

A Proposal for Statewide Knee-of-the-Curve BMP Sizing Criteria

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Research Training Public Education

Overview

- Background
- Existing Methods
- Differences between and within Methods
- Comparisons of Sizing Results
- Proposal for New Knee-of-the-Curve Approach



Background: Different Sizing Methods

Volume Based Sizing

- Design storm (85th percentile, 24-hour)
- Percent capture (80%)
- SCS curve number
- 9 4% of catchment area
- Flow Based Sizing
 - 0.2 in/hr rain intensity
 - 2 x (85th percentile hourly rainfall intensity)



Background: Different Method Applications

- Post-Construction BMPs Permit Methods
 - Phase II
 - Use volume or flow methods
 - Caltrans
 - Use 85th percentile design storm
 - CGP

Use SCS curve number



Research Training Public Education Background: Different Questions

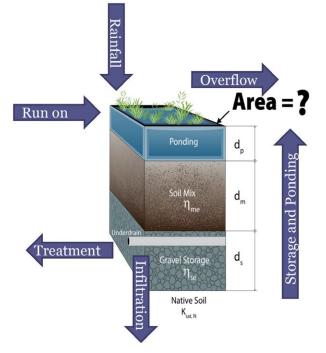
- Why so many methods?
- Why different statewide methods?
- How do the sizing results compare?
 - Hang around to find out!
 - Example: Percent Capture vs Design Storm



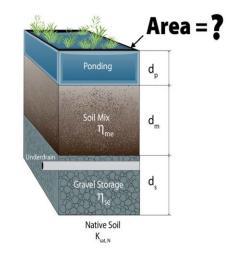
Existing Methods: Percent Capture vs Design Storm

Percent Capture

Continuous simulation (volumes over time)



Design Storm Storage volume (one point in time)



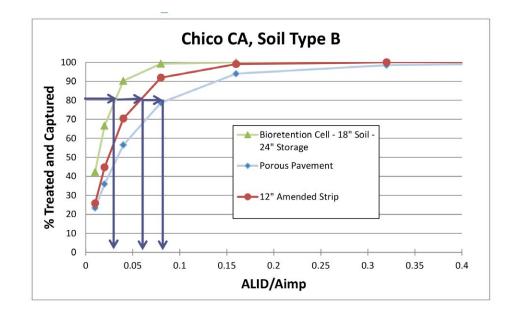


Existing Methods: Percent Capture

- Integrated Water Balance
 - Calculate % capture:
 - Develop design curves for multiple scenarios
 - Historic rainfall
 - BMP characteristics
 - Underlying soils
 - Lookup % capture
 - Read off area

 \sum Volume retained

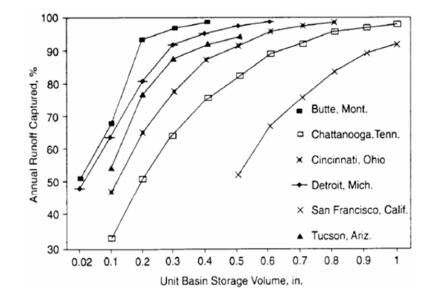
 Σ volume entering BMP





Existing Methods: Why 80% Capture?

- Roesner et al., 1991
 - o detention basins in US
 - Volume capture vs BMP size
 - Size indicates cost
 - Point of diminishing returns (knee-of-the-curve)
 - Optimized storage volume
 - Knee-of-the-curve capture ranged 80 - 90%



Source: Storm Water Best Management Practices Design Guide (EPA, 2004)

- Standard Urban Stormwater Mitigation Plans, 2000
 - Adopt 80% (the low end)

Source: Storm Water Best Management Practices Design Guide (EPA, 2004)



Existing Methods: Why 80% Capture?

- Guo and Urbanos 1996
 - 7 US locations
 - Volume and event captures ranged 82 88%
- CASQA Handbook 2003
 - Use local requirement for % capture
 - If not specified, use knee-of-the-curve (typ. 75-85%)

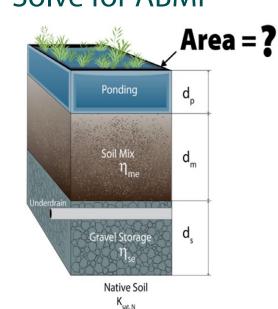
Source: CASQA New Development and Redevelopment BMP Handbook

- Caltrans Basin Sizer
 - Dozens of California locations
 - Knee-of-curve ranged 70-95%



Existing Methods: Design Storm

- Algebraic Water Balance
 - BMP Storage = Run on + BMP Rainfall
 - $d_s * \eta_s * A_{BMP} = RF_{ds} * (C*A_{Catchment} + A_{BMP})$ • Solve for ABMP



WATER PROGRAMS

Existing Methods: Why 85th Percentile Design Storm?

- Not sure
- CA Rainfall Analysis?
 - 80% capture size = 85th percentile design storm size



Differences between Methods

- Different Mathematics
 - Static vs dynamic
 - Design storm: volume at one point in time
 - Percent capture: volume throughout time
- 80% Capture based on 1 BMP, 6 US Locations
 - Not representative of CA climate variations
 - Not representative of LID BMPs (treat and retain)
 - Single discharge mechanism vs. multiple mechanisms
 - Size not the only indicator of cost



Differences between Methods

- Different Mathematics
 - Green Ampt vs Horton
 - Orifice sizing (stage-storage-discharge)
 - Rainfall to runoff conversion
 - Runoff coefficient
 - Initial abstraction
 - Curve number

For Example

- CA LID Sizing Tool vs EPA Stormwater Calculator
 - SWMM vs SWMM
 - Up to 4% differences
- CA LID Sizing Tool vs SAHM
 - SWMM vs HSPF
 - Up to 24% differences
 - Difference due to stage-storage-discharge relationships



Comparison of Sizing Results: CA Phase II LID Sizing Tool

- Inputs
 - Location
 - Ksat
 - Catchment area

California Phase II LI	D Sizing Tool
requirements set forth in Califo location, soil type, and Imperiv sites for each LID BNP type. 5 Performance Method: Sizing re factors beyond sizing, such as output. Further information app	es I Low Insure Destormed (5.0) Barg Thol. The is a relationed to the access atomicine practicities in existing and access to the service and the service atomicine in existing and access the service atomicine in the servi
	that is invest to a destable through a server. The destables stores precipitation and evacoration data for multiple destability (cations throughout California, pre-defined parameters for multiple LD)
BMP types and project soll typ	the all means of biblioset income server, the biblioset some preparation are exponent on the preparation control or the preparation of the prepara
Use base Learns to halp you have the ingoids for steps 1 to 3 below the major Colorest Brackows Bits 1 Colorest Brackows Bits 2 Colorest Brackows Bits 2 Colorest Brackows Disance (herb: 0 Area Sports' 0 To create Hond Sources	
Step 1 - Select a climate sta	
CHICD UNIV FARM	This tool currently provides results based on 15 climate stations troughout California. Use the diop down to choose the climate station that best neresents your project sits. You can view the stations on the map to checking the "Climate stations" boar under likes 1 of the Layes stateor. Then click on any station on the map to learn its name, yeas on record, 85m percentile design storm, and orber information. The will be able to even the blowing boar.
Step 2 - input a saturated hy	staulic conductivity
1 Inches per hour	Enter your project site is saturated hydraulic conductivity.
	If you don't know it, check with your local requisitor to see if it is acceptable to use estimates from the USDA NROS. If it is, you can view the USDA NROS hybridication provide a solution on the map above by checking the "Soll Types" local in Sites 2 of the Layees sidebar and clicking on the color covering your project location.
	To see tables of saturated hydraulic conductivities for soil groups and textures click here 🕏
Step 3 - Input the Impervious	arca
	The CA Phase II NPDES gemit requires that the project site be divided into discrete Drainage Management Areas (DMAs). Runoff from each DMA must be managed using LID BMPs that meet
1 Acres	specific sking oriteria specified in the permit. The tool uses a scenario where the DNA consists of a 100% impervious catchment draining to a LID BMP, input the size of the impervious catchment of the DNA of interest for your project.
1 Acres	
Arres	catchment of the DIIA of Interest for your project.

• Output: BMP Sizes

- Multiple BMPs
 - Bioretention
 - Biostrips & bioswales
 - Porous pavement
 - Infiltration trenches, galleries, etc.
- Multiple Sizing Methods
 - 85th percentile, 24-hr design storm
 - 80% capture
 - 4% equivalent
 - Central Coast simple method

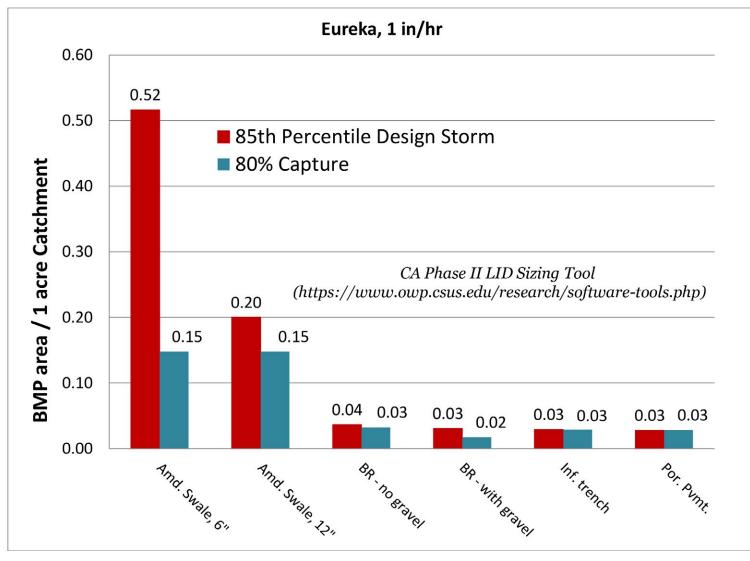


Comparison of Sizing Results:

Storm Water Treatment Measures						
	Permit Compliant LID BMP Areas (acres)					
LID BMP Types	Design Storm 0.8 inches ^{1, 8}	Percent Capture ²	Baseline Bioretention or Equivalent Performance ³	Central Coast Simple Method 0.8 inches ^{4, 8}		
Bioretention Cell - 18" Soil - 12" Gravel Storage	<u>0.048</u>	<u>0.018</u>	<u>0.040</u>	0.210		
Bioretention Cell - 18" Soil - 24" Gravel Storage	0.038	<u>0.018</u>	<u>0.040</u>	<u>0.094</u>		
Bioretention Cell - 18" Soil - 36" Gravel Storage	<u>0.031</u>	<u>0.018</u>	<u>0.039</u>	0.060		
Bioretention Cell - 24" Soil - 12" Gravel Storage	0.043	<u>0.018</u>	<u>0.039</u>	0.210		
Bioretention Cell - 24" Soil - 24" Gravel Storage	<u>0.034</u>	<u>0.017</u>	<u>0.039</u>	0.094		
Bioretention Cell - 24" Soil - 36" Gravel Storage	0.029	<u>0.017</u>	0.039	0.060		
Bioretention Cell - Soil Depth Varies ⁵ - No Gravel Storage	<u>0.045</u>	0.033	<u>0.075</u>	0.045		
Infiltration Basin - Vegetated	<u>0.015</u>	<u>0.016</u>	0.037	0.015		
Infiltration Gallery	<u>0.012</u>	<u>0.016</u>	<u>0.037</u>	0.012		
Infiltration Trench	<u>0.035</u>	0.029	<u>0.069</u>	0.035		
Overland Flow no amendment	<u>N/A</u>	<u>0.100</u>	0.300	<u>N/A</u>		
Porous Pavement	<u>0.034</u>	0.028	0.068	0.034		
Strip, Amended 6"	<u>0.710</u>	0.068	<u>0.160</u>	<u>0.710</u>		
Strip, Amended 12"	0.250	0.057	<u>0.140</u>	0.250		
Strip, Amended 18"	<u>0.160</u>	0.048	<u>0.130</u>	<u>0.160</u>		
Swale, Amended 6"6	<u>0.710</u>	<u>0.150</u>	<u>0.480</u>	<u>0.710</u>		
Swale, Amended 12"6	<u>0.250</u>	0.150	0.480	<u>0.250</u>		

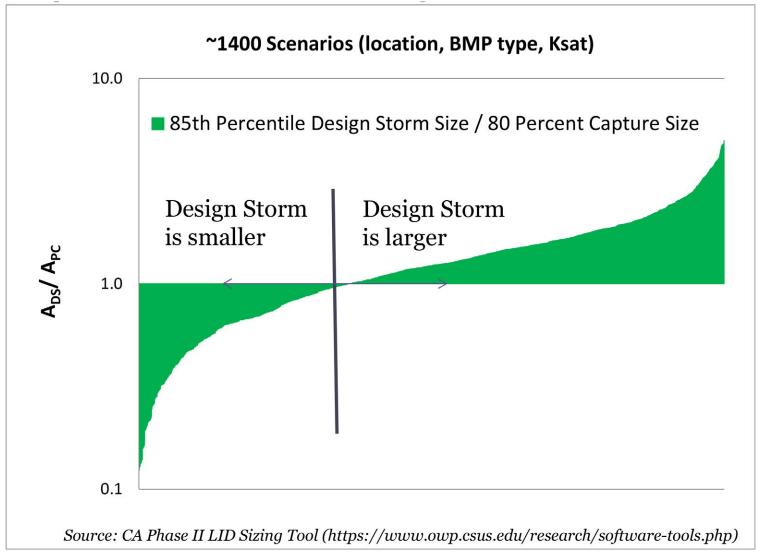


Comparison of Sizing Results:





Comparison of Sizing Results:





Are We Making a Difference?

- Regarding Stormwater Management and BMP Implementation, Intent is there
 - Simplified, uniform procedures
 - Multiple benefits
 - Improve receiving water quality
 - Stormwater as a resource
- Perhaps design standards need to catch up
 - More systematic approaches
 - Better understanding of design standards
 - Updated design standards for LID BMPs being implemented in CA



Proposal for New Knee-of-the-Curve

- Calculate design curves for LID BMPs
 - Determine true knee-of-the curve capture
 - Determine corresponding design storm size
- Redefine cost/practicality indicator
 - Replace size with materials
 - Replace size with water quality benefit measurement
- Monitor performance
 - Compare actual performance to intended design
 - Compare performance among design approaches



What do you think/know?

- Is there a need for new design curves (and storms)?
 - CA specific locations
 - LID BMP characteristics
 - New "diminishing returns" indicator
- How can we gather design/performance information to get meaningful data?
- Are we making a difference?
- Where <u>DID</u> the 85th percentile design storm come from?!



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