Phase II Post-Construction Stormwater Requirements Workshop - February 10, 2014

Sizing Stormwater Control Measures for Treatment, Retention, and Peak Management

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Outline of Presentation

- Procedure for Sizing Control Measures
- Determining Requirements (Thresholds)
- Sizing Treatment Measures
- Sizing Retention Measures
- Tools/Resources

Procedure for Sizing SCMs

- Collect and tabulate project data
- Determine which requirements apply
  - Compute new, replaced and "net" impervious surface
- If in Tier 2 or above:
  - Delineate drainage management areas (DMAs), each containing one type of surface
  - Identify self-treating and self-retaining areas and impervious areas draining to self-retaining areas
  - Tabulate DMA sizes and surface types
  - Locate & size SCMs for DMAs needing treatment
  - ★ Recalculate DMA size to omit SCM surface area

Procedure for Sizing SCMs, cont.

- If in Tier 3 or above:
  - Determine applicable storm depth (95th percentile)
  - Determine **Retention Tributary Area**
  - Determine any allowable adjustments
    - Replaced impervious surface may be multiplied by 0.5
  - Compute required retention volume by simple or routing method
  - Compute size of SCM needed for retention, adjusting depth and surface area until adequate
  - If infeasible, adjust to ≥ 10% of EISA
  - If still infeasible, look at reducing impervious area

Procedure for Sizing SCMs, cont.

- If in Tier 4:
  - Evaluate whether peak management can be addressed with runoff retention measures
  - IF NOT:
    - Determine whether there are flood control requirements
    - Evaluate options for increased storage, in combination with flood control facilities if any

Determine Requirements

Tier	Threshold	Performance Requirement	Criteria
1	≥ 2,500 SF (new/replaced IS)	Site Design	LID Site Design Measures
2	≥ 5,000 SF (net) ≥ 15,000 SF (net) for single-family homes	Water Quality Treatment	Treat 85th percen-tile 24-hr storm
3	≥ 15,000 SF (new/replaced IS) ≥ 15,000 SF (net) for single-family homes	Runoff Retention	Retain 85th or 95th percentile 24-hr storm
4	≥ 22,500 SF (new/replaced IS)	Peak Management	Match 2- to 10-Yr peak flows

New vs. Replaced Impervious Surface*

Lot size:
16,000 SF

Impervious Area:
12,000 SF

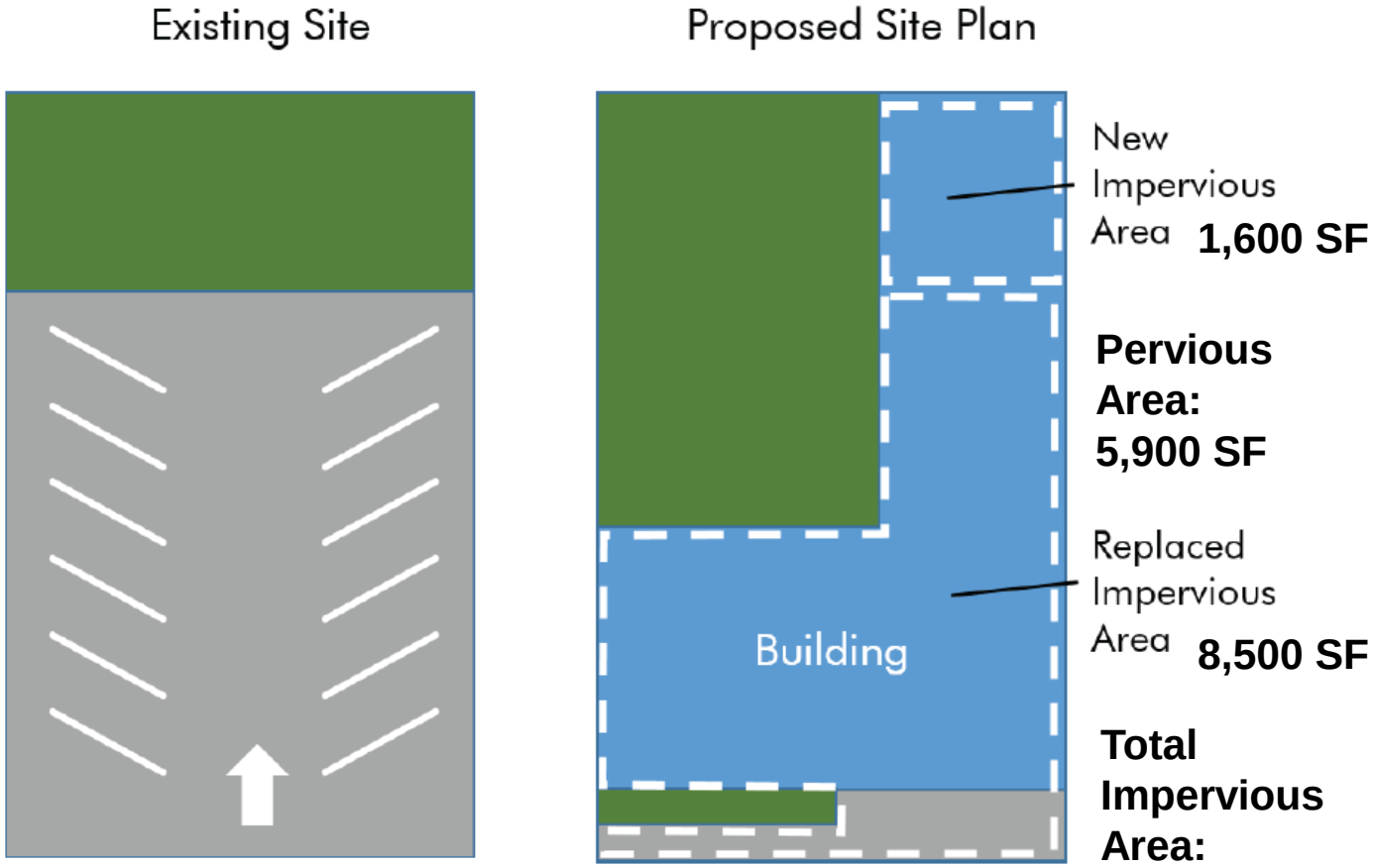


Figure 3-1. Illustration of Replaced Impervious Area

*From Santa Barbara County Stormwater Technical Guide

Net Impervious Area

Net Impervious Area = (New and Replaced Impervious Area) - (Reduced Impervious Area Credit)

where Reduced Impervious Area Credit is the total pre-project to post-project reduction in impervious area, if any.

- Calculate for:
  - Single family homes
  - Other projects that create or replace < 15,000 sq. ft. of impervious surface (above that, don't bother!)

Net Impervious Area

Example Figure 3-1:

- Existing parking lot with 12,000 sf of impervious surface.
- The new project will have a total new and replaced impervious area of 10,100 sf.
- The **Reduced Imperious Area Credit** is: 12,000 – 10,100 = 1,900 sf.
- The **Net Impervious Area** is: 10,100 – 1,900 = 8,200 sf. (> 5,000 sf)
- If single-family home, < 15,000 ⇨ Tier 1
- If other project, > 5,000 and < 15,000 ⇨ Tier 2

Tier 2 - Water Quality Treatment Sizing Criteria

SCM Type	Sizing Criteria
Volume-Based: • Infiltration • Harvest and Use	85th percentile, 24-hour storm event volume
Flow-Based: • Bioretention • Biofiltration • Media Filters	Runoff from: • 2 X 85th percentile hourly rainfall intensity; • 0.2 in/hr rainfall intensity (0.04 sizing factor for bioretention/biofiltration)

Derivation of 0.04 Sizing Factor

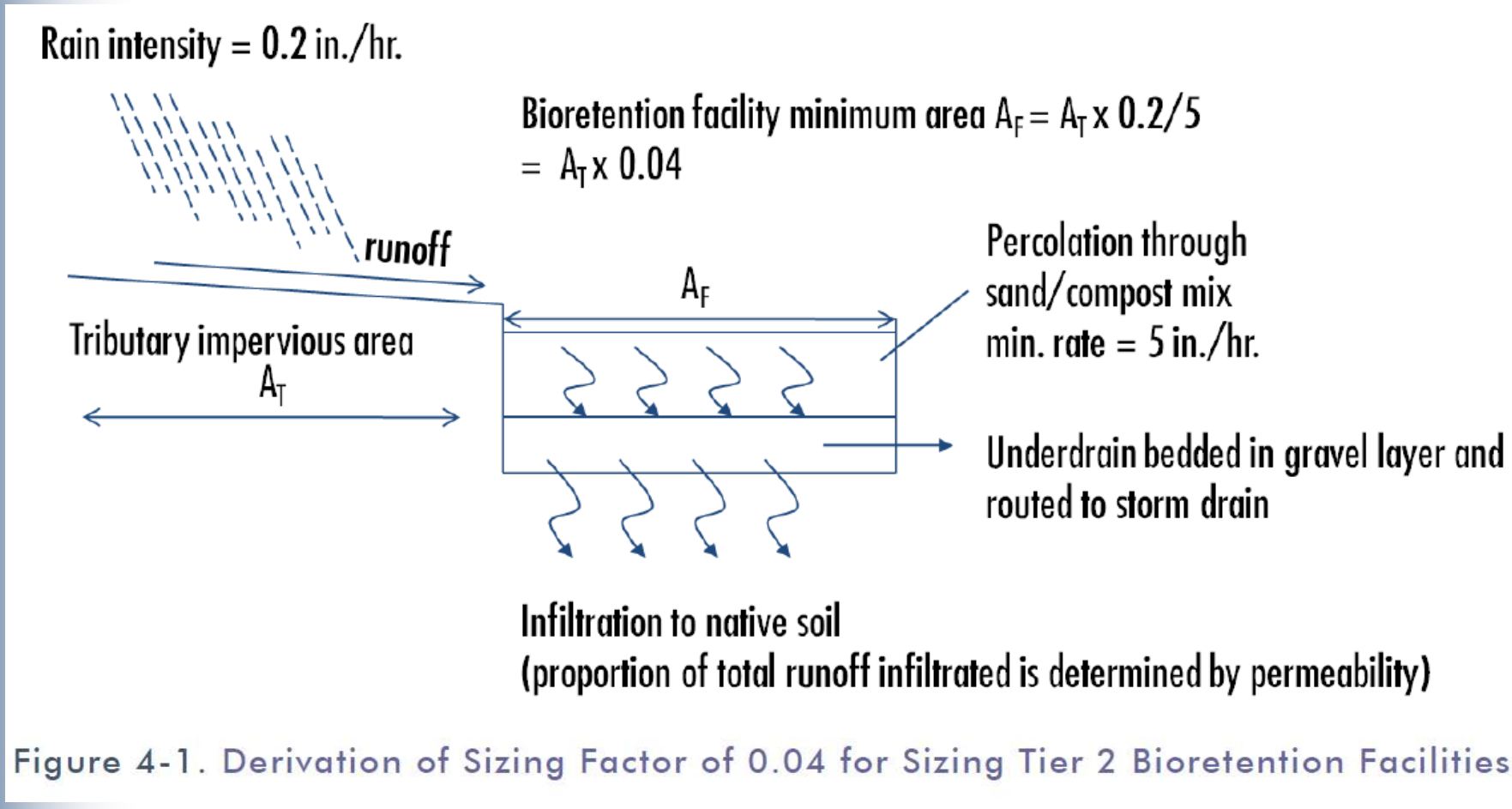
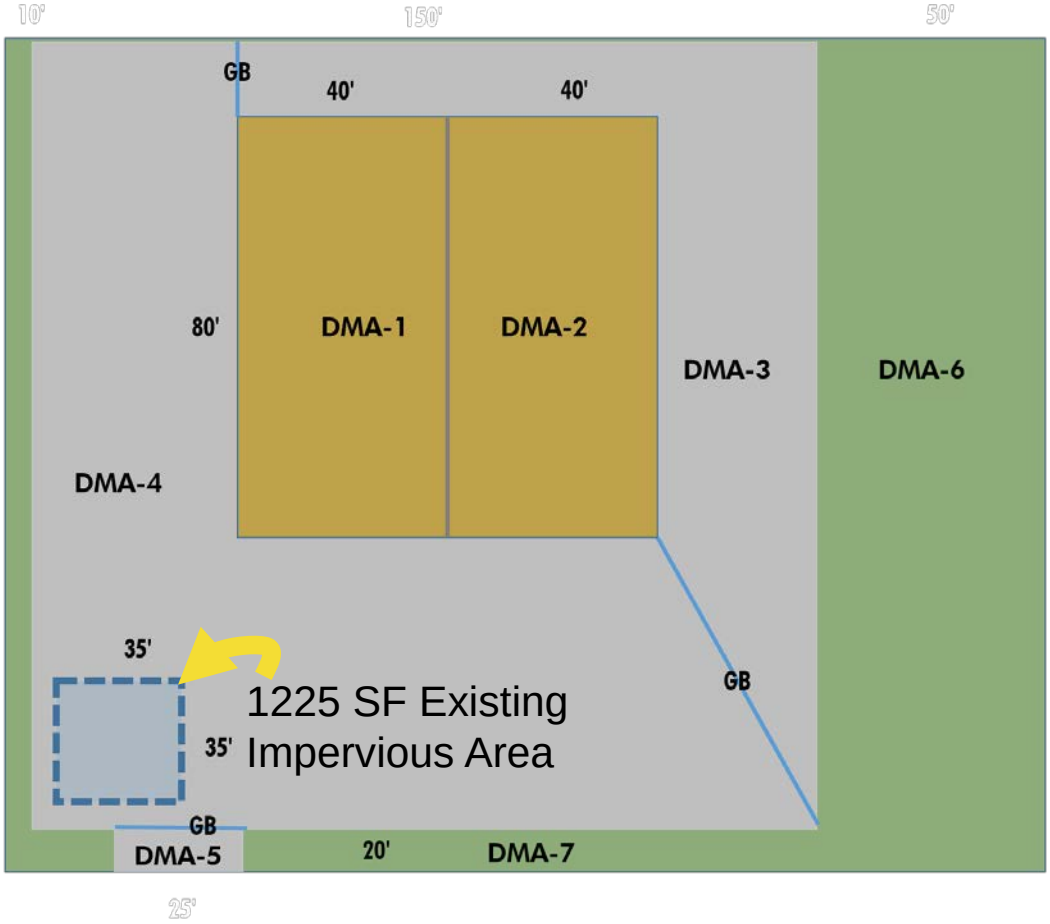


Figure 4-1. Derivation of Sizing Factor of 0.04 for Sizing Tier 2 Bioretention Facilities

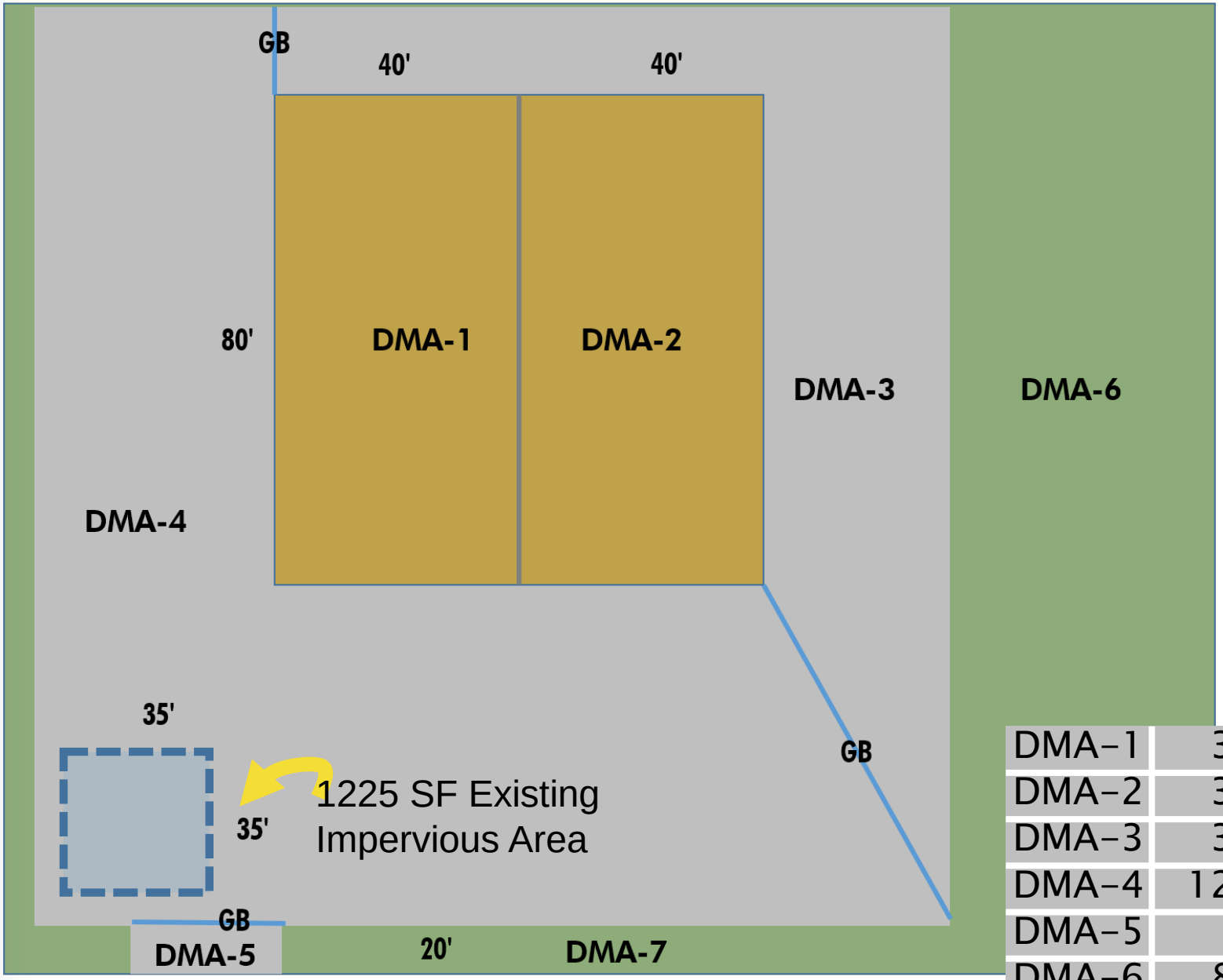
*From Santa Barbara County Stormwater Technical Guide

Drainage Management Areas

- Follow roof ridges and grade breaks
- Different DMA for each surface type



Slide courtesy of Santa Barbara County and Dan Cloak

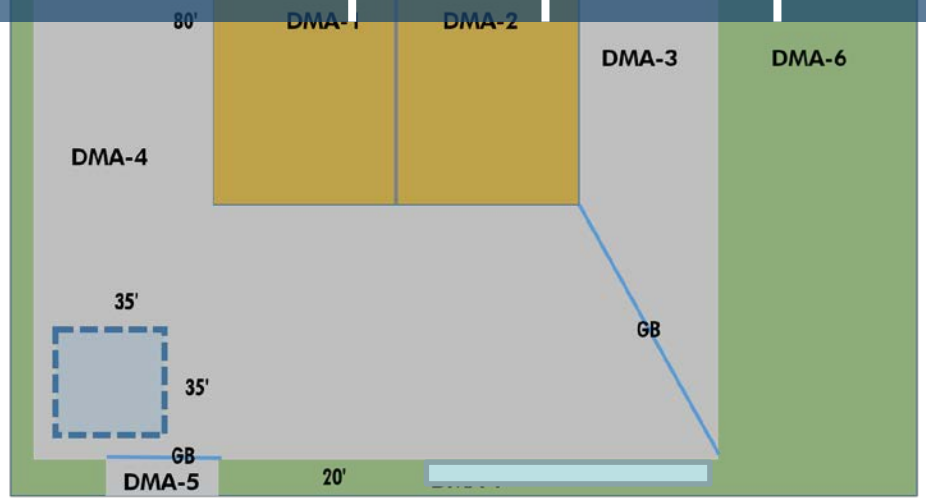


DMA-1	3200
DMA-2	3200
DMA-3	3700
DMA-4	12400
DMA-5	500
DMA-6	8500
DMA-7	4200
Total	**35700**

Slide courtesy of Santa Barbara County and Dan Cloak

Sizing – Treatment Only

DMA Name	DMA Area (SF)	Post-project surface type	DMA Runoff factor	DMA Area × runoff factor	Facility Name		
DMA-1	3200	Roof	1.0	3200			
DMA-2	3200	Roof	1.0	3200	Facility Sizing factor	Minimum Facility Size	Proposed Facility Size
DMA-4	12400	Paved	1.0	12400			
Total>				**18800**	**0.04**	**752**	**900**



DMA-1	3200
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DMA-6	8500
DMA-7	4200
Total	35700

Runoff Factors for LID Design*

Table 4-1. Runoff Factors for small storms (for LID design)

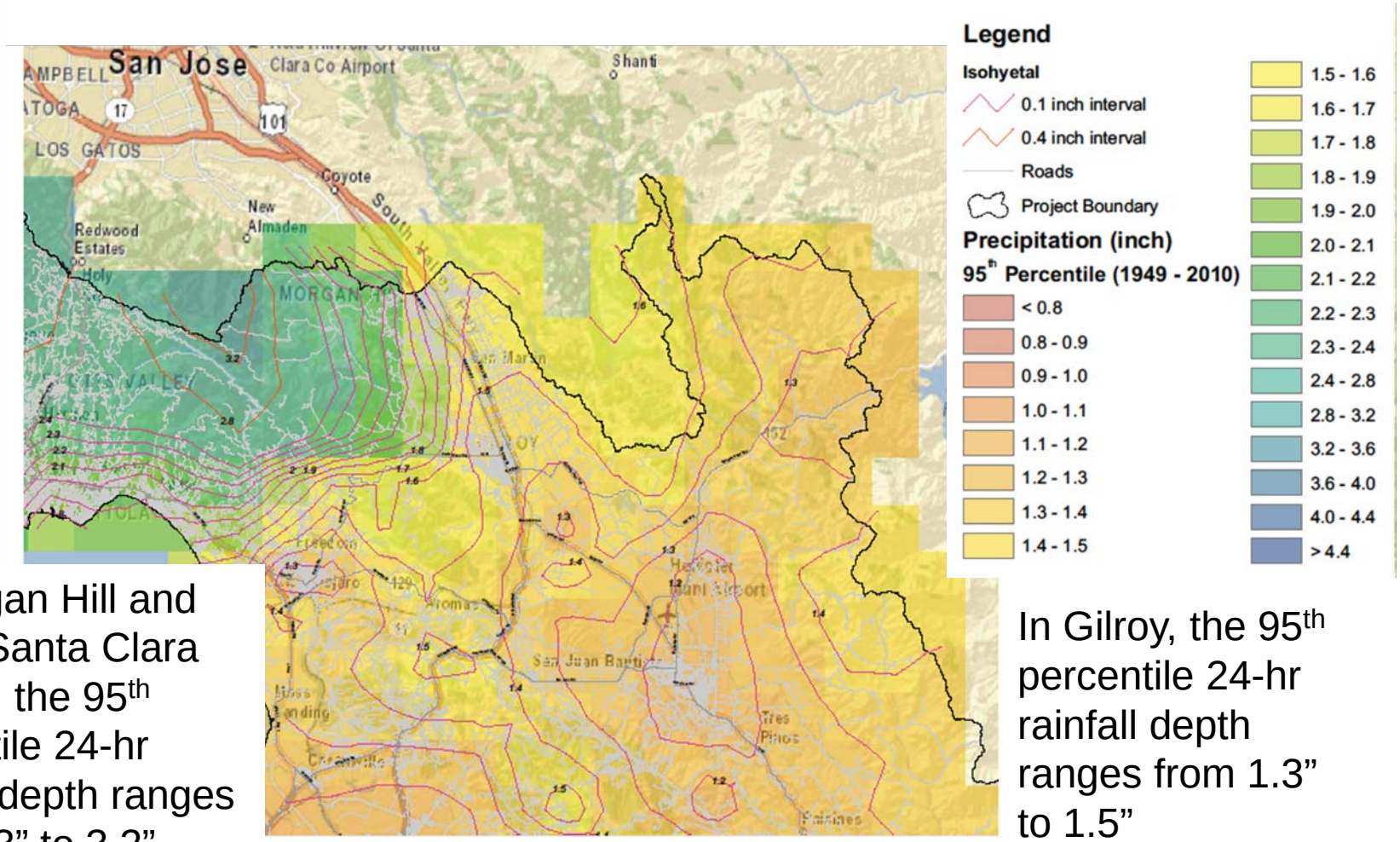
Roofs and paving	1.0
Landscaped areas	0.1
Bricks or solid pavers on sand base	0.5
Pervious concrete or asphalt	0.0
Turfblock or gravel—total section at least 6" deep	0.0

*From Santa Barbara County Stormwater Technical Guide

Tier 3: Runoff Retention

- Recall the procedure:
  - Determine applicable storm depth (95th percentile)
  - Determine **Retention Tributary Area**
  - Determine any allowable adjustments
    - Replaced impervious surface may be multiplied by 0.5
  - Compute required retention volume by simple or routing method
  - Compute size of SCM needed for retention, adjusting depth and surface area until adequate
  - If infeasible, adjust to ≥ 10% of EISA

Performance Requirement No.3
95th Percentile 24-Hour Rainfall Depth



In Morgan Hill and South Santa Clara County, the 95th percentile 24-hr rainfall depth ranges from 1.3” to 3.2”

In Gilroy, the 95th percentile 24-hr rainfall depth ranges from 1.3” to 1.5”

Retention Tributary Area

- From PCRs, Attachment D

  Retention Tributary Area *= (Entire Project Area) – (Undisturbed or Planted Areas) – (Impervious Surface Areas that Discharge to Infiltrating Areas)*

  OR IN OTHER WORDS:

  Retention Tributary Area *= (Entire Project Area) – (Self-Treating Areas) – (Self-Retaining Areas and the Impervious Areas that Drain to Them)*

- Redevelopment project credit:

  When calculating the Retention Tributary Area, the total amount of replaced impervious area is multiplied by a factor of 0.5.

Calculation of Retention Volume

Approach in Technical Guide

- Simple Method:
  - Determine storm depth; convert to feet
  - Determine the required minimum volume V (in cubic feet) as follows:

$$\mathbf{V = \sum [DMA \times Runoff\ Factor] \times Storm\ Depth}$$

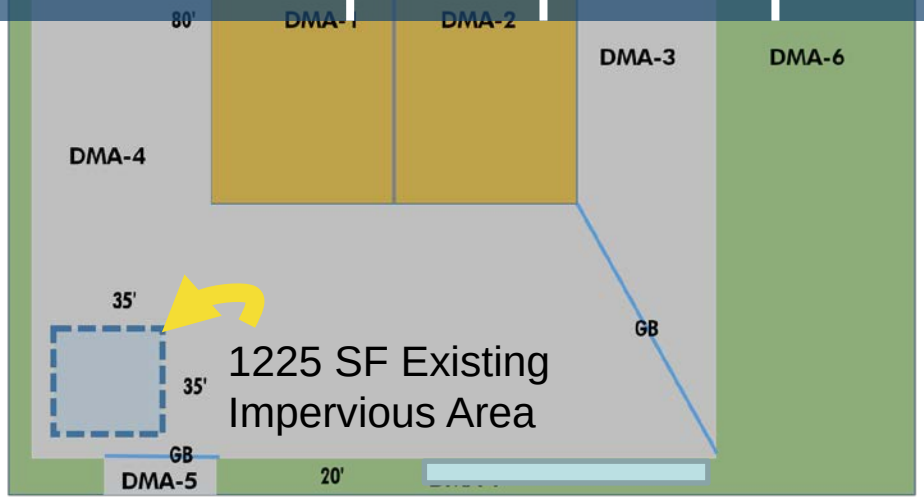
- Technical Guide uses same runoff factors as for water quality sizing

Example Sizing – Retention

DMA Name	DMA Area (SF)	Post-project surface type	DMA Runoff factor	DMA Area × runoff factor	Facility Name		
DMA-1	3200	Roof	1.0	3200	95th % storm depth (ft)	Retention Volume (cu. ft.)	Actual Facility Volume
DMA-2	3200	Roof	1.0	3200			
DMA-4	11787	Paved	1.0	11787			
Total>				18187	0.12	2182	?

Size reduced by 0.5 X 1225

Assume storm depth is 1.4”



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DMA-4	12400
DMA-5	500
DMA-6	8500
DMA-7	4200
Total	35700

Resize SCM for Retention

- Bioretention area for treatment = 900 SF
- Required retention volume = 2,182 CF
- Storage in gravel layer with 40% void space: 2,182 ÷ 0.4 = 5,455 CF*
- If keep same footprint, need 6 ft of gravel
- If reduce gravel to 2-ft depth, need 2,727 SF surface area

*Need to confirm whether surface ponding and biotreatment soil can be used for storage

Calculation of Retention Volume

Approach in PCRs, Attachment D

- Simple Method:
  - Determine storm depth; convert to feet
  - Compute the runoff coefficient C for area tributary to SCMs:

$$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$$

  - Determine the Retention Volume:

$$V = C \times \text{Rainfall Depth} \times \text{Retention Tributary Area}$$

Calculation of Retention Volume

- Routing Method:
  - Conduct hydrologic analysis to route single storm event through SCM
  - Takes into account surface storage and infiltration into underlying soil during storm event, so results in smaller retention volume
  - Technical Guide Sizing calculator uses Santa Barbara Unit Hydrograph Method (can also use NRCS method)
  - If Retention Volume cannot infiltrate in 48 hours, must apply multiplier of 1.2 to the SCM Volume calculated by the routing method

10% Adjustment to Runoff Retention Requirement

- If technically infeasible, on-site retention of full Retention Volume is not required
- Project must dedicate at least 10% of the **Equivalent Impervious Surface Area** to retention-based structural control measures

EISA *= (Impervious Tributary Surface Area) + [(Pervious Tributary Surface Area) * (Runoff Coefficient)]*

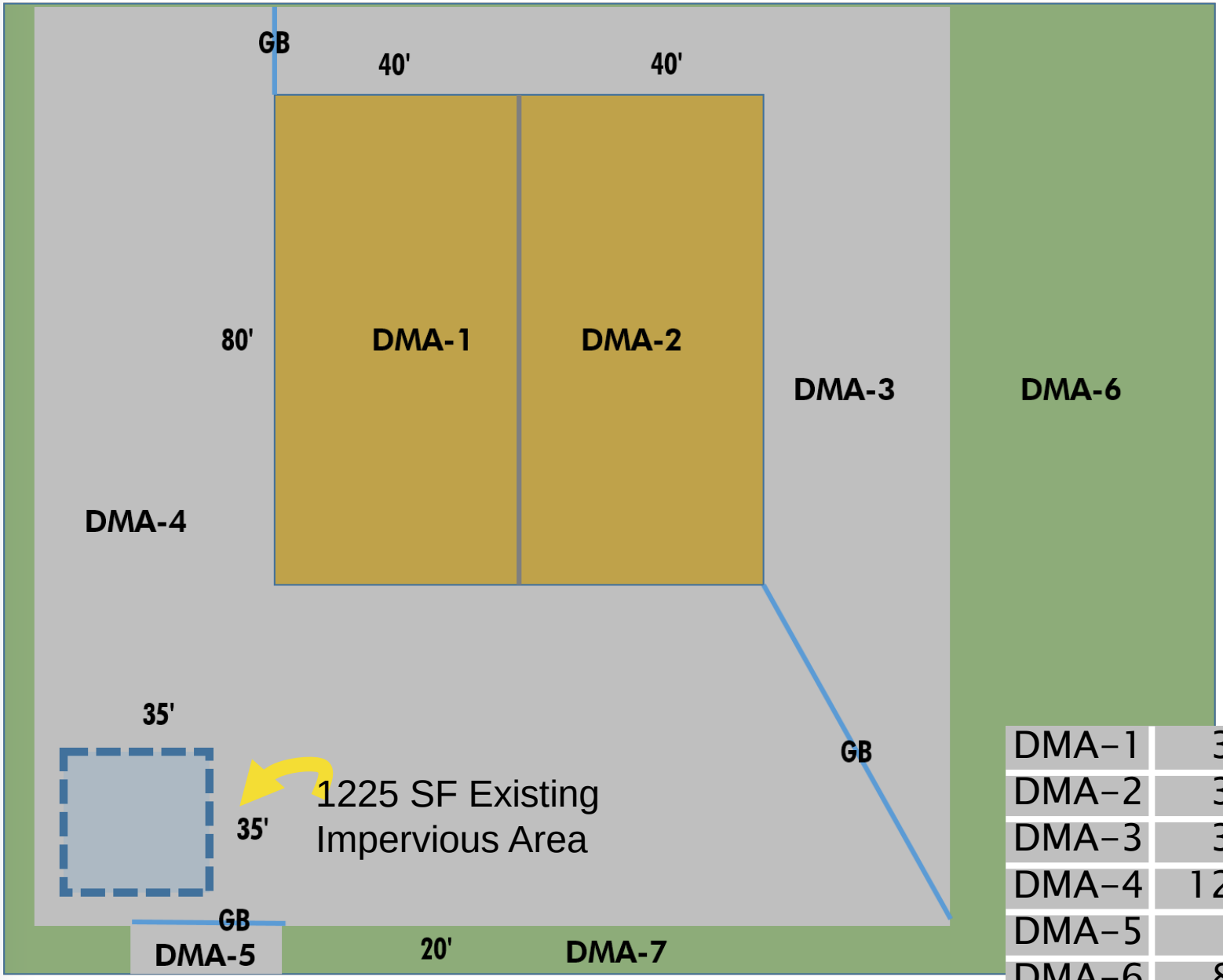
Runoff Coefficients for EISA*

Table 4- 6.

Correction Factors for Use in Calculating Equivalent Impervious Surface Area (EISA) (from the PCRs)

Pervious Surface	Correction Factor
Pervious concrete	0.60
Cobbles	0.60
Pervious Asphalt	0.55
Natural Stone (without grout)	0.25
Turf Block	0.15
Brick (without grout)	0.13
Unit Pavers on Sand	0.10
Crushed Aggregate	0.10
Grass	0.10

*From Santa Barbara County Stormwater Technical Guide



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DMA-7	4200
Total	**35700**

Slide courtesy of Santa Barbara County and Dan Cloak

Example - 10% Adjustment

EISA *= (Impervious Tributary Surface Area) + [(Pervious Tributary Surface Area) * (Runoff Coefficient)]*

DMA	SF	Factor	Product
DMA-1	3200	1.0	3200
DMA-2	3200	1.0	3200
DMA-3	3700	1.0	3700
DMA-4	12400	1.0	12400
DMA-5	500	1.0	500
DMA-6	8500	0.1	850
DMA-7	4200	0.1	420
Total	35700		24270

EISA = 24,270 SF

10% of 24,270 = 2,427 SF

Therefore, could reduce surface of bioretention from 2,727 to 2,427 SF if demonstrate infeasibility

Sizing Pervious Paving and Infiltration Trenches

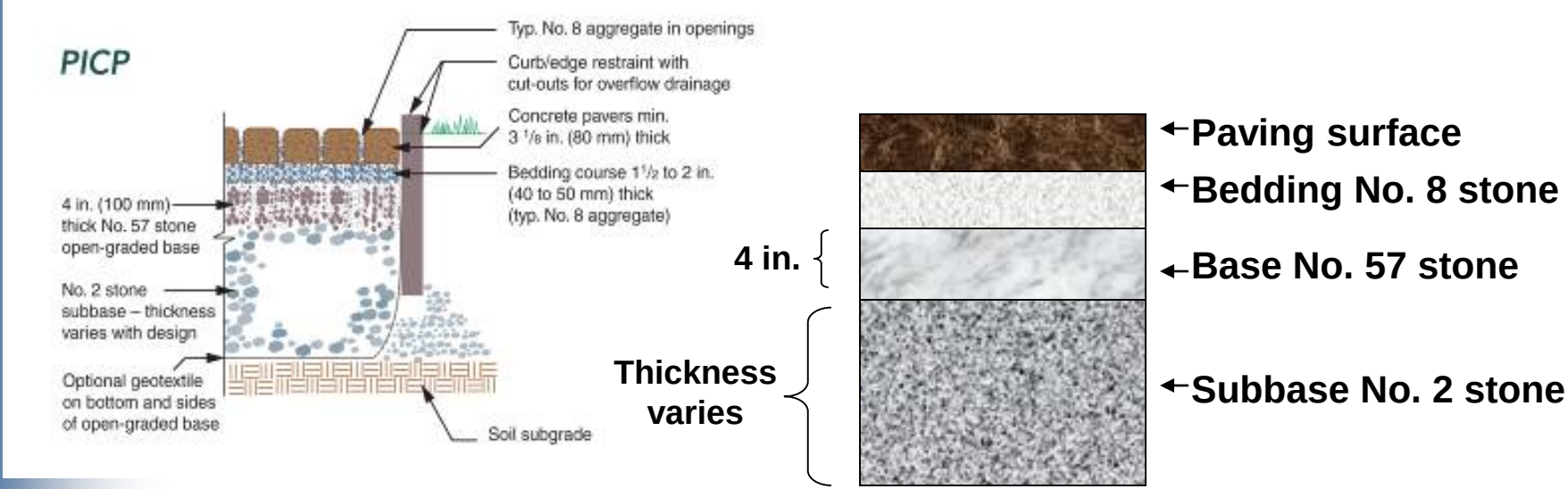
- General Principles
  - Store the design volume $\mathbf{V_D}$ in void space of stone base/subbase and infiltrate into subgrade
  - Surface allows water to infiltrate at a high rate (assume does not limit flow into pervious paving)
  - Any underdrains must be placed above the void space needed to store and infiltrate the design volume

Sizing Pervious Paving and Infiltration Trenches

- Pervious Paving
  - May be self-retaining area and may accept some runoff from other areas
  - Can only be considered a “pervious area” if stone base/subbase sized to store the design volume
  - 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 $\leq$ 1% (or use cutoff trenches)

Pervious Paving

Typical Section



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

Pervious Paving

- Approach to Sizing Pervious Paving
  - Self-retaining, no drainage from adjacent areas
    - $\mathbf{V_D}$ = 85th percentile storm volume for treatment OR 95th percentile storm volume for retention
    - Check the depth of $\mathbf{V_D}$ in base/subbase:
      $\mathbf{V_D}$ (in.) ÷ 0.40 = Depth (in.)

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

Pervious Paving

- Self-Retaining (drainage from adjacent areas)
  - Add the $\mathbf{V_D}$ for adjacent areas to the $\mathbf{V_D}$ for the pervious paving area itself (should not exceed 2:1 ratio of contributing area to pervious area)
  - Divide total $\mathbf{V_D}$ by pervious paving area and convert to inches
  - Check depth of total $\mathbf{V_D}$ in base/subbase:
    Total $\mathbf{V_D}$ (in.) ÷ 0.40 = Depth (in.)

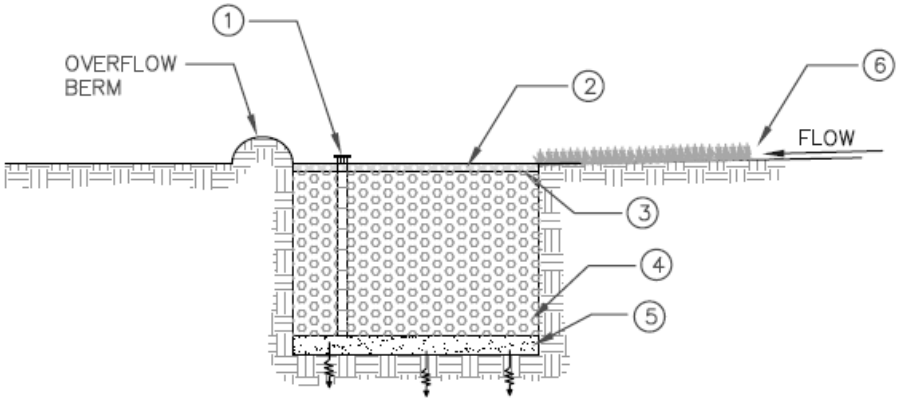
    Example: Total $\mathbf{V_D}$ = 3.0 in., depth = 7.5 in.
  - Check the time required for stored water to drain:
    Total $\mathbf{V_D}$ (in.) ÷ Infiltration rate (in/hr) = Drain time (hrs)

Infiltration Trench Sizing

- Differences from Pervious Paving
  - More runoff must infiltration 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 SCVWD 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 design volume



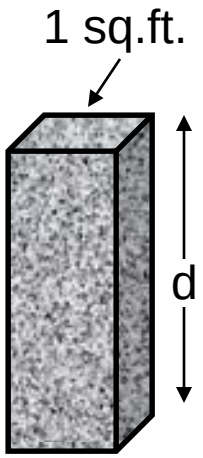
Section A – A'
(Not to Scale)

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: **$S_i = k \times t \div 12$**
    k = subsoil permeability (in/hr); t = time (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)



Infiltration Trench Sizing

- Approach to Sizing Infiltration Trenches, cont.
  - Determine required trench area:
    - **$A_T = V_D \div S$**

      A_T = Trench area required to store treatment volume (sq. ft.)

      V_D = Treatment volume (cu. ft.)

      S = Trench unit storage volume (ft.)
  - Determine required trench width:
    - **$W = A_T \div L$**

      W = Width of trench (ft.)

      A_T = Required trench area (sq. ft.)

      L = Length of trench (ft.) (normally length of treatment area)

Tools and Resources

- Santa Barbara County Project Clean Water Technical Guide and Sizing Calculator
  http://www.sbprojectcleanwater.org/
- Central Coast Low Impact Development Initiative
  www.centralcoastlidi.org
- Santa Clara Valley Urban Runoff Program C.3 Stormwater Handbook (Treatment Sizing)
  www.scvurppp.org (click on LID)

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Questions?

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