

Central Coast Region Stormwater Control Measure Sizing Calculator

Introduction and Instructions

Version: 2/26/2014



Software Features and Notes

- Calculator is a MS Excel workbook with VBA code to guide data entry and hydraulic calculations
 - **Allow “Macros” when opening**
- Worksheets are “protected” to prevent changes in format, row and column locations, etc., and to protect embedded equations
- Cells are color-shaded to match their use:

yellow = data entry

Name
DMA #1
DMA #2

blue = generated results

Min. Required Storage Vol. (ft3)
455
109

grayed-out = not used

Surface Type

```

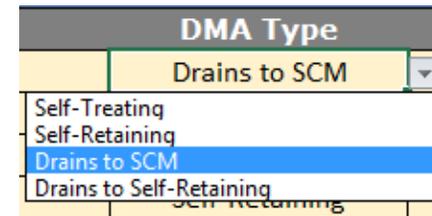
'-----
'Runoff Retention option
'-----

'-----
'Prepare an SBUH model for each active SCM
'-----
'Switch to "SBUH Model" tab and delete all but the first SBUH mode
Worksheets("SBUH Model").Activate
Columns("R:XFD").Delete

'Count the number of SCMs that receive flow from DMAs
ActiveSCM_Count = 0
For i = 1 To nSCMrows
    If Worksheets("Project Information").Cells(SCMcellUL.Row + (i
        ActiveSCM_Count = ActiveSCM_Count + 1
    End If
Next
'MsgBox ActiveSCM_Count & " SCMs connected to DMAs"

If ActiveSCM_Count = 0 Then
    MsgBox "No SCMs have been connected to DMAs. Please revise inp
Worksheets("Project Information").Activate
Cells(1, 1).Select
Exit Sub
End If
    
```

- Combo box/drop down lists are used wherever possible to guide data entry values:



Software Features and Notes (Cont.)

- Calculator contains four worksheets:

1. Project Information:

- Project site, DMA, SCM characterization and results summary

2. SBUH Model:

- Location where model calculations are performed

3. SCS, SBUH Equations:

- Reference equations used by Calculator

4. Lookups, Constants:

- Values used in drop down lists and equations

Core of the user interface:
Described in detail over the next 7 slides

Background calculations:
Described in the final 3 slides



Project Information Worksheet Overview

Central Coast Region Stormwater Control Measure Sizing Calculator						Version: 2/26/2014
1. Project Information						
Project name:	Test Project -- Santa Barbara					
Project location:	Santa Barbara					
Tier 2/Tier 3:	Tier 3 - Retention					
Design rainfall depth (in):	2.0					
Total project area (ft2):						
Total new impervious area (ft2):						
Total replaced impervious in a USA (ft2):						
Total replaced impervious not in a USA (ft2):						
Total pervious/landscape area (ft2):						
2. DMA Characterization						<input type="button" value="Add DMA Row"/>
						<input type="button" value="Remove DMA Row"/>
Name	DMA Type	Area (ft2)	Surface Type	New, Replaced?	Connection	
DMA #1	Drains to SCM	5000	Roof	Replaced	SCM #1	
DMA #2	Self-Retaining	2500				
DMA #3	Drains to SCM	4000	Landscape	New		
DMA Summary Area						
Total project impervious area (ft2):	5000					
New impervious area (ft2):	0					
Replaced impervious within a USA (ft2):	0					
Replaced impervious not in a USA (ft2):	5000					
Total pervious/landscape area (ft2):	4000					
3. SCM Characterization						<input type="button" value="Add SCM Row"/>
						<input type="button" value="Remove SCM Row"/>
Name	SCM Type	Safety Factor	SCM Soil Type	Infiltr. Rate (in/hr)	Area (ft2)	
SCM #1	Direct Infiltration	2	HSG A/B	0.75	500	
SCM #3	Bioretention	1	HSG A/B	0.75	600	
SCM #8	Bioretention	1	HSG A/B	0.75	600	
SCM #8B	Bioretention	1	HSG A/B	0.75	700	

Enter project site location and characteristics using drainage planning documents

Define Drainage Management Areas. Iteratively add/remove and modify their characteristics

Define Stormwater Control Measure characteristics. Iteratively test different configurations



Project Information Overview (Cont.)

After DMAs and SCMs are defined, click to launch sizing calculations

4. Run SBUH Model				
<div style="border: 1px solid gray; padding: 2px; display: inline-block;">Launch Model</div>				
5. SCM Minimum Sizing Requirements				
SCM Name	Min. Required Storage Vol. (ft3)	Depth Below Underdrain (ft)	Drain Time (hours)	
SCM #1	455	2.27	2.8	
SCM #3	109	0.45	0.0	
6. Self-Retaining Area Sizing Checks				
Self-Retaining DMA Name	Self-Retaining DMA Area (ft2)	Tributary DMA Name	Tributary DMA Area (ft2)	Area Ratio
DMA - SRA #1	4300	DMA #2	2500	0.58

Calculator runs SBUH model and provides min. volume, depth and drainage time for each SCM

Calculator tracks connections and tributary area ratio for each Self-Retaining Area



Project Information Table

1. Project Information	
Project name:	Test Project -- Santa Barbara
Project location:	Santa Barbara
Tier 2/Tier 3:	Tier 3 - Retention
Design rainfall depth (in):	2.0
Total project area (ft²):	
Total new impervious area (ft ²):	
Total replaced impervious in a USA (ft ²):	
Total replaced impervious not in a USA (ft ²):	
Total pervious/landscape area (ft ²):	

Enter project name and location

Select: "Tier 2 – Treatment" or "Tier 3 – Retention"

Select design rainfall depth

Summarize from your drainage plan.
Calculator will compare these values to the DMAs you enter later



DMA Characteristics Table

Add or remove DMAs here: not by manually inserting/deleting rows

2. DMA Characterization			Add DMA Row	Remove DMA Row	
Name	DMA Type	Area (ft2)	Surface Type	New, Replaced?	Connection
DMA #1	Self-Treating	5000			
DMA #3	Drains to SCM	4000	Grouted unit pavers	New	SCM #1
DMA - SRA #1	Self-Retaining	4300			
Building Roof DMA	Drains to Self-Retaining	2000	Roof		DMA - SRA #1

Provide descriptive name

Select:
 1) Self-Treating
 2) Self-Retaining
 3) Drains to SCM
 4) Drains to Self-Retaining

Enter DMA Area

Select:
 1) Roof
 2) Concrete/asphalt
 3) Grouted unit pavers
 4) Pervious concrete
 5) Porous asphalt
 6) Unit pavers in sand
 7) Open/porous pavers
 8) Crushed aggregate
 9) Turfblock
 10) Landscape

For impervious areas, select:
 1) New
 2) Replaced
 3) Replaced in an Urban Sustainability Area

Select DMA connection for "Drains to SCM" and "Drains to Self-Retaining" DMA types:



DMA Characteristics Table (Cont.)

- Calculator summarizes DMA impervious and pervious area types

DMA Summary Area	
Total project impervious area (ft ²):	5000
New impervious area (ft ²):	0
Replaced impervious within a USA (ft ²):	0
Replaced impervious not in a USA (ft ²):	5000
Total pervious/landscape area (ft ²):	4000

Compare the results to the values entered in the “Project Information” table



SCM Characteristics Table

Add or remove SCMs here: not by manually inserting/deleting rows

3. SCM Characterization					
Name	SCM Type	Safety Factor	SCM Soil Type	Infilt. Rate (in/hr)	Area (ft ²)
SCM #1	Direct Infiltration	2	HSG A/B	0.75	800
SCM #3	Bioretention	1	HSG A/B	0.75	500
SCM #8	Bioretention	1	HSG A/B	0.75	450
SCM #8B	Bioretention	1	HSG A/B	0.75	600



Add SCM Row Remove SCM Row



Provide descriptive name Select: 1) Direct Infiltration 2) Bioretention Safety factor is computed Select: 1) HSG A/B 2) HSG C/D 3) Site-specific Reads selection on the left: A/B = 0.75 in/hr C/D = 0.25 in/hr Site-specific = user-provided Enter SCM plan area

Notes:

- You will need to enter SCMs here before you can “connect” DMAs to them
- You can iteratively modify SCM characteristics to test design concepts and fine tune your design

Launching Calculations and Viewing Results

4. Run SBUH Model

Launch Model

Click here after you have entered/updated all DMAs and SCMs. Software runs SBUH model for each connected SCM.

5. SCM Minimum Sizing Requirements

SCM Name	Min. Required Storage Vol. (ft ³)	Depth Below Underdrain (ft)	Drain Time (hours)
SCM #1	831	2.60	4.3
SCM #3	136	0.68	0.0

Model results/minimum sizing is reported here.

Note: Drain Time = 0 means the bioretention is dry before the 24 storm has ended (exfiltration > inflow)

6. Self-Retaining Area Sizing Checks

Self-Retaining DMA Name	Self-Retaining DMA Area (ft ²)	Tributary DMA Name	Tributary DMA Area (ft ²)	Tributary / SRA Area Ratio
DMA - SRA #1	4300	Building Roof DMA	2000	0.47

Self-Retaining Area tributary connections are reported here. If the Tributary Area Ratio > 2 the cells turns red.



SBUH Model Worksheet

Yellow-shaded cells are copied from "Project Information" sheet

Blue-shaded cells contains results that are copied to the "Project Information" sheet

SCM #1																
SBUH Parameters:											SCM Parameters:					
Design rainfall depth (in) =	2.00					Plan area (ft2) =	800									
Model time step (min) =	10					Sizing factor =	0.114									
DMA Summary		Area (ft2)	CN	S	Weighting	Design infiltration rate (in/hr) =	0.75									
New impervious area:		7000	98	0.20	1	Safety factor =	2									
Replaced impervious in USA:		0	98	0.20	0	SCM Exfiltration rate (cfs) =	0.0139									
Replaced impervious not USA:		0	98	0.20	0.5	Drainage time (hours) =	4									
Landscape area:		0	68	4.71	1	Minimum storage volume (ft3) =	831									
Solid unit pavers set in sand:		0	89	1.24	1	Gravel volume (ft3) =	2076									
Non-runoff generating area:		4300	N/A	N/A	N/A	Gravel depth (ft) =	2.6									
Travel path length (ft) =	150.3					% inflow that										
Time of concentration (min) =	5.0		(rain/runoff)		(rain/runoff)		(rain/runoff)				runoff %	direct rain vol	is exfiltrated	(max/total vol.)		
			89%		10%		51%				89%	133.3	100%	36%		
SBUH Runoff Calculations											Bioretention Hydraulics					
Time (minutes)	Distribution (Type I)	Rainfall Depth (in)	Cumulative Rainfall (in)	Impervious		Landscape		Solid unit pavers set in sand		Instantaneous Runoff Rate (cfs)	Routed Flow Rate (cfs)	Stormwater Inflow (ft3)	Direct Rain (ft3)	Exfiltration Outflow (ft3)	Bioretention Water Volume (ft3)	
				Cumulative Runoff Depth (in)	Instantaneous Runoff (in)	Cumulative Runoff Depth (in)	Instantaneous Runoff (in)	Cumulative Runoff Depth (in)	Instantaneous Runoff (in)							
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
10	0.0027	0.0054	0.0054	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3600	-0.3600	0.0000	
20	0.0026	0.0052	0.0106	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3467	-0.3467	0.0000	
30	0.0027	0.0054	0.0160	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3600	-0.3600	0.0000	

SBUH runoff and routing calculations. Equations are visible to the user

Bioretention hydraulic calculations

SCS, SBUH Equations Worksheet

- Documents SCS rainfall distribution and equations used in hydrologic and hydraulic calculations

SCS Type I Distribution (10-min)				SCS Type I Distribution (2-min)				Stormwater Runoff and Routing Equations:			
Step	Minute	Cummulative Distribution	Incremental Distribution	Step	Minute	Cummulative Distribution	Incremental Distribution				
0	0	0	0.0000	0	0	0	0.0000	<u>Computing Runoff (SCS and SBUH are the same):</u>			
1	10	0.0027	0.0027	1	2	0.0005	0.0005	$R = \frac{(P - I_a)^2}{P - I_a + S}$	where: R = runoff (in) P = rainfall (in) I _a = initial abstraction (in) S = potential maximum soil moisture retention after runoff begins (in) CN = runoff curve number		
2	20	0.0053	0.0026	2	4	0.0011	0.0006				
3	30	0.008	0.0027	3	6	0.0016	0.0005	$I_a = 0.2S$			
4	40	0.011	0.0030	4	8	0.0021	0.0005	$R = \frac{(P - 0.2S)^2}{P - 0.8S}$			
5	50	0.014	0.0030	5	10	0.0027	0.0006	$S = \frac{1000}{CN} - 10$			
6	60	0.017	0.0030	6	12	0.0032	0.0005	<u>SBUH Runoff Routing:</u>			
7	70	0.02	0.0030	7	14	0.0037	0.0005	$I_t = \frac{R_t \times A}{dt} \times \frac{1}{12 \times 60}$	where: I _t = instantaneous hydrograph (cfs) R _t = runoff for current time step (in) A = contributing area (ft) dt = calculation time step (min)		
8	80	0.023	0.0030	8	16	0.0043	0.0006				
9	90	0.026	0.0030	9	18	0.0048	0.0005	$Q_{t+1} = Q_t + w[I_t + I_{t+1} - 2Q_t]$			
10	100	0.029	0.0030	10	20	0.0053	0.0005	$w = \frac{dt}{(2T_c + dt)}$			
11	110	0.032	0.0030	11	22	0.0059	0.0006	$T_c = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} \times s^{0.4}}$			
12	120	0.035	0.0030	12	24	0.0064	0.0005				
13	130	0.0383	0.0033	13	26	0.0069	0.0005				
14	140	0.0417	0.0034	14	28	0.0075	0.0006				
15	150	0.045	0.0033	15	30	0.008	0.0005				
16	160	0.0483	0.0033	16	32	0.0086	0.0006				
17	170	0.0517	0.0034	17	34	0.0092	0.0006				
18	180	0.055	0.0033	18	36	0.0098	0.0006				
19	190	0.0583	0.0033	19	38	0.0104	0.0006				
20	200	0.0617	0.0034	20	40	0.011	0.0006				
21	210	0.065	0.0033	21	42	0.0116	0.0006				
22	220	0.0687	0.0037	22	44	0.0122	0.0006				
23	230	0.0723	0.0036	23	46	0.0128	0.0006				
24	240	0.076	0.0037	24	48	0.0134	0.0006				
25	250	0.0797	0.0037	25	50	0.014	0.0006				
26	260	0.0833	0.0036	26	52	0.0146	0.0006				
27	270	0.087	0.0037	27	54	0.0152	0.0006				
28	280	0.091	0.0040	28	56	0.0158	0.0006				
29	290	0.095	0.0040	29	58	0.0164	0.0006				
30	300	0.099	0.0040	30	60	0.017	0.0006				



Lookups, Constants Worksheet

Lookup Tables for Combo Boxes		Hydraulic Constants	
DMA Type	Code	Gravel layer porosity:	0.4
Self-Treating	STA		
Self-Retaining	SRA		
Drains to SCM	2SCM		
Drains to Self-Retaining	2SRA		
SCM Type			
Bioretention			
Direct Infiltration			
DMA Surface Types	Curve Number	Runoff Factor (WQ)	
Roof	98	0.9	
Concrete or asphalt	98	0.9	
Grouted unit pavers	98	0.9	
Pervious concrete		0.0	
Porous asphalt		0.0	
Unit pavers set in sand	89	0.2	
Open/porous pavers		0.0	
Crushed aggregate		0.0	
Turfblock		0.0	
Landscape	68	0.1	
SCM Optimization			
Area			
Depth			
USA Lookup			
Yes			
No			
Compliance Approach			
WQ Treatment			
Runoff Retention			
Infiltration Rate			
HSG A/B			
HGS C/D			
Site-Specific			

- Contains lists of values used by combo boxes and constants used by SBUH model

