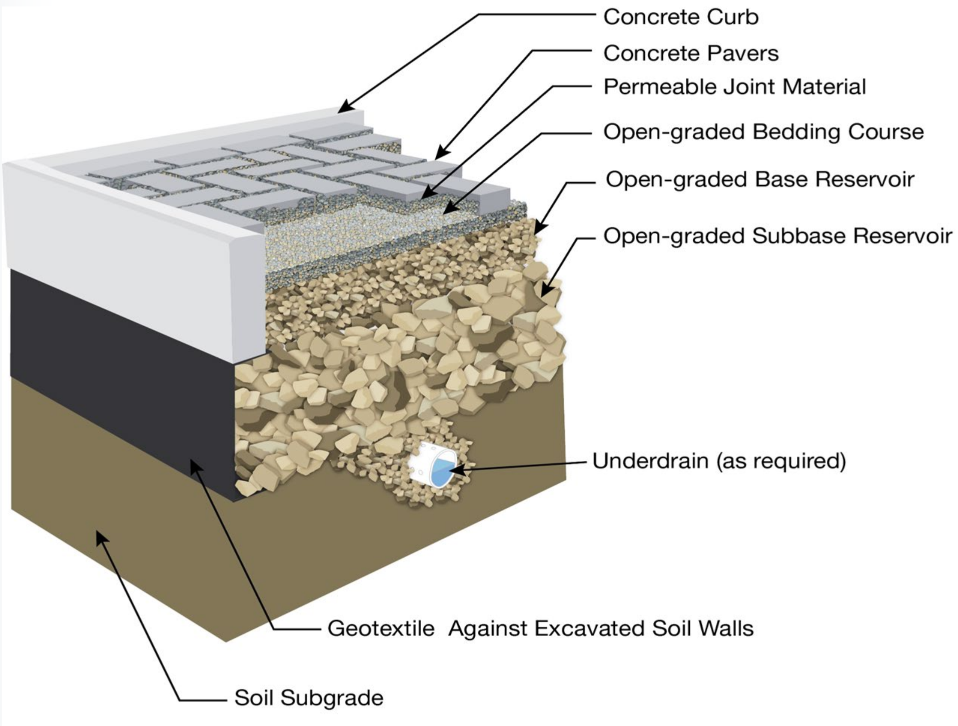
Pervious Pavement

- Approach to Sizing Pervious Pavement
  - Self-Retaining (receives runoff from adjacent areas)
    - Do not exceed 2:1 ratio of contributing area to pervious area
    - Add the V_{WQ} for adjacent areas to the **V_{WQ} for the pervious pavement area itself**, divide the total V_{WQ} by pervious pavement area to get depth
    - Check depth of total V_{WQ} in base/subbase:
      V_{WQ} (in.) ÷ 0.40 = Depth (in.)

      Example: V_{WQ} = 3.0 in., depth = 7.5 in.
    - Check the time required for stored water to drain:
      V_{WQ} (in.) ÷ Infiltration rate (in/hr) = Drain time (hrs)

Assume pervious pavement is impervious!

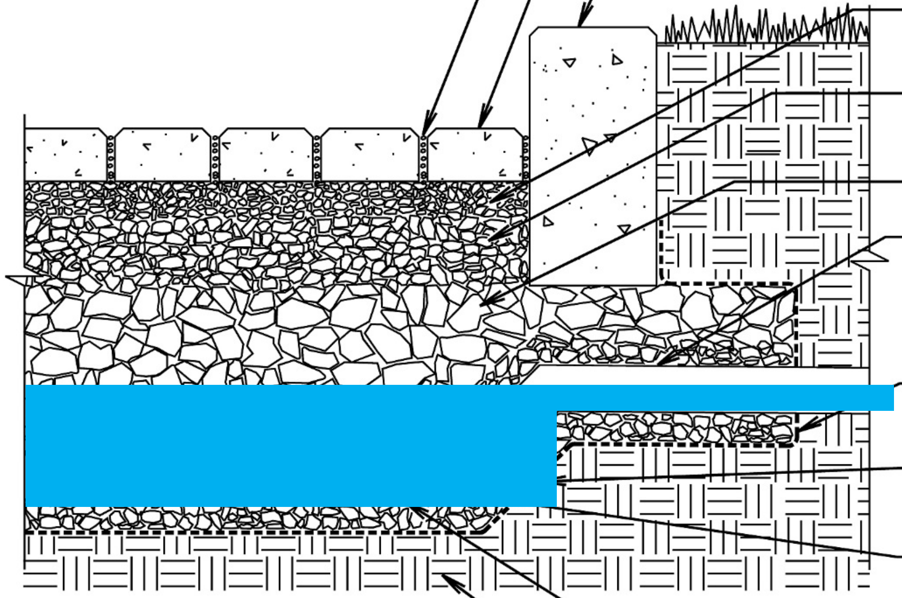
Pervious Pavement Underdrains



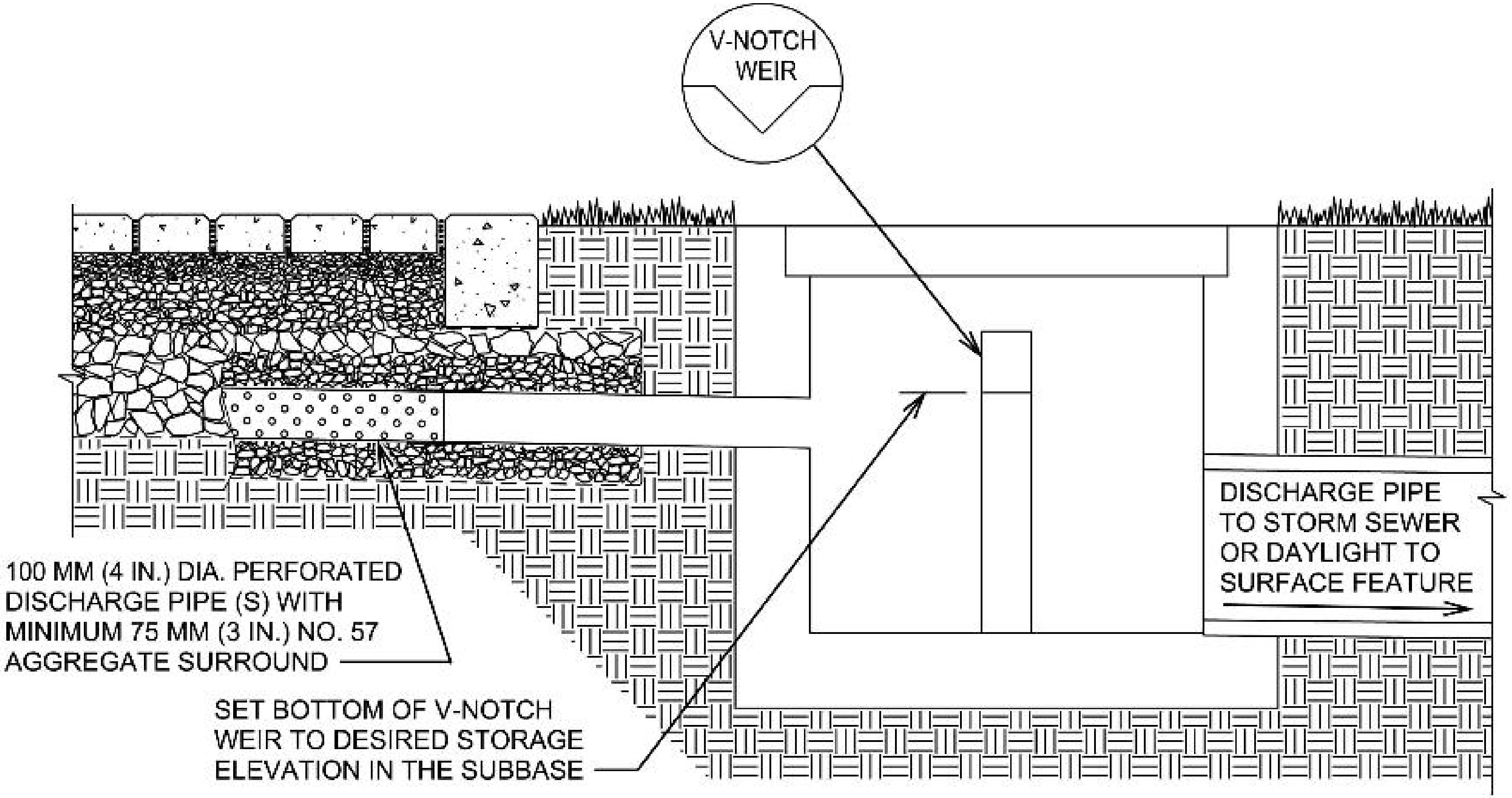
- Underdrain at this elevation will not promote storage in subbase and infiltration of captured runoff

- Underdrain placed in trench at bottom of section is OK with raised outlet to allow water storage in subbase

Underdrain: Upturned Elbow



Underdrain: Connection to Catch Basin/Utility Structure

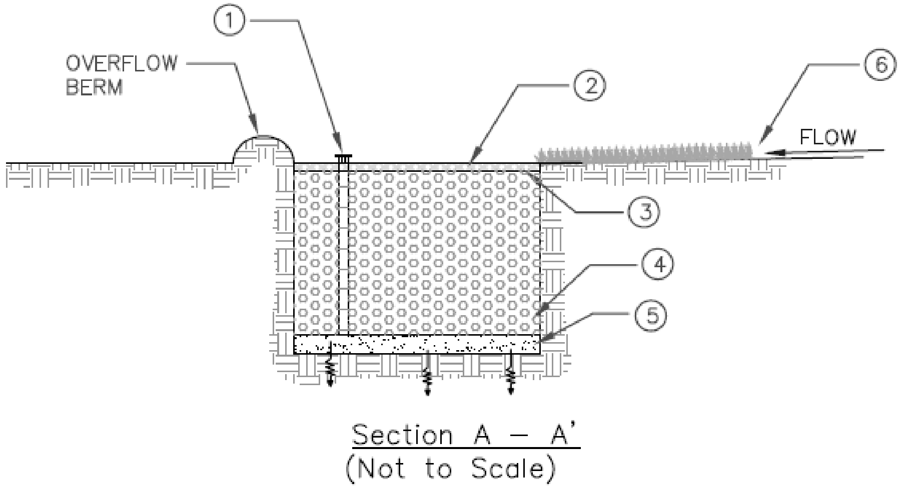


Infiltration Trench Sizing

- Differences from Pervious Pavement
  - More runoff must infiltrate in a smaller footprint
  - Infiltration rate of site soils must be at least 0.5 in/hr (i.e., not suitable for "C" or "D" soils)
  - Trench depths are typically between 3 and 8 feet
  - Infiltration trench is an "infiltration device"
    - Minimum 10-foot separation from seasonal high groundwater level
    - Must meet other MRP and Valley Water requirements
    - Cannot be "deeper than wide" (Class V injection well)

Infiltration Trench Sizing

- Design Parameters
  - Trench depth is calculated based on the soil infiltration rate, aggregate void space, and the trench storage time
  - The stone aggregate used in the trench is typically 1.5 to 2.5 inches in diameter, which provides a void space of approximately 35 %
  - Trenches should drain within 72 hours
  - Place underdrain above void space needed for storage of $\mathbf{V_{WQ}}$



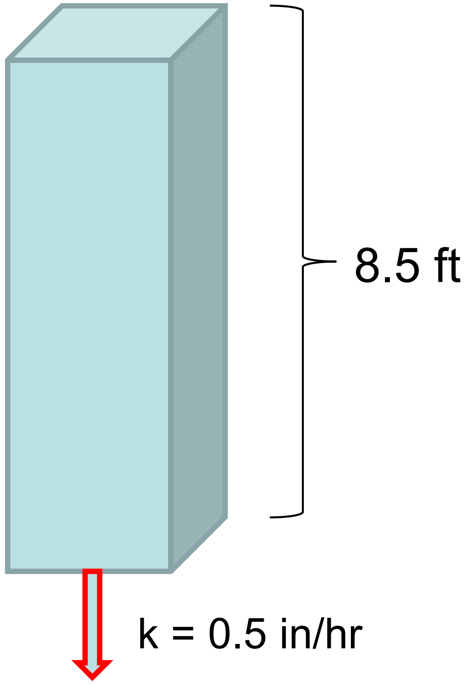
Infiltration Trench Sizing

- Approach to Sizing Infiltration Trenches
  - Trench unit storage volume: **$S = n \times d$**
    n = gravel porosity (0.35); d = gravel depth (ft)
  - Subsoil unit infiltration capacity: **$S_i = k \div 12 \times t$**
    k = subsoil permeability (in/hr); t = time (max 72 hrs)
  - Check for trench drainage by infiltration:

    If $S \leq S_i$: Increase depth of media until $S = S_i$
    to match trench capacity to infiltration capacity
    (may decrease surface area needed)

    If $S > S_i$: Decrease depth of media until $S = S_i$
    (surface area may increase)

$S = 0.35 \times 8.5\ \text{ft} = 3\ \text{ft}$



$S_i = 0.5\ \text{in/hr} \div 12\ \text{in/ft} \times 72\ \text{hrs} = 3\ \text{ft}$

Infiltration Trench Sizing

- Approach to Sizing Infiltration Trenches
  - Determine required trench area:
    - $\mathbf{A_T = V_{WQ} \div S}$

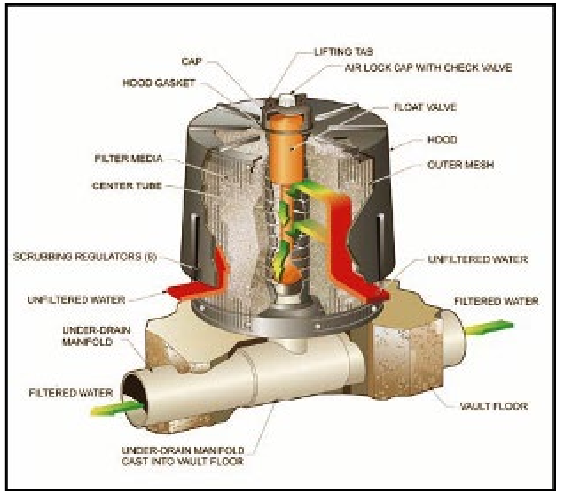
      A_T = Trench area required to store treatment volume (sq.ft.)
      V_{WQ} = Water quality design volume (cu. ft.)
      S = Trench unit storage volume (cu.ft./sq.ft.)
  - Determine required trench width:
    - $\mathbf{W = A_T \div L}$

      W = Width of trench (ft.)
      A_T = Required trench area (sq. ft.)
      L = Length of trench (ft.) (normally length of treatment area)

Sizing High-Rate Media Filters

Media Filters (cartridge type)

- Determine $\mathbf{Q_{WQ}}$ using Rational Method (Q=CIA)
- Select a product that is certified by Washington State TAPE program*
- Determine the TAPE-approved design flow rate per cartridge
- Divide $\mathbf{Q_{WQ}}$ by the cartridge flow rate to calculate the required number of cartridges (round up)



*General Use Level Designation (GULD) for Basic Treatment

See: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html

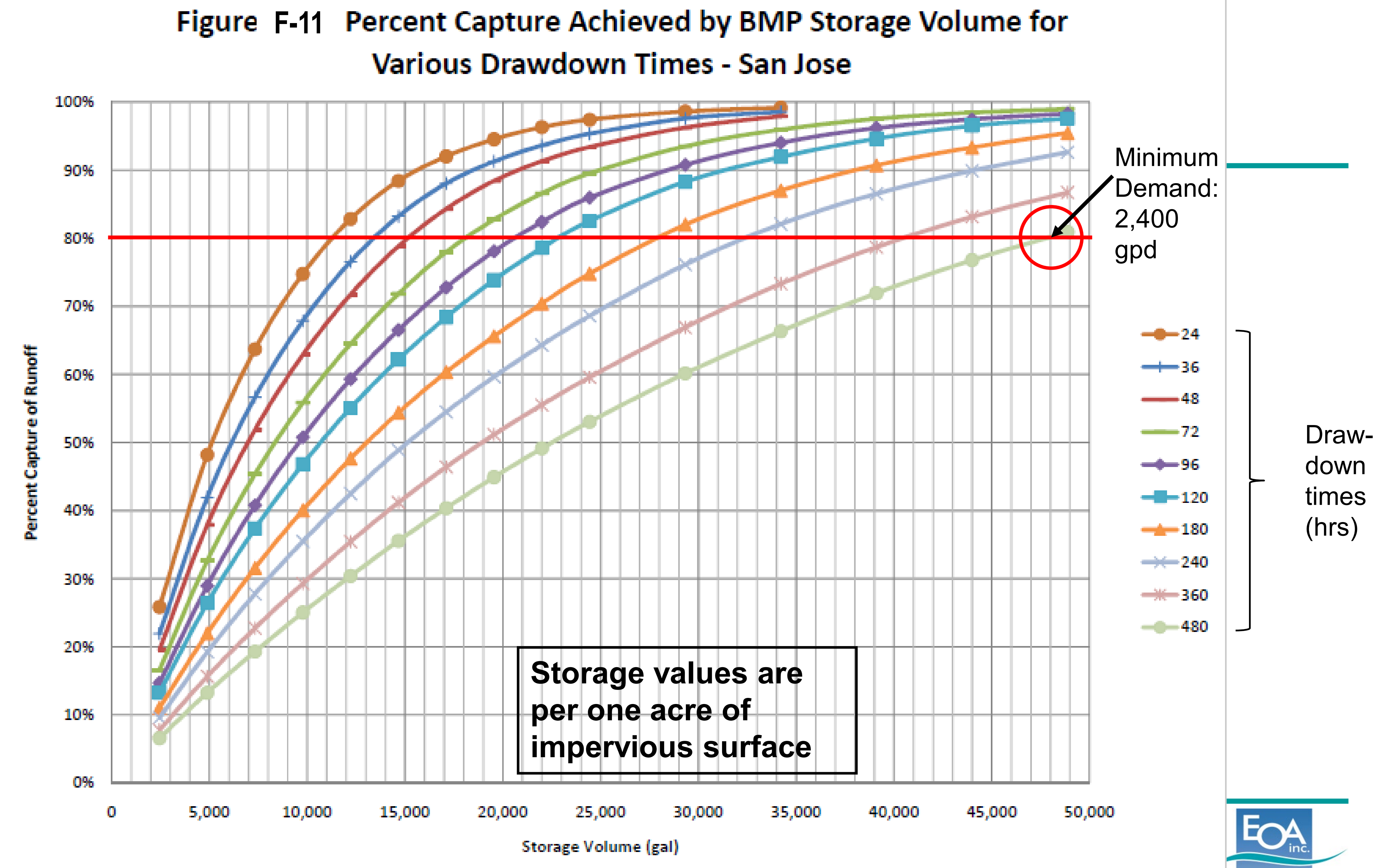
Sizing High-Rate Media Filters

Proprietary Tree Box Filters

- Determine $\mathbf{Q_{WQ}}$ using Rational Method (Q=CIA)
- Select a product that is certified by Washington State TAPE program
- Determine the TAPE-approved infiltration rate for the media
- Calculate the required surface area by dividing $\mathbf{Q_{WQ}}$ by the infiltration rate (ft/sec)
- A tree box filter that uses biotreatment soil media can be sized like a flow-through planter

Sizing Rainwater Harvesting Cisterns

- **Rainwater Harvesting and Use**
  - Types of Demands
    - Irrigation
    - Toilet flushing
    - Other non-potable
  - Volume based sizing criteria in C.3.d is 80% capture of the annual runoff
  - Need to size with continuous simulation modeling (see curves in Appendix I of C.3 Handbook)
  - Key parameters are drawdown time and associated demand requirement



Pollution Prevention Program

Estimate Actual Demand

Daily Use Rates for Toilets and Urinals[1]

Land Use Type	User Unit	User Unit Factor[2]	Daily Use/Unit (gal/day/unit)
Residential	Resident	2.9 residents per dwelling unit	8.6
Office or Retail	Employee (non-visitor)	200 SF per employee	6.9
Schools	Employee (not including students)	50 SF per employee	33.9

[1]References: CCCWP Stormwater C.3 Guidebook, 6th edition, 2012; BASMAA LID Feasibility Report, 2011; California Plumbing Code, 2010.
[2]Use project-specific data if available

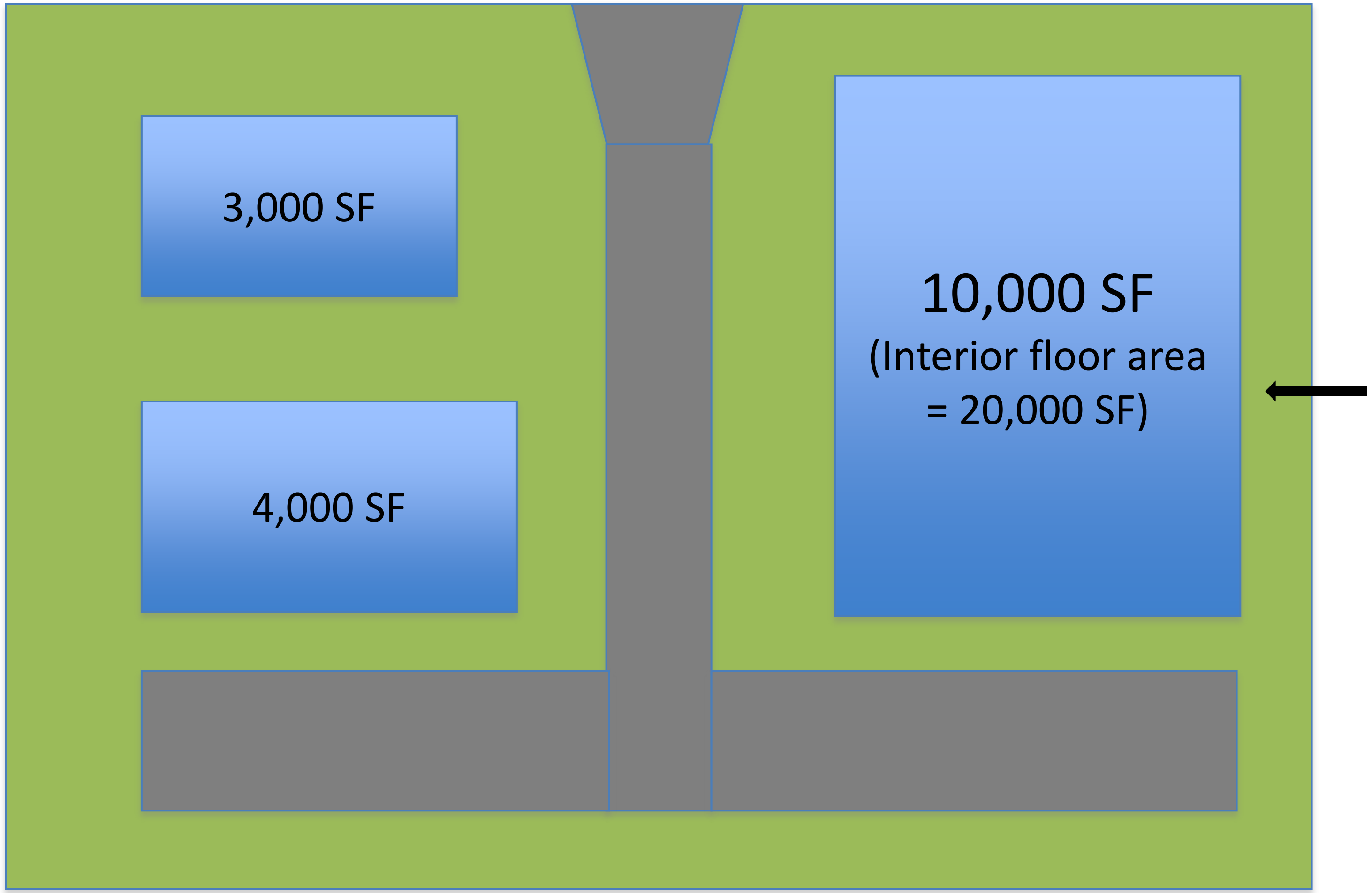
Estimate Minimum Demand Required for 80% Capture

Toilet Flushing Demand Required Per Impervious Acre

Rain Gauge[3]	Required Demand (gal/day/IA)[4]	Residential		Office/Retail[5]	
		No. of residents per IA[7]	Dwelling Units per IA[8]	Employees per IA[9]	Interior Floor Area (sq.ft./IA)[10]
Morgan Hill	6,500	760	260	940	188,000
Palo Alto	2,900	340	116	420	84,000
San Jose	2,400	280	96	350	70,000

References: SCVURPPP C.3 Handbook, Appendix I, Attachment 1, Table 2; BASMAA LID Feasibility Report, 2011; California Plumbing Code, 2010.

Sizing Example #2:
2-Story Office Building in San Jose



Can this new building use rainwater harvesting/use to meet C.3?

Check Rainwater Harvesting Feasibility

- Assume rainwater capture area = area of building roof (10,000 SF or 0.23 acres)
- Assume it is a commercial building with interior floor area of 20,000 SF
- Calculate interior floor area per acre of capture area: 20,000 SF ÷ 0.23 acres = 87,000 SF/ac
- Use App. I, Attachment 1,Table 2 to determine minimum floor area needed to meet toilet flushing demand for 80% capture of annual runoff:
  Answer = 70,000 SF per acre of impervious surface
- 87,000 SF > 70,000 SF ⇨ Building will have minimum toilet flushing demand to meet C.3

Determine Building Toilet Flushing Demand

- Building interior floor area = 20,000 SF
- Estimate no. of employees:
  - 20,000 SF ÷ 200 SF/employee = 100 employees
  - 100 employees × 6.9 gpd/employee = 690 gpd
- Convert to equivalent demand per impervious acre (to allow use of sizing curves):
  - 10,000 SF roof area ÷ 43,560 SF/ac = 0.23 ac.
  - 690 gpd ÷ 0.23 = 3,000 gpd per impervious acre

Determine Required Cistern Size

- From sizing curves, find right combination of drawdown time, tank size and required demand:
  - 480-hr (20-day) drawdown ⇨ 48,000 gallon tank ⇨ 2,400 gpd (48,000÷20)
  - 360-hr (15-day) drawdown ⇨ 40,000 gallon tank ⇨ 2,667 gpd
  - 240-hr (10-day) drawdown ⇨ 32,000 gallon tank ⇨ 3,200 gpd
  - 288-hr (12-day) drawdown ⇨ 36,000 gallon tank ⇨ 3,000 gpd √
- Adjust tank size back to actual impervious area:
  - 36,000 gallons needed per 1 acre of impervious area
  - 36,000 × 0.23 acres = 8,300-gallon cistern
- Option: Use smaller cistern and provide treatment for overflow (e.g., bioretention)

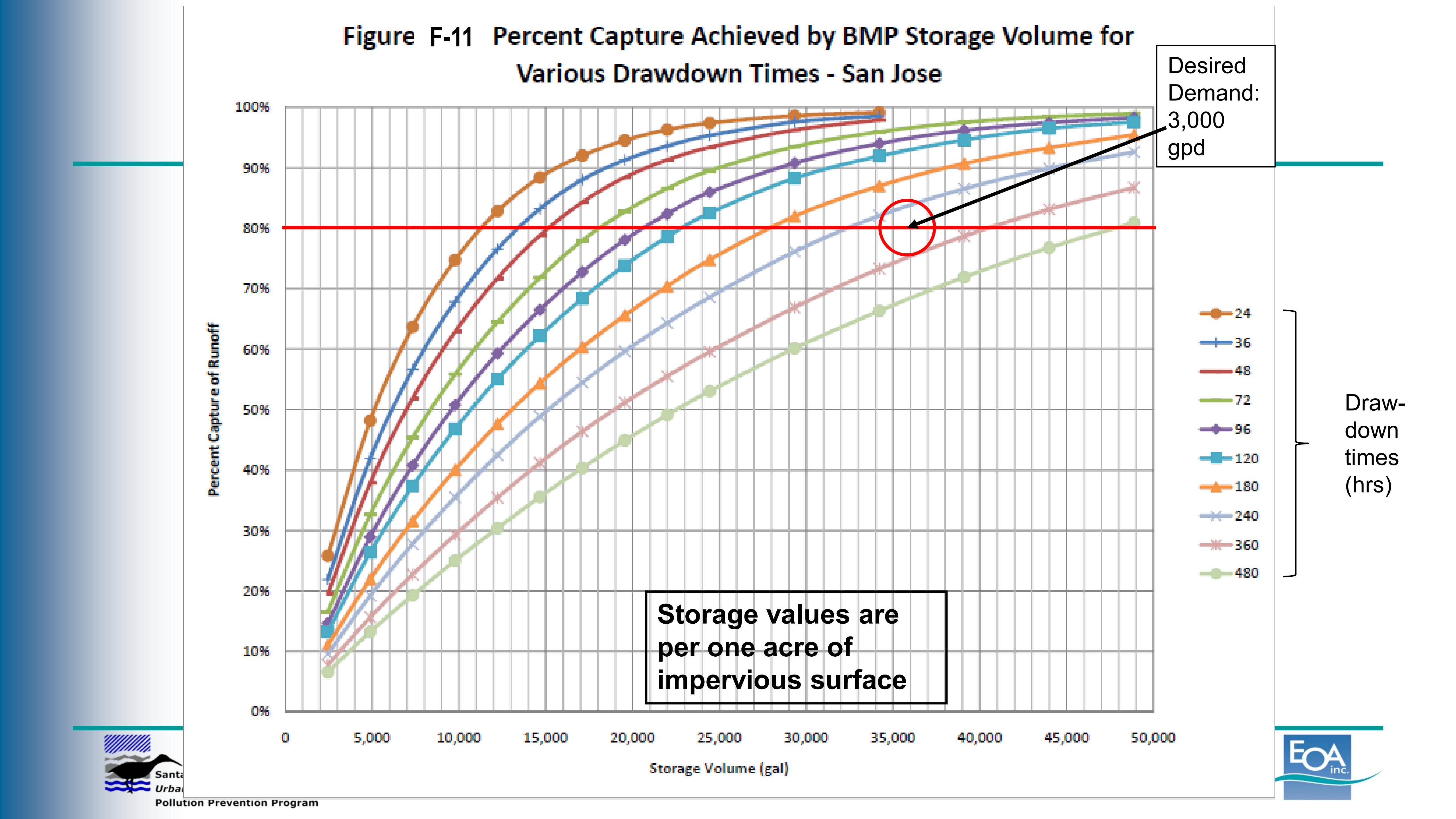
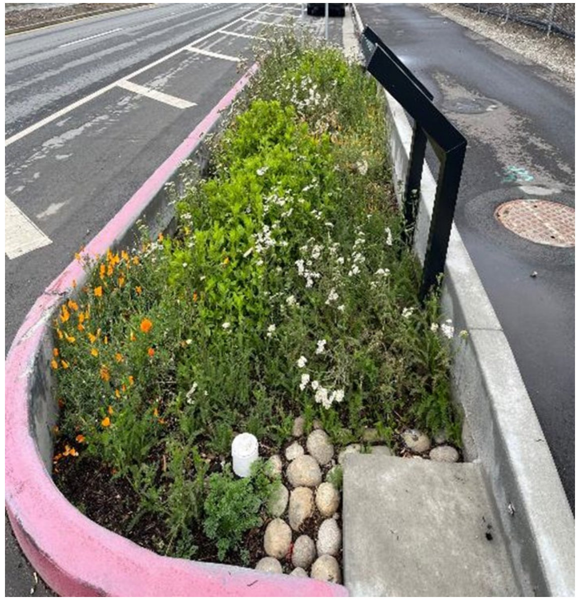


Figure F-11 Percent Capture Achieved by BMP Storage Volume for Various Drawdown Times - San Jose
Desired Demand: 3,000 gpd
Percent Capture of Runoff
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
50,000
Storage Volume (gal)
Storage values are per one acre of impervious surface
24
36
48
72
96
120
180
240
360
480
Draw-down times (hrs)
Pollution Prevention Program
EOA inc.

Questions?



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