City of Columbia BMP Manual

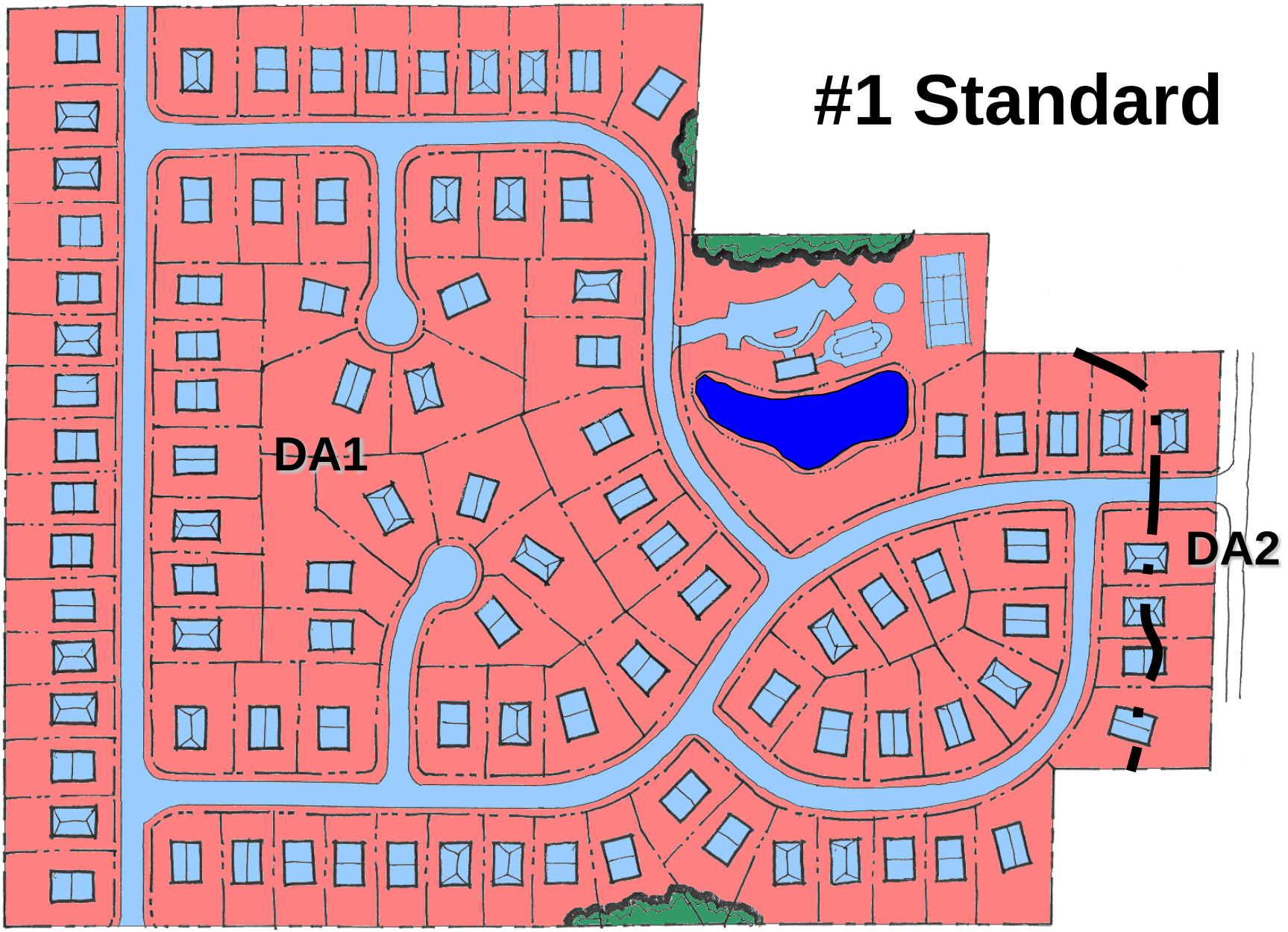
Volume Calculation Tool and Examples

July 24, 2013

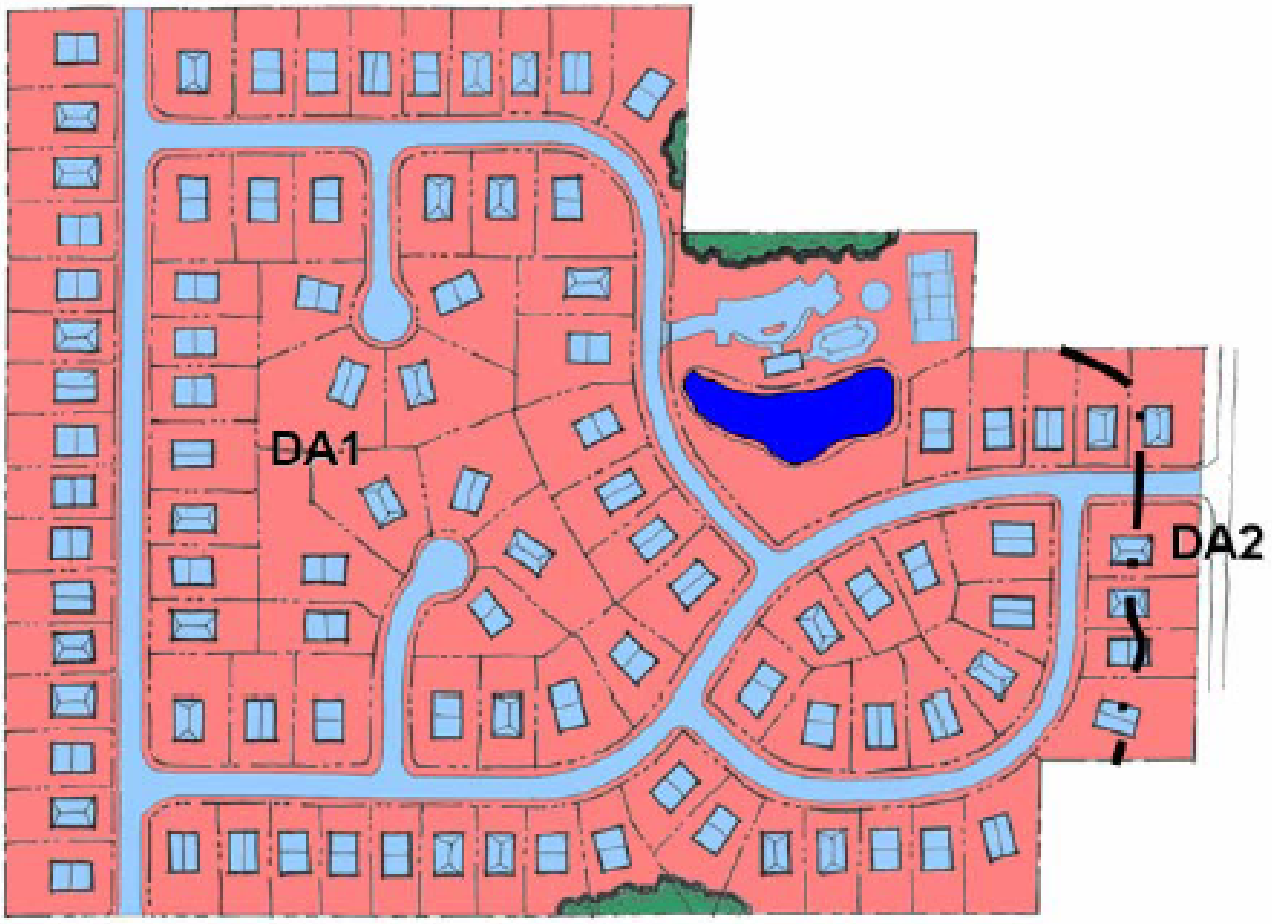
Today's Agenda

1. Welcome
2. Review City's Design Aid Tools – Example Project
3. Revisit City's BMP Maintenance Agreement Procedure
4. Discuss Scheduling August (Final) Meeting
5. Questions?
6. Adjourn

Design Aid Tools:
Example Residential Project


#1 Standard
DA1
DA2
RESIDENTIAL SUBDIVISION -- CONVENTIONAL DESIGN

Description: A medium-density residential subdivision designed with a conventional layout. The proposed site design has 96 single-family lots along with an amenity area, which includes the clubhouse, pool and tennis court. The entire site will be cleared and mass-graded.



RESIDENTIAL SUBDIVISION -- CONVENTIONAL DESIGN

Planned Site Design:

Total Size = 83.41 acres
Number of Lots = 96
Total Impervious Cover = 20.75 acres
- Rooftops/Driveways/Decks = 10.33 acres
- Streets (1.10 linear miles – 34’ width) = 9.00 acres
- Amenity Area (Clubhouse, Pool, Tennis Court, Parking) = 1.42 acres

Percent Impervious Cover = 25%
Natural Conservation Area = 1.16 acres

Drainage Area 1 (DA1) = 80.60 acres

- Impervious Area = 20.52 acres
- Percent Impervious Cover = 25.5%
- Natural Conservation Area = 1.16 acres
- Structural Control: Stormwater Pond

Drainage Area 2 (DA2) = 2.81 acres

- Impervious Area = 0.23 acres
- Percent Impervious Cover = 8.2%
- Natural Conservation Area = 0
- Structural Control: None

CoC's Volume Calculation Tool:

Volume Calculation Executive Summary

Project Name: Residential Example: #1 Standard
Project Number: -
Date: 7/24/2013
Site Location: City of Columbia, SC
Drainage Area: DA1

data input cells

Site Hydrology

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Pre-Development	80.6	0	74	73.1
Post-Development	80.6	20.52	84	53.7

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr [cfs]	25yr [cfs]	100yr [cfs]
Pre-Development	N/A	41.1	52.1	116.7	140.1	192.3
Post-Development		87.5	101.5	188.6	220.2	288.9

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Pre-Development	-	-	-	-	-	-
Post-Development	98,001	328,744	167,369	268,886	306,240	385,564

Better Site Design

Credited Practice	Area Draining to BMP [acres]	WQv Credit [cf]
Natural Area Conservation	1.16	1,411
Stream Buffer		-
Vegetated Channel		-
Overland Flow Filtration/Infiltration Zones		-
Environmentally Sensitive Large Lot		-
Total WQv stored with BSD practices [cf]		1,411

Applicable BSD Credits to Adjust Site's CN:		
Conservation Areas	1,411	cf
Stream Buffers	-	cf
Infiltration Zones	-	cf
Adjustment to Runoff Reduction Volume (BSD)	1,411	cf
Adjusted CN'_{post}	84	

* Adjusted CN'_{post} is based off runoff reduction from the 100-yr event (most conservative)

Pre vs. Post Drainage Area Summary

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Post-Development	80.6	20.52	84	53.7
Post-Dev. with BSD	80.6	20.52	84	53.7

Pre vs. Post Peak Flow Summary

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr [cfs]	25yr [cfs]	100yr [cfs]
Post-Development	N/A	87.5	101.5	188.6	220.2	288.9
Post-Dev. with BSD		87.5	101.5	188.6	220.2	288.9

Pre vs. Post Volume Summary

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Post-Development	98,001	328,744	167,369	268,886	306,240	385,564
Post-Dev. with BSD	96,590	328,744	167,369	268,886	306,240	385,564
% Reduction with BSD	1.44	-	-	-	-	-

Page 1

Volume Calculation Executive Summary

Structural BMPs

Credited Practices in CoC BMP Manual	WQv Credit [cf]
Bioretention Area	
Infiltration Trench	
Grass Filter Strip	
Dry Swale	
Pervious Surfaces	

***Retrieve WQ Volumes from BMP Design Aid Worksheets*

Credited Practices for Other Accepted Structural BMPs	WQv Credit [cf]
Wetlands	
Wet Swale	
Gravity Separator	
Commercial SW Controls	
Multi-Purpose Detention Area	
Underground Detention	
Rain Garden/Cistern	

***Provide Supporting Calculations for WQ Volumes*

Total WQv stored with BMPs [cf]	-

Applicable BSD Credits to Adjust Site's CN:		
Conservation Areas	1,411	cf
Stream Buffers	-	cf
Infiltration Zones	-	cf

Applicable BMP Credits to Adjust Site's CN:		
Bioretention	-	cf
Infiltration Trench	-	cf
Porous Surfaces	-	cf
Dry Swale	-	cf
Rain Garden/Cistern	-	cf
Runoff Reduction Vol. Adjustment (BSD + BMP)	1,411	cf
Adjusted CN''_{post}	84	

* Adjusted CN''_{post} is based off runoff reduction from the 100-yr event (most conservative)

Pre vs. Post Drainage Area Summary

	Total Drainage Area [acres]	Imperv. Area [acres]	CN	tc [min]
Post-Development	80.6	20.52	84	53.7
Post-Dev. with BSD	80.6	20.52	84	53.7
Post-Dev. with BSD & BMPs	80.6	20.52	84	53.7

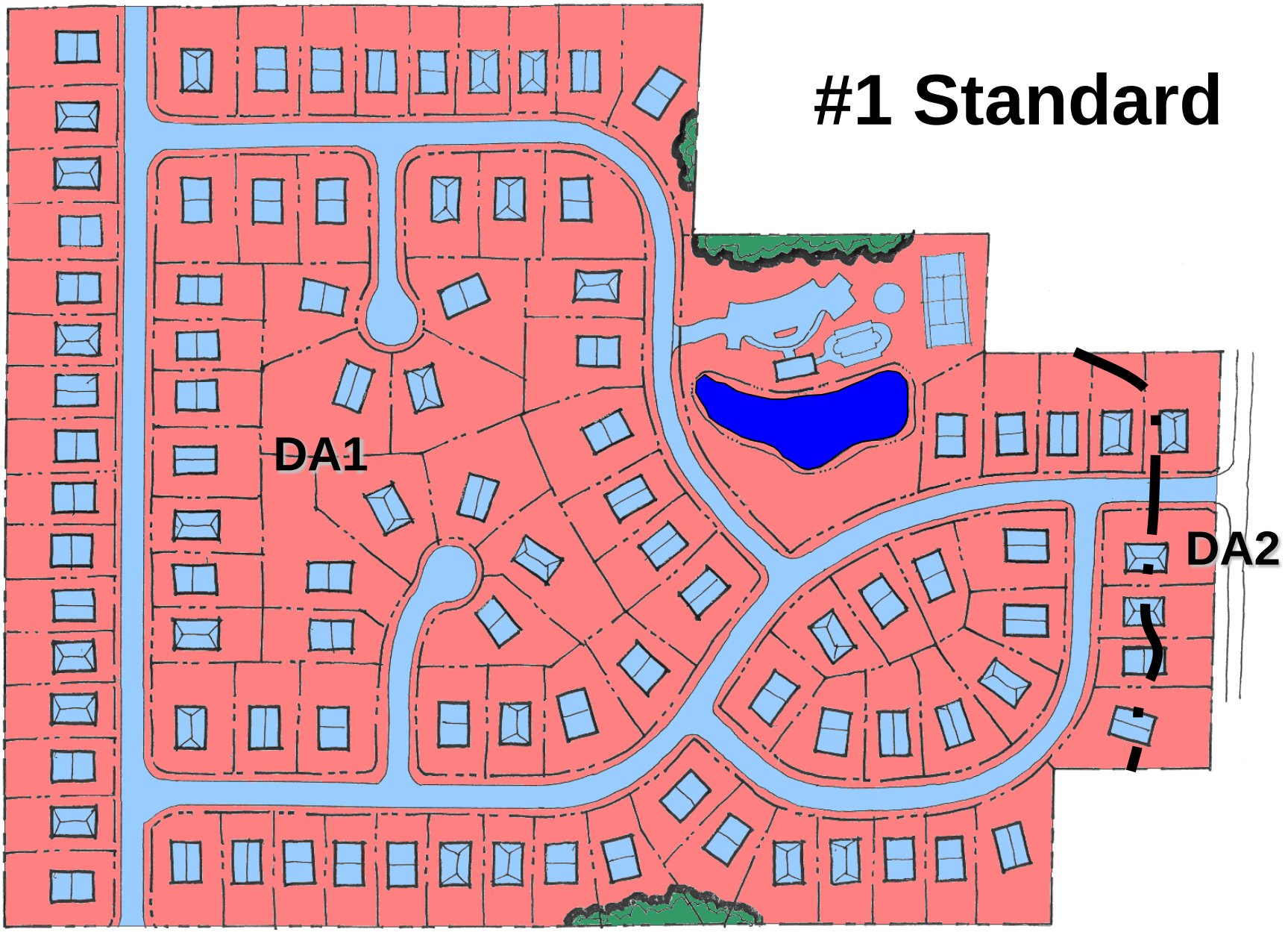
Pre vs. Post Peak Flow Summary

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr [cfs]	25yr [cfs]	100yr [cfs]
Post-Development	N/A	87.5	101.5	188.6	220.2	288.9
Post-Dev. with BSD		87.5	101.5	188.6	220.2	288.9
Post-Dev. with BSD & BMPs		87.5	101.5	188.6	220.2	288.9

Pre vs. Post Volume Summary

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Post-Development	98,001	328,744	167,369	268,886	306,240	385,564
Post-Dev. with BSD	96,590	328,744	167,369	268,886	306,240	385,564
Post-Dev. with BSD & BMPs	96,590	328,744	167,369	268,886	306,240	385,564
% Reduction w. BSD & BMPs	1.44	-	-	-	-	-

Page 2


#1 Standard
DA1
DA2
RESIDENTIAL SUBDIVISION -- CONVENTIONAL DESIGN

#1 Standard 'DA1'

Project Name:	Residential Example: #1 Standard
Project Number:	-
Date:	7/24/2013
Site Location:	City of Columbia, SC
Drainage Area:	DA1

data input cells

Site Hydrology

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Pre-Development	80.6	0	74	73.1
Post-Development	80.6	20.52	84	53.7

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Pre-Development	N/A	41.1	52.1	116.7	140.1	192.3
Post-Development		87.5	101.5	188.6	220.2	288.9

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Pre-Development	-	-	-	-	-	-
Post-Development	98,001	328,744	167,369	268,886	306,240	385,564

Better Site Design

Credited Practice	Area Draining to BMP [acres]	WQv Credit [cf]
Natural Area Conservation	1.16	1,411
Stream Buffer		-
Vegetated Channel		-
Overland Flow Filtration/Infiltration Zones		-
Environmentally Sensitive Large Lot		-
Total WQv stored with BSD practices [cf]		1,411

Applicable BSD Credits to Adjust Site's CN:		
Conservation Areas	1,411	cf
Stream Buffers	-	cf
Infiltration Zones	-	cf
Adjustment to Runoff Reduction Volume (BSD)	1,411	cf
Adjusted CN'_{post}	84	

* Adjusted CN'post is based off runoff reduction from the 100-yr event (most conservative)

Pre vs. Post Drainage Area Summary

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Post-Development	80.6	20.52	84	53.7
Post-Dev. with BSD	80.6	20.52	84	53.7

Pre vs. Post Peak Flow Summary

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Post-Development	N/A	87.5	101.5	188.6	220.2	288.9
Post-Dev. with BSD		87.5	101.5	188.6	220.2	288.9

Pre vs. Post Volume Summary

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Post-Development	98,001	328,744	167,369	268,886	306,240	385,564
Post-Dev. with BSD	96,590	328,744	167,369	268,886	306,240	385,564
% Reduction with BSD	1.44	-	-	-	-	-

Instructions | Input Output | Pre | Post | BSD Credits | BSD Credits (format 2) | Post BS

Input Pre-Development parameters

Input Post-Development parameters

Input DA1's Natural Conservation Area

Not enough infiltration from cons. area to change site's CN

Summary of Pre Dev vs. Post Dev with BSD:

- Peak Flows
- Storage Volumes

% Volume Reduction Utilizing BSD Practices:

	WQv	CPv	2yr	10yr	25yr	100yr
% Red. w. BSD	1.44	-	-	-	-	-

#1 Standard ‘DA2’

Project Name:	Residential Example: #1 Standard
Project Number:	-
Date:	7/24/2013
Site Location:	City of Columbia, SC
Drainage Area:	DA2

Site Hydrology

data input cells

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Pre-Development	2.81	0	74	32.1
Post-Development	2.81	0.23	81	26.0

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Pre-Development	N/A	2.3	3.0	6.6	7.9	10.8
Post-Development		4.0	4.7	9.0	10.6	14.1

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Pre-Development	-	-	-	-	-	-
Post-Development	1,513	10,435	4,402	7,346	8,435	10,749

Input Pre-Development parameters

Input Post-Development parameters

DA2 did not conserve any natural features

Better Site Design

Credited Practice	Area Draining to BMP [acres]	WQv Credit [cf]
Natural Area Conservation		-
Stream Buffer		-
Vegetated Channel		-
Overland Flow Filtration/Infiltration Zones		-
Environmentally Sensitive Large Lot		-
Total WQv stored with BSD practices [cf]		-

Applicable BSD Credits to Adjust Site's CN:		
Conservation Areas	-	cf
Stream Buffers	-	cf
Infiltration Zones	-	cf
Adjustment to Runoff Reduction Volume (BSD)	-	cf
Adjusted CN'_{post}	81	

* Adjusted CN'post is based off runoff reduction from the 100-yr event (most conservative)

No infiltration BSD practices were preserved on DA2, hence same CN

Pre vs. Post Drainage Area Summary

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Post-Development	2.81	0.23	81	26
Post-Dev. with BSD	2.81	0.23	81	26

Pre vs. Post Peak Flow Summary

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Post-Development	N/A	4.0	4.7	9.0	10.6	14.1
Post-Dev. with BSD		4.0	4.7	9.0	10.6	14.1

Pre vs. Post Volume Summary

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Post-Development	1,513	10,435	4,402	7,346	8,435	10,749
Post-Dev. with BSD	1,513	10,435	4,402	7,346	8,435	10,749
% Reduction with BSD	-	-	-	-	-	-

Summary of Pre Dev vs. Post Dev with BSD:

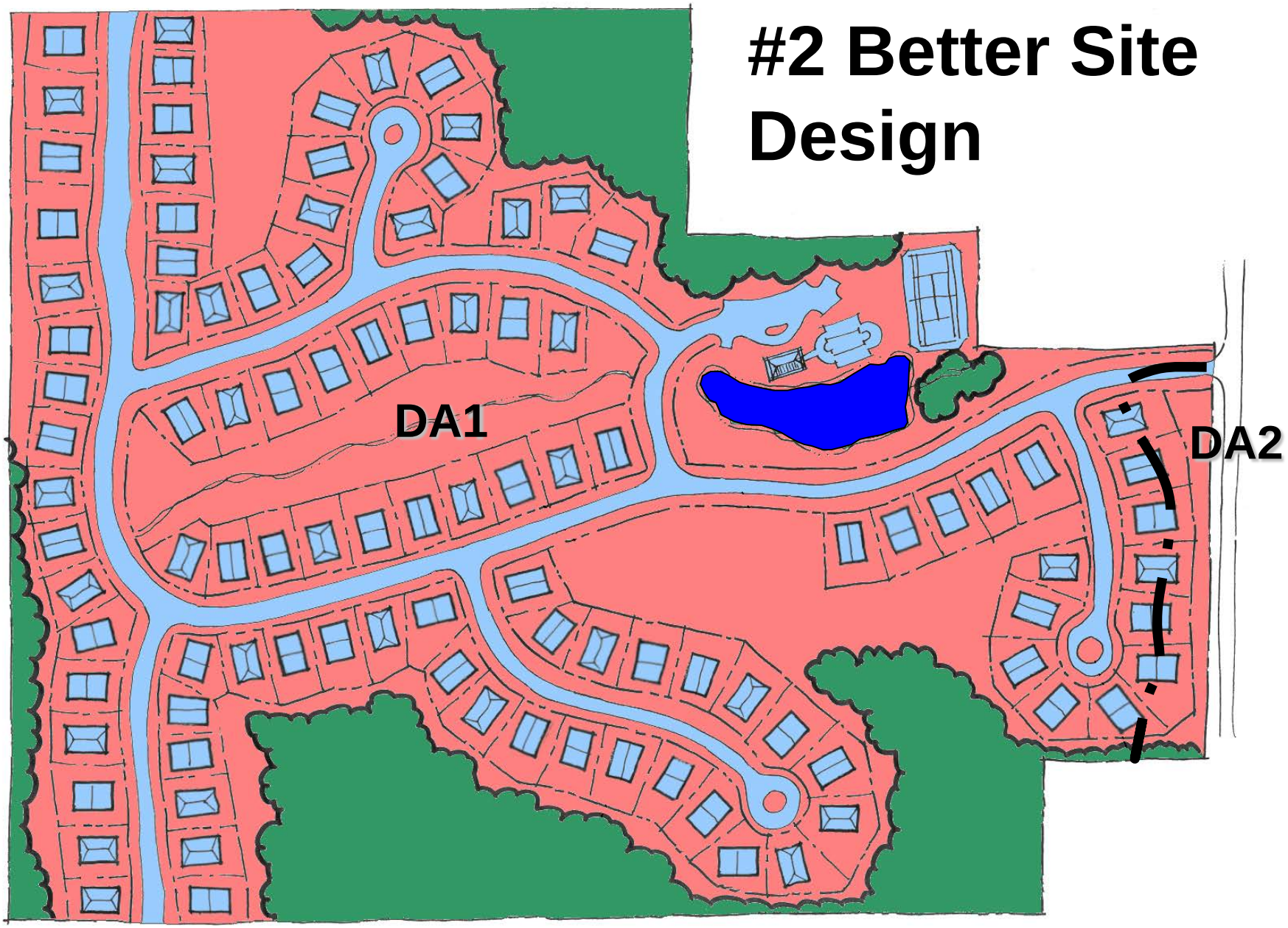
- Peak Flows
- Storage Volumes

% Volume Reduction Utilizing BSD Practices:

	WQv	CPv	2yr	10yr	25yr	100yr
% Red. w. BSD	-	-	-	-	-	-

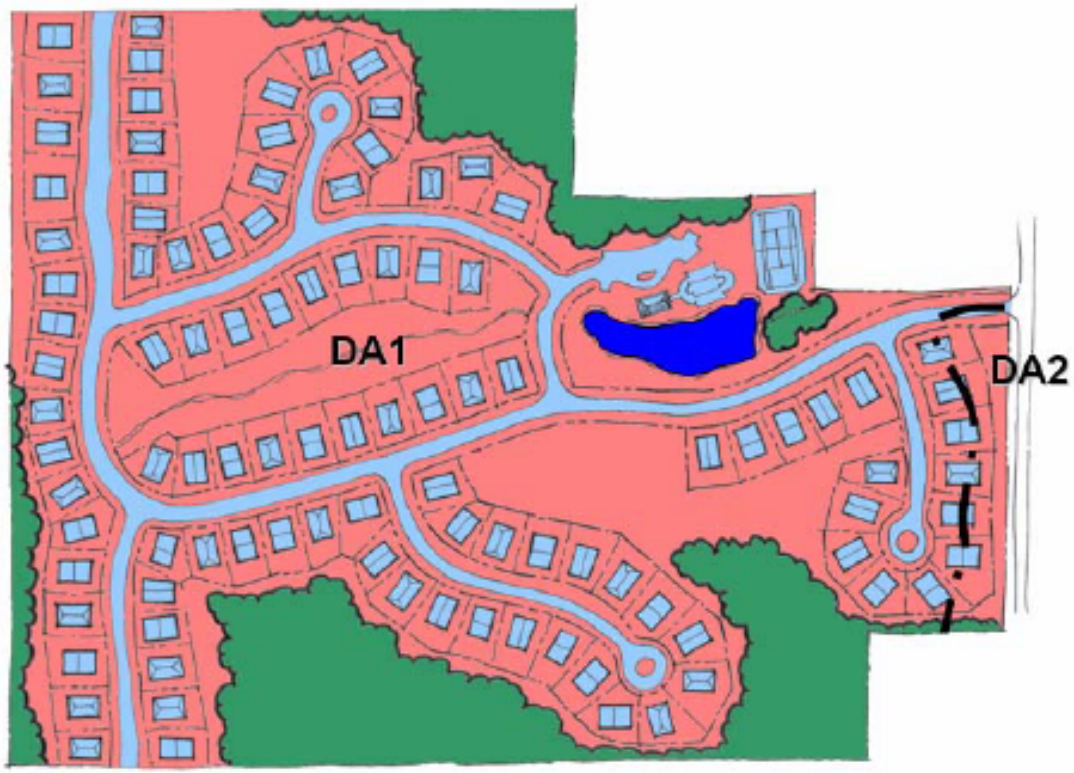
Instructions | Input_Output | Pre | Post | BSD_Credits | BSD_Credits (format 2) | Post_

#2 Better Site Design



RESIDENTIAL SUBDIVISION -- BETTER SITE DESIGN

Description: A medium-density residential subdivision designed using stormwater "better site design" principals and techniques. The proposed site design has 102 single-family lots along with an amenity area, which includes the clubhouse, pool and tennis court. Almost one-fifth of the original site has been left in its undisturbed natural state in protected natural conservation areas. In addition, the subdivision layout was designed around the natural drainage patterns of the site in order to reduce the need for a storm drainage pipe system. Only the building envelopes and minor areas of each home site will be graded. Street width has been minimized and pervious vegetated "islands" are designed for each cul-de-sac.



RESIDENTIAL SUBDIVISION -- BETTER SITE DESIGN

Propose Stormwater Management: The subdivision will utilize the natural drainage patterns of the site as much as possible to carry runoff through the subdivision. A stormwater wet pond (located within the amenity area) is the proposed stormwater management facility for both quality and quantity control.

Total Size = 83.41 acres
Number of Lots = 102 (+6)
Total Impervious Cover = 16.81 acres
- Rooftops/Driveways/Decks = 9.11 acres
- Streets (1.10 linear miles – 34’ width) = 6.28 acres
- Amenity Area (Clubhouse, Pool, Tennis Court, Parking) = 1.42 acres

Percent Impervious Cover = 20% (-5%)
Natural Conservation Area = 14.21 acres

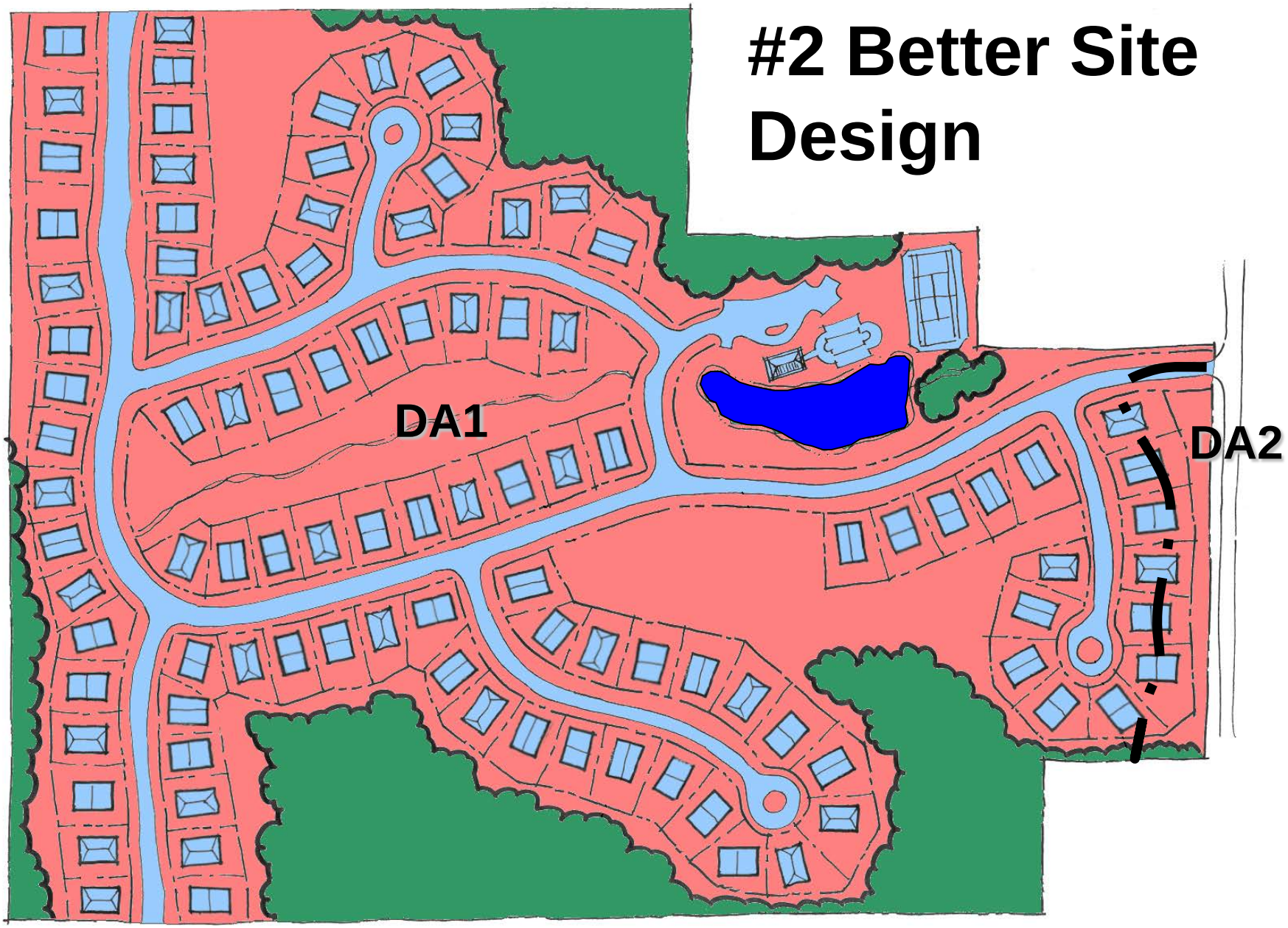
Drainage Area 1 (DA1) = 80.84 acres

- Impervious Area = 16.71 acres (- 3.81 acres)
- Percent Impervious Cover = 20.7% (- 4.8%)
- Natural Conservation Area = 14.14 acres (+ 12.98 acres)
- Structural Control: Stormwater Pond

Drainage Area 2 (DA2) = 2.57 acres

- Impervious Area = 0.10 acres (- 0.13 acres)
- Percent Impervious Cover = 3.9% (- 4.3%)
- Natural Conservation Area = 0.07 (+ 0.07)
- Structural Control: None

#2 Better Site Design



RESIDENTIAL SUBDIVISION -- BETTER SITE DESIGN

#2 BSD 'DA1'

Project Name:	Residential Example: #2 BSD
Project Number:	-
Date:	7/24/2013
Site Location:	City of Columbia, SC
Drainage Area:	DA1

data input cells

Site Hydrology

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Pre-Development	80.84	0	74	73.1
Post-Development	80.84	16.71	82	57.4

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Pre-Development	N/A	41.2	52.3	117.0	140.5	192.9
Post-Development		77.4	90.4	172.2	202.1	267.4

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Pre-Development	-	-	-	-	-	-
Post-Development	83,116	301,350	141,814	234,530	268,871	341,933

Better Site Design

Credited Practice	Area Draining to BMP [acres]	WQv Credit [cf]
Natural Area Conservation	14.14	14,538
Stream Buffer		-
Vegetated Channel		-
Overland Flow Filtration/Infiltration Zones		-
Environmentally Sensitive Large Lot		-
Total WQv stored with BSD practices [cf]		14,538

Applicable BSD Credits to Adjust Site's CN:		
Conservation Areas	14,538	cf
Stream Buffers	-	cf
Infiltration Zones	-	cf
Adjustment to Runoff Reduction Volume (BSD)	14,538	cf
Adjusted CN'_{post}	81	

* Adjusted CN'post is based off runoff reduction from the 100-yr event (most conservative)

Pre vs. Post Drainage Area Summary

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Post-Development	80.84	16.71	82	57.4
Post-Dev. with BSD	80.84	16.71	81	57.4

Pre vs. Post Peak Flow Summary

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Post-Development	N/A	77.4	90.4	172.2	202.1	267.4
Post-Dev. with BSD		74.0	86.8	167.5	197.2	262.0

Pre vs. Post Volume Summary

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Post-Development	83,116	301,350	141,814	234,530	268,871	341,933
Post-Dev. with BSD	68,578	288,379	131,822	221,839	255,404	327,069
% Reduction with BSD	17.49	4.30	7.05	5.41	5.01	4.35

Instructions | Input Output | Pre | Post | BSD Credits | BSD Credits (format 2) | Post BS

Input Pre-Development parameters

Input Post-Development parameters

Input DA1's Natural Conservation Area

Enough infiltration from cons. areas to lower site's CN

Summary of Pre Dev vs. Post Dev with BSD:

- Peak Flows
- Storage Volumes

% Volume Reduction Utilizing BSD Practices:

	WQv	CPv	2yr	10yr	25yr	100yr
% Red. w. BSD	17.49	4.30	7.05	5.41	5.01	4.35

#2 BSD 'DA2'

Project Name:	Residential Example: #2 BSD
Project Number:	-
Date:	7/24/2013
Site Location:	City of Columbia, SC
Drainage Area:	DA2

Site Hydrology

data input cells

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Pre-Development	2.57	0	74	32.1
Post-Development	2.57	0.1	80	26.9

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Pre-Development	N/A	2.1	2.7	6.0	7.2	9.9
Post-Development		3.4	4.0	7.9	9.3	12.4

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Pre-Development	-	-	-	-	-	-
Post-Development	951	9,119	3,664	6,175	7,112	9,106

Better Site Design

Credited Practice	Area Draining to BMP [acres]	WQv Credit [cf]
Natural Area Conservation	0.07	26
Stream Buffer		-
Vegetated Channel		-
Overland Flow Filtration/Infiltration Zones		-
Environmentally Sensitive Large Lot		-
Total WQv stored with BSD practices [cf]		26

Applicable BSD Credits to Adjust Site's CN:		
Conservation Areas	26	cf
Stream Buffers	-	cf
Infiltration Zones	-	cf
Adjustment to Runoff Reduction Volume (BSD)	26	cf
Adjusted CN'_{post}	80	

* Adjusted CN'post is based off runoff reduction from the 100-yr event (most conservative)

Pre vs. Post Drainage Area Summary

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Post-Development	2.57	0.1	80	26.9
Post-Dev. with BSD	2.57	0.1	80	26.9

Pre vs. Post Peak Flow Summary

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Post-Development	N/A	3.4	4.0	7.9	9.3	12.4
Post-Dev. with BSD		3.4	4.0	7.9	9.3	12.4

Pre vs. Post Volume Summary

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Post-Development	951	9,119	3,664	6,175	7,112	9,106
Post-Dev. with BSD	925	9,119	3,664	6,175	7,112	9,106
% Reduction with BSD	2.73	-	-	-	-	-

Instructions | Input_Output | Pre | Post | BSD_Credits | BSD_Credits (format 2) | Post_BSD

Input Pre-Development parameters

Input Post-Development parameters

Input DA2's Natural Conservation Area

Not enough infiltration from cons. area to change site's CN

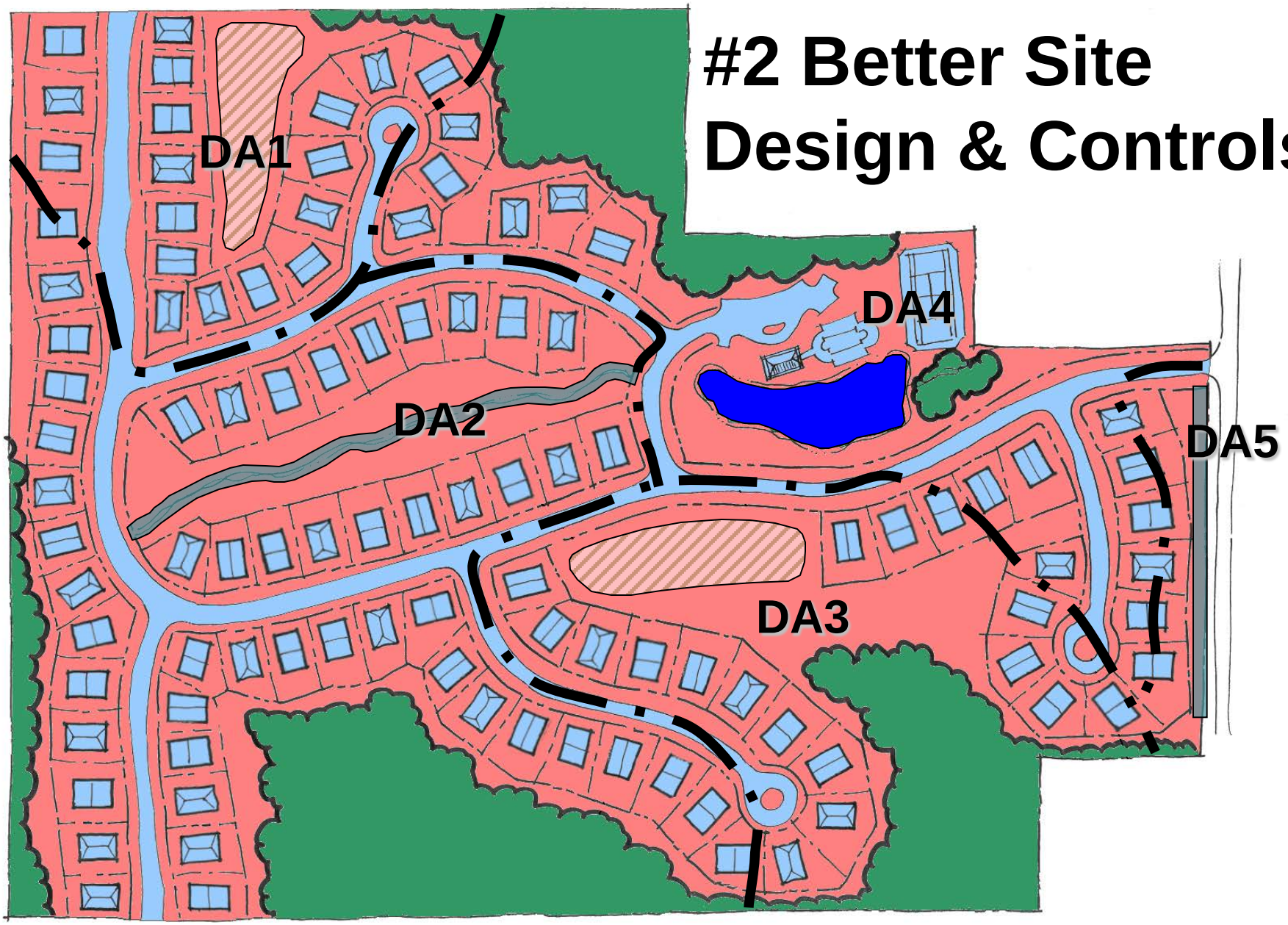
Summary of Pre Dev vs. Post Dev with BSD:

- Peak Flows
- Storage Volumes

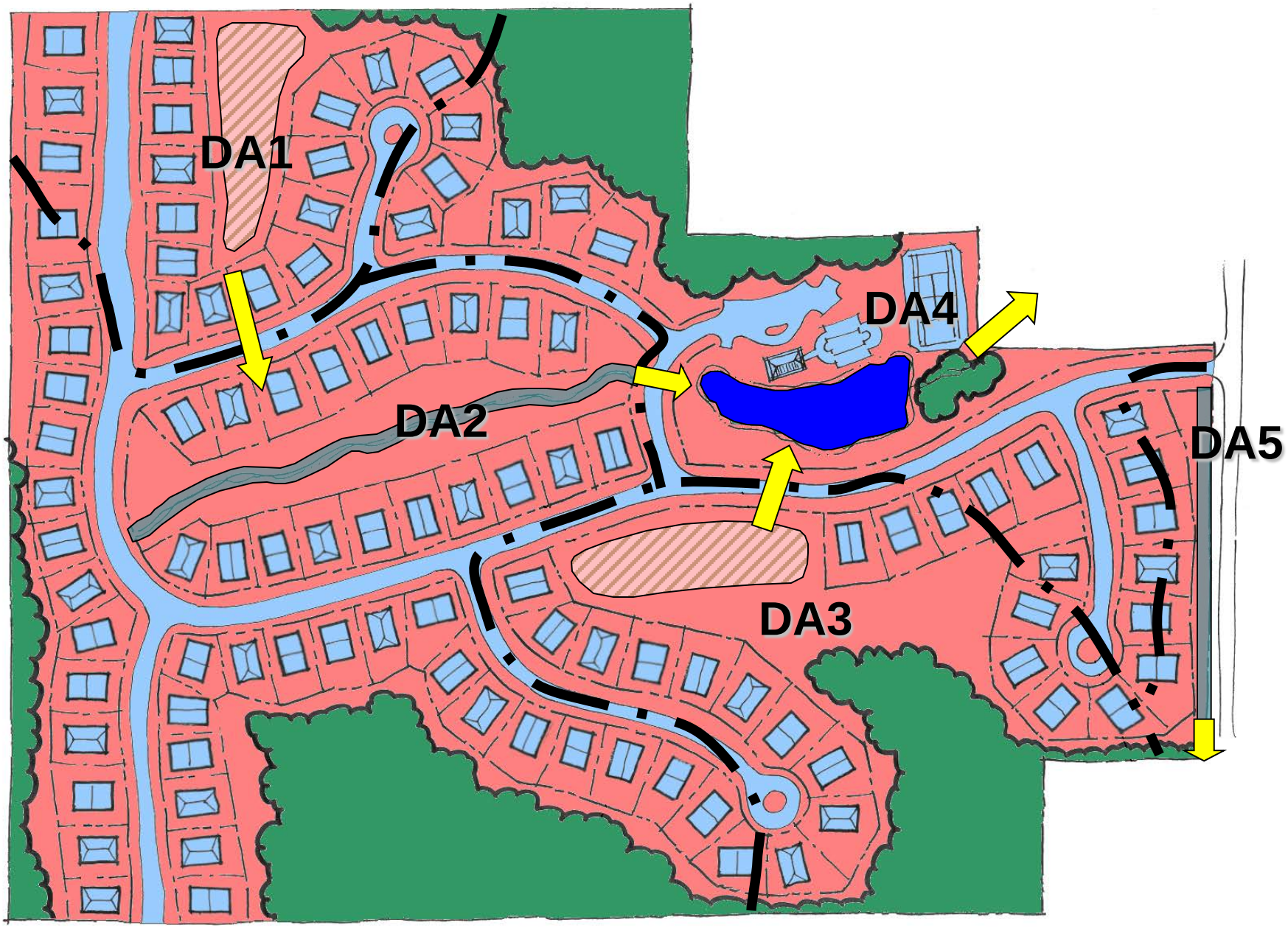
% Volume Reduction Utilizing BSD Practices:

	WQv	CPv	2yr	10yr	25yr	100yr
% Red. w. BSD	2.73	-	-	-	-	-

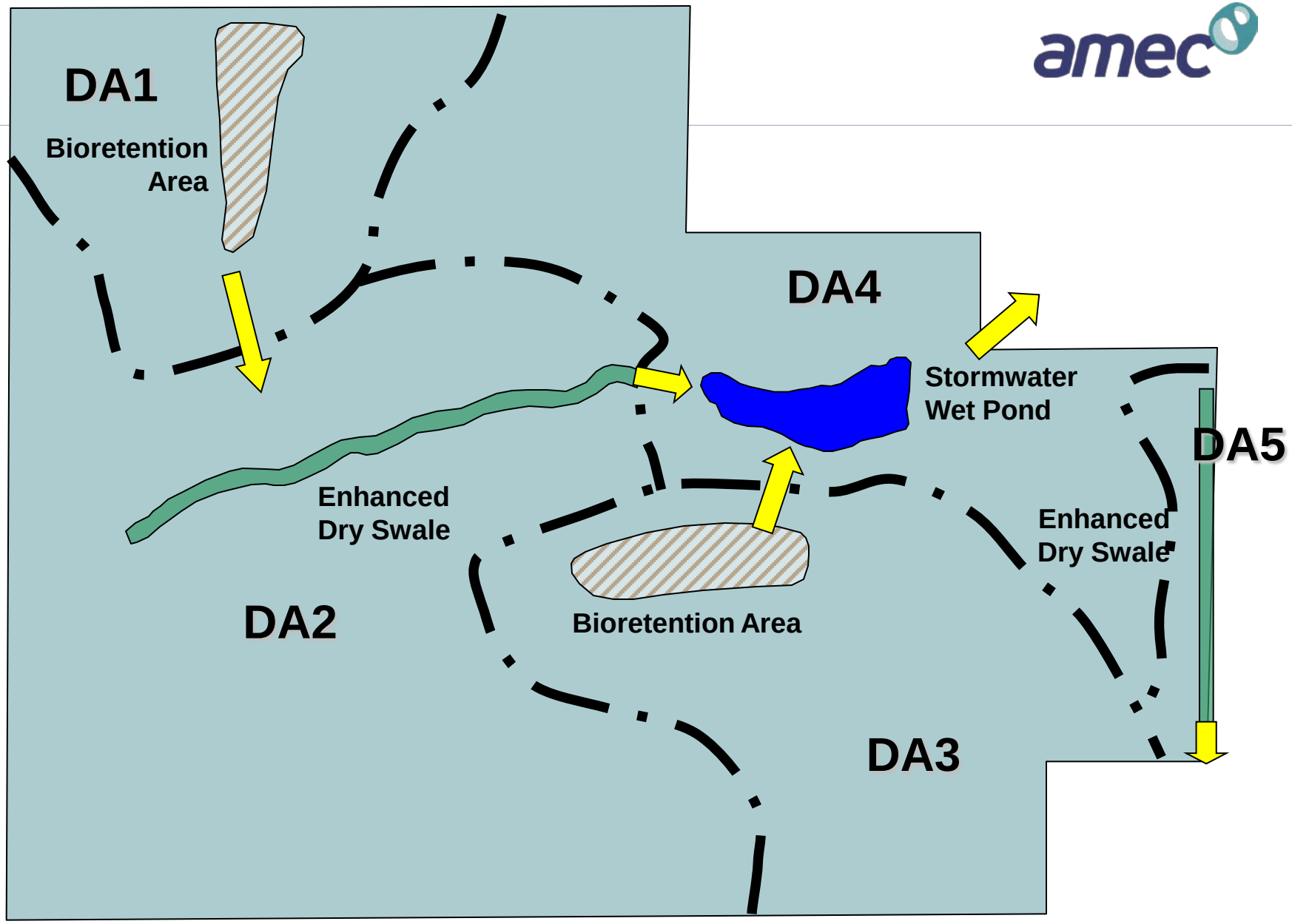
#2 Better Site Design & Controls



RESIDENTIAL SUBDIVISION -- BETTER SITE DESIGN



RESIDENTIAL SUBDIVISION -- BETTER SITE DESIGN


DA1
Bioretention Area
DA4
Stormwater Wet Pond
DA5
Enhanced Dry Swale
Enhanced Dry Swale
DA2
Bioretention Area
DA3

Same as last time…

Site Info:

Total Size = 83.41 acres
Number of Lots = 102 (+6)
Total Impervious Cover = 16.81 acres
- Rooftops/Driveways/Decks = 9.11 acres
- Streets (1.10 linear miles – 34’ width) = 6.28 acres
- Amenity Area (Clubhouse, Pool, Tennis Court, Parking) = 1.42 acres

Percent Impervious Cover = 20% (-5%)
Natural Conservation Area = 14.21 acres

Drainage Area 1 (DA1) = 10.07 acres

Impervious Area = 2.66 acres

Percent Impervious Cover = 26.4%

Natural Conservation Area = 0.33 acres

Structural Control: Bioretention Area

Drainage Area 2 (DA2) = 38.22 acres

Impervious Area = 7.98 acres

Percent Impervious Cover = 20.9%

Natural Conservation Area = 5.28 acres

Structural Control: Enhanced Dry Swale

Drainage Area 3 (DA3) = 14.47 acres

Impervious Area = 2.21 acres

Percent Impervious Cover = 15.2%

Natural Conservation Area = 3.88 acres

Structural Control: Bioretention Area

Drainage Area 4 (DA4) = 18.08 acres

Impervious Area = 3.86 acres

Percent Impervious Cover = 21.3%

Natural Conservation Area = 4.65 acres

Structural Control: Stormwater Pond

Drainage Area 5 (DA5) = 2.57 acres [previously DA2]

Impervious Area = 0.10 acres

Percent Impervious Cover = 3.9%

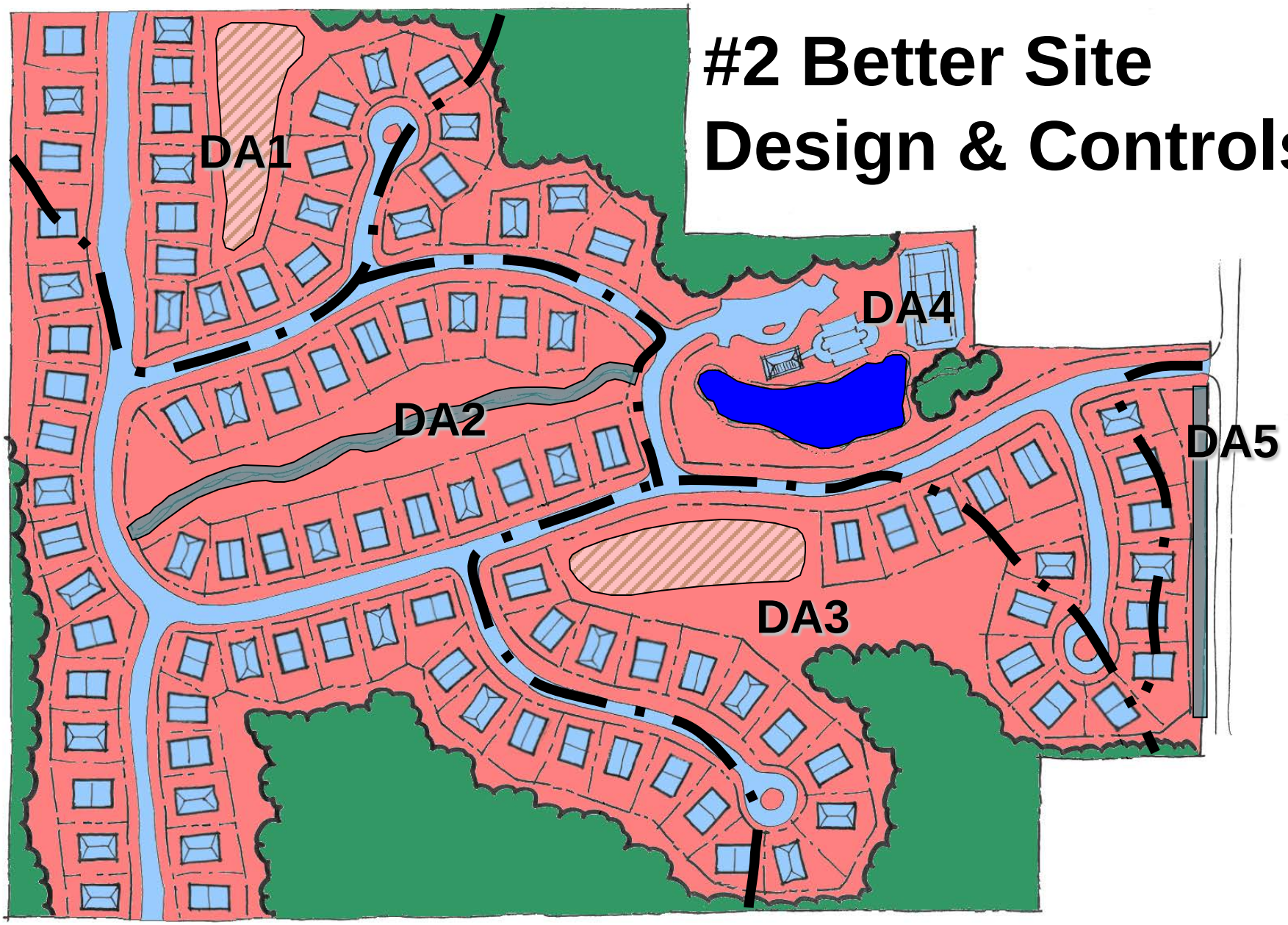
Natural Conservation Area = 0.07

Structural Control: Enhanced Dry Swale

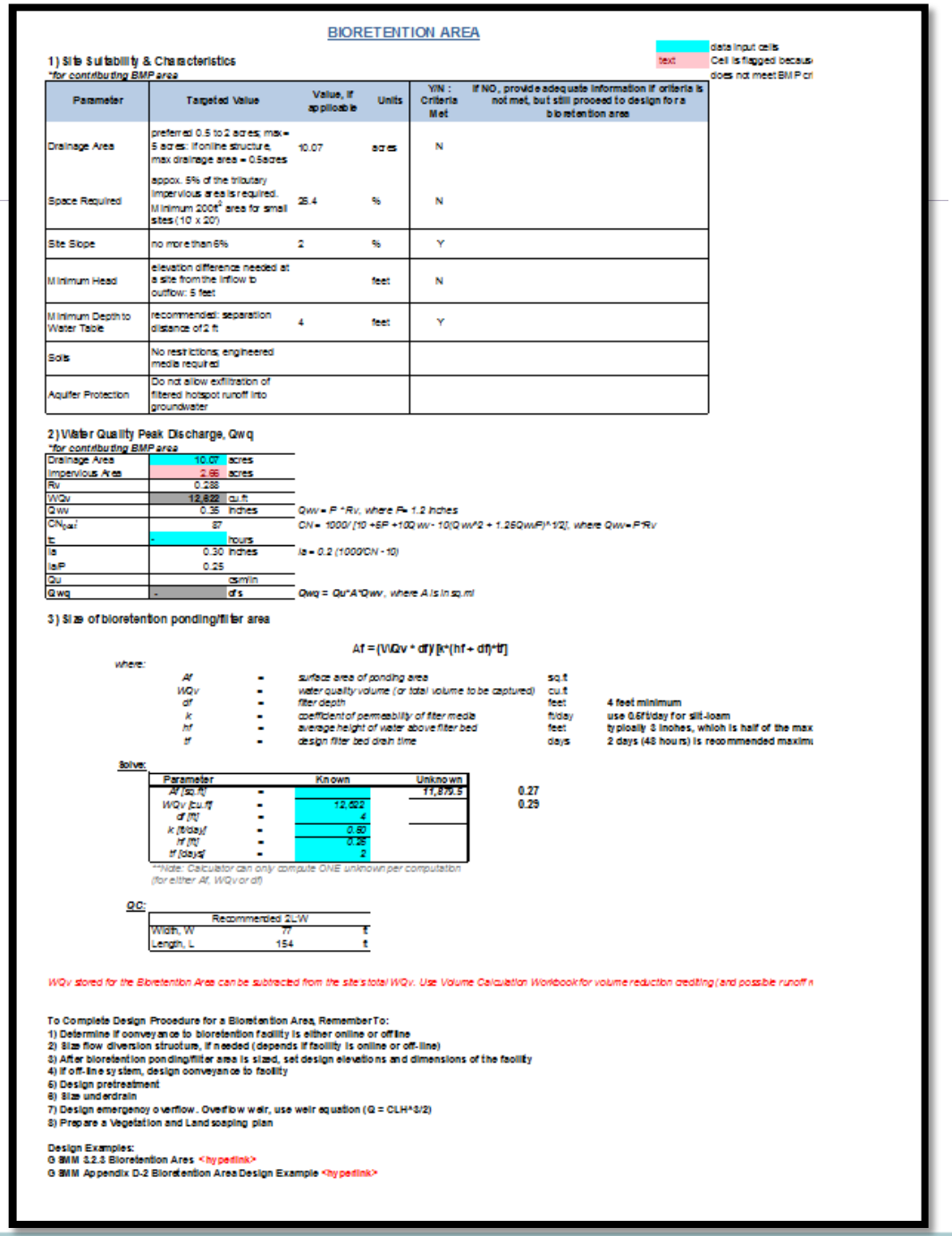
*Bioretention Areas were sized to treat each DA's (DA1 and DA3) WQv (procedure on following slide)

*Enhanced Dry Swale sized for 1660 linear feet in DA2 and for 1200 linear feet in DA5 (procedure on following slide)

#2 Better Site Design & Controls



RESIDENTIAL SUBDIVISION -- BETTER SITE DESIGN



BIORETENTION AREA

data input cells
text Cell is flagged because does not meet BMP cri

1) Site Suitability & Characteristics
*for contributing BMP area

Parameter	Targeted Value	Value, if applicable	Units	Y/N : Criteria Met	If NO, provide adequate information if criteria is not met, but still proceed to design for a bioretention area
Drainage Area	preferred 0.5 to 2 acres; max = 5 acres; if online structure, max drainage area = 0.5acres	10.07	acres	N	
Space Required	appox. 5% of the tributary impervious area is required. Minimum 200ft² area for small sites (10 x 20')	25.4	%	N	
Site Slope	no more than 6%	2	%	Y	
Minimum Head	elevation difference needed at a site from the inflow to outflow: 5 feet		feet	N	
Minimum Depth to Water Table	recommended: separation distance of 2 ft	4	feet	Y	
Soils	No restrictions; engineered media required				
Aquifer Protection	Do not allow exfiltration of filtered hotspot runoff into groundwater				

2) Water Quality Peak Discharge, Qwq
*for contributing BMP area

Drainage Area	10.07	acres	
Impervious Area	2.66	acres	
Rv	0.288		
WQv	12,822	cu.ft	
Qw	0.35	inches	Qw = P * Rv, where P= 1.2 inches
CN_{adj}	87		CN = 1000/ [10 +5P +10Qw - 10(Qw^2 + 1.25QwP)^1/2], where Qw=P*Rv
tc	-	hours	
Ia	0.30	inches	Ia = 0.2 (1000/CN - 10)
Ia/P	0.25		
Qu		cfs/in	
Qwq	-	cfs	Qwq = Qu*A*Qw, where A is in sq.mi

3) Size of bioretention ponding/filter area

$$Af = (WQv * df) / [k*(hf + df)*tf]$$

where:

Af	=	surface area of ponding area	sq.ft	
WQv	=	water quality volume (or total volume to be captured)	cu.ft	
df	=	filter depth	feet	4 feet minimum
k	=	coefficient of permeability of filter media	ft/day	use 0.5ft/day for silt-loam
hf	=	average height of water above filter bed	feet	typically 3 inches, which is half of the max
tf	=	design filter bed drain time	days	2 days (48 hours) is recommended maximu

Solve:

Parameter		Known	Unknown	
Af [sq.ft]	=		11,879.5	0.27
WQv [cu.ft]	=	12,822		0.29
df [ft]	=	4		
k [ft/day]	=	0.50		
hf [ft]	=	0.25		
tf [days]	=	2		

**Note: Calculator can only compute ONE unknown per computation (for either Af, WQv or df)

QC:

Recommended 2L:W		
Width, W	77	ft
Length, L	154	ft

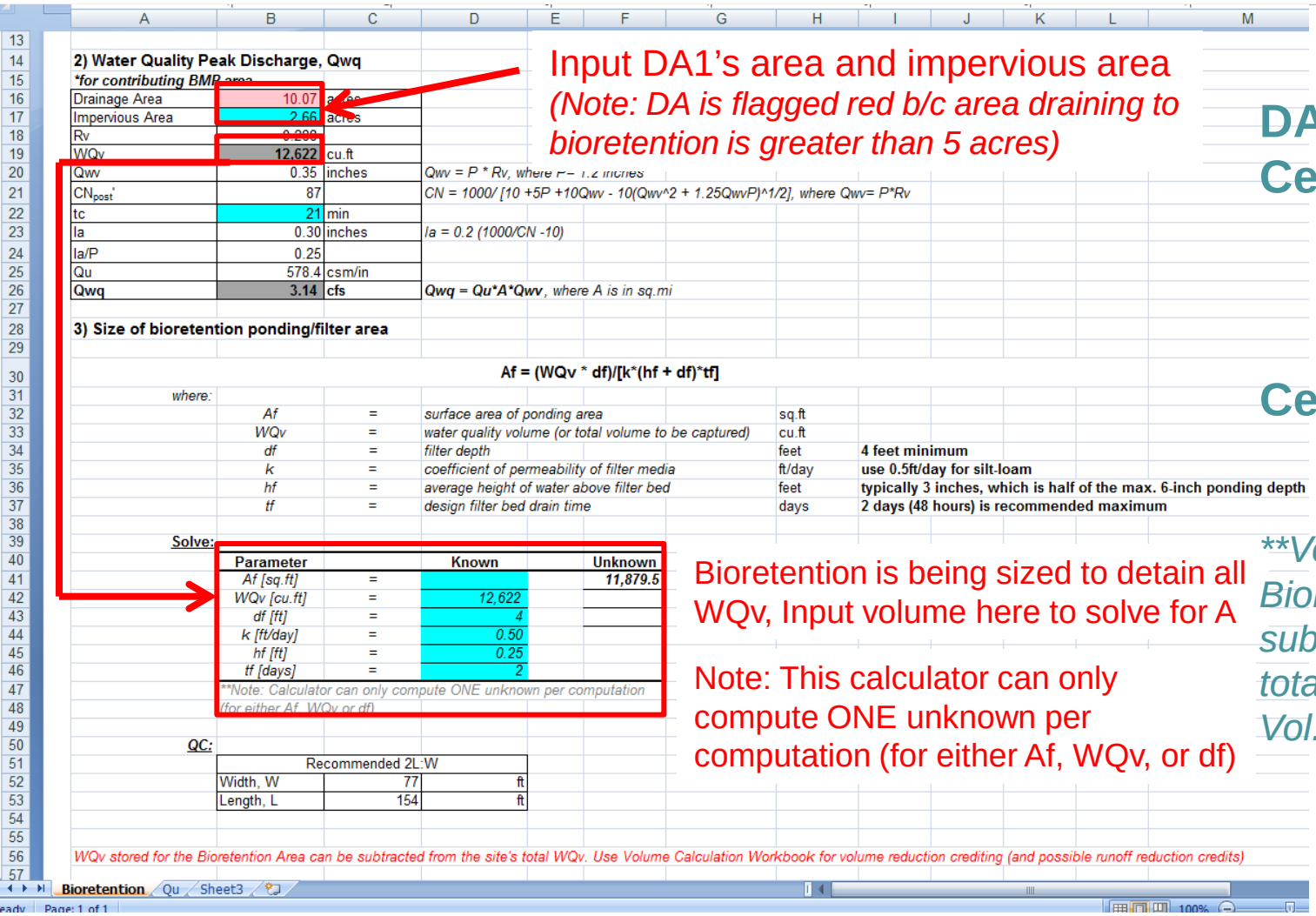
WQv stored for the Bioretention Area can be subtracted from the site's total WQv. Use Volume Calculation Workbook for volume reduction crediting (and possible runoff r

To Complete Design Procedure for a Bioretention Area, Remember To:
1) Determine if conveyance to bioretention facility is either online or offline
2) Size flow diversion structure, if needed (depends if facility is online or off-line)
3) After bioretention ponding/filter area is sized, set design elevations and dimensions of the facility
4) If off-line system, design conveyance to facility
5) Design pretreatment
6) Size underdrain
7) Design emergency overflow. Overflow weir, use weir equation (Q = CLH^3/2)
8) Prepare a Vegetation and Landscaping plan

Design Examples:
G BMM 3.2.3 Bioretention Area <hyperlink>
G BMM Appendix D-2 Bioretention Area Design Example <hyperlink>

CoC's Bioretention Area Sizing Tool

Sizing DA1's Bioretention Cell



2) Water Quality Peak Discharge, Qwq

**for contributing BMP area*

Drainage Area	10.07	acres
Impervious Area	2.66	acres
Rv	0.269	
WQv	12,622	cu.ft
Qwv	0.35	inches
CN_{post}	87	
tc	21	min
Ia	0.30	inches
Ia/P	0.25	
Qu	578.4	csm/in
Qwq	**3.14**	**cfs**

*Qwv = P * Rv, where P= 1.2 inches*

*CN = 1000/ [10 +5P +10Qwv - 10(Qwv^2 + 1.25QwvP)^1/2], where Qwv= P*Rv*

Ia = 0.2 (1000/CN -10)

***Qwq** = **Qu*A*Qwv**, where A is in sq.mi*

3) Size of bioretention ponding/filter area

Af = (WQv * df)/[k*(hf + df)*tf]

where:

Af	=	*surface area of ponding area*	sq.ft	
WQv	=	*water quality volume (or total volume to be captured)*	cu.ft	
df	=	*filter depth*	feet	**4 feet minimum**
k	=	*coefficient of permeability of filter media*	ft/day	**use 0.5ft/day for silt-loam**
hf	=	*average height of water above filter bed*	feet	**typically 3 inches, which is half of the max. 6-inch ponding depth**
tf	=	*design filter bed drain time*	days	**2 days (48 hours) is recommended maximum**

Solve:

Parameter		Known	Unknown
Af [sq.ft]	=		***11,879.5***
WQv [cu.ft]	=	*12,622*	
df [ft]	=	*4*	
k [ft/day]	=	*0.50*	
hf [ft]	=	*0.25*	
tf [days]	=	*2*	

***Note: Calculator can only compute ONE unknown per computation (for either Af, WQv or df)*

QC:

Recommended 2L:W		
Width, W	77	ft
Length, L	154	ft

WQv stored for the Bioretention Area can be subtracted from the site's total WQv. Use Volume Calculation Workbook for volume reduction crediting (and possible runoff reduction credits)

Bioretention Qu Sheet3

Input DA1's area and impervious area
(Note: DA is flagged red b/c area draining to bioretention is greater than 5 acres)

Bioretention is being sized to detain all WQv, Input volume here to solve for A

Note: This calculator can only compute ONE unknown per computation (for either Af, WQv, or df)

DA1 Bioretention Cell Area:
= 11,880 sq.ft
= 0.27 acres

Cell Volume:
= 12,622 cu.ft

***Volume stored in the Bioretention Area can be subtracted from site's total WQv. Use CoC's Vol. Calc. Spreadsheet*

Sizing DA3's Bioretention Cell

2) Water Quality Peak Discharge, Qwq

for contributing BMP area

Drainage Area	14.47	acres	
Impervious Area	2.21	acres	
Rv	0.167		
WQv	11,816	cu.ft	
Qwv	0.22	inches	*Qwv = P * Rv, where P= 1.2 inches*
CN_{post}	83		*CN = 1000/ [10 +5P +10Qwv - 10(Qwv^2 + 1.25QwvP)^1/2], where Qwv= P*Rv*
tc	34.4	min	
Ia	0.41	inches	*Ia = 0.2 (1000/CN -10)*
Ia/P	0.34		
Qu	406.4	csm/in	
Qwq	**2.07**	**cfs**	***Qwq = Qu*A*Qwv**, where A is in sq.mi*

Input DA3's area and impervious area
(Note: DA is flagged red b/c area draining to bioretention is greater than 5 acres)

3) Size of bioretention ponding/filter area

Af = (WQv * df)/[k*(hf + df)*tf]

where:

Af	=	*surface area of ponding area*	sq.ft	
WQv	=	*water quality volume (or total volume to be captured)*	cu.ft	
df	=	*filter depth*	feet	**4 feet minimum**
k	=	*coefficient of permeability of filter media*	ft/day	**use 0.5ft/day for silt-loam**
hf	=	*average height of water above filter bed*	feet	**typically 3 inches, which is half of the max. 6-inch ponding depth**
tf	=	*design filter bed drain time*	days	**2 days (48 hours) is recommended maximum**

Solve:

Parameter		Known	Unknown
Af [sq.ft]	=		***11,120.9***
WQv [cu.ft]	=	*11,816*	
df [ft]	=	*4*	
k [ft/day]	=	*0.50*	
hf [ft]	=	*0.25*	
tf [days]	=	*2*	

***Note: Calculator can only compute ONE unknown per computation (for either Af, WQv or df)*

Bioretention is being sized to detain all WQv, Input volume here to solve for A

Note: This calculator can only compute ONE unknown per computation (for either Af, WQv, or df)

QC:

Recommended 2L:W		
Width, W	74	ft
Length, L	148	ft

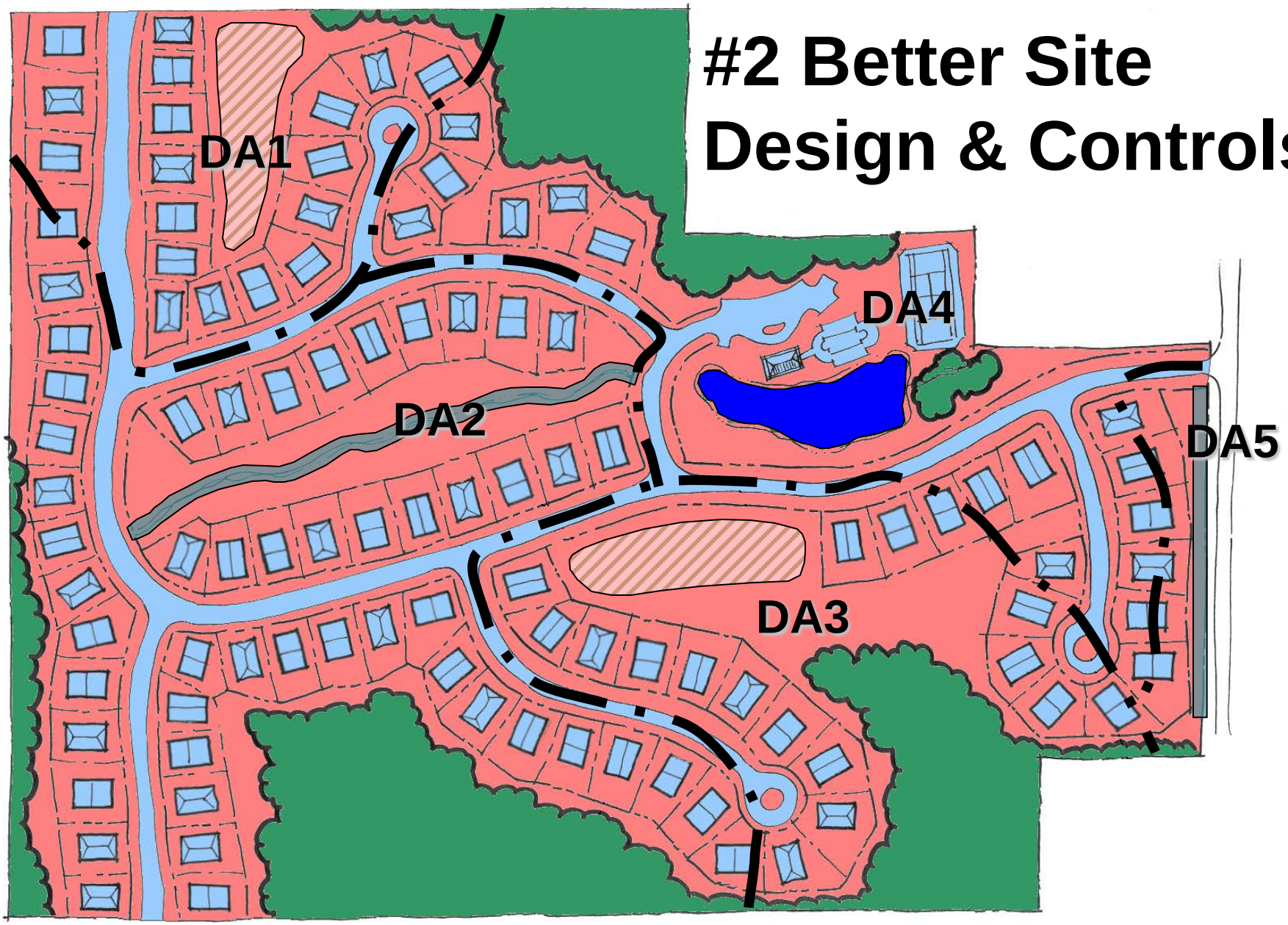
WQv stored for the Bioretention Area can be subtracted from the site's total WQv. Use Volume Calculation Workbook for volume reduction crediting (and possible runoff reduction credits)

DA3 Bioretention Cell Area:
= 11,120 sq.ft
= 0.26 acres

Cell Volume:
= 11,816 cu.ft

***Volume stored in the Bioretention Area can be subtracted from site's total WQv. Use CoC's Vol. Calc. Spreadsheet*

#2 Better Site Design & Controls



RESIDENTIAL SUBDIVISION -- BETTER SITE DESIGN

CoC's Enhanced Dry Swale Sizing Tool

ENHANCED DRY SWALE

data input cells
text Cell is flagged because it does not meet BMP criteria

1) Site Suitability & Characteristics

**for contributing BMP area*

Parameter	Criteria	Value, if applicable	Units	Y/N : Criteria Met	If NO, provide adequate information if criteria is not met, but still proceed to design for infiltration trench
Drainage Area	Max. 5 acres	5	acres	Y	
Space Required	~10 to 20% of the tributary impervious area		%		
Site Slope	typically no more than 4% channel slope. Recommended 1-2%	2	%	Y	
Minimum Head	elevation difference needed at a site from the inflow to outflow: 3 to 6 ft		ft		
Minimum Depth to Water Table	recommended: separation distance of 2 ft between bottom of a dry swale and elev. of seasonally high water table	4	ft		
Soils	Engineered media for dry swale: infiltration rate of at least 1.0 ft/day, max of 1.5 ft/day		ft/day		
Infiltration	Max ponding time = 48 hours (24 hours is more desirable)		hours	Y	
Aquifer Protection	Exfiltration should not be allowed for hotspots				
Inlet to Swale	Inlets to enhanced swales must be provided with energy dissipators, such as riprap				
Pretreatment	Typically provided by a sediment forebay at the inlet. Pretreatment Vol. should be equal to 0.1 inches per impervious acre (this storage is usually obtained by check dams at pipe inlets and/or driveway crossings)				
Pretreatment	Pea gravel diaphragm and gentle side slopes should be provided along the top channels for pretreatment and lateral sheet flow				
Site Runoff	Swales systems that receive direct concentrated runoff may have a 6" drop to a pea gravel diaphragm flow spreader at the upstream end of the control				

2) Water Quality Peak Discharge, Qwq

**for contributing BMP area*

Drainage Area	38	acres
Impervious Area	8.0	acres
Rv	0.238	
WQv	39,609	cu.ft
Qw	0.29	inches
CN_{bar}	85	
tc	5	hours
Ia	0.353	inches
Ia/P	0.294	
Qu		csm/in
Qwq	#VALUE!	cfs

Qw = P * Rv, where P= 1.2 inches

CN = 1000/ [10 +5P + 10Qw - 10(Qw^2 + 1.25QwP)^1/2], where Qw= P*Rv

Ia = 0.2 (1000/CN - 10)

Qwq = Qu*A*Qw , where A is in sq.mi

3) Size of the dry swale

Existing Ground Elev.	922	feet
Seasonally High Water Table Elev.	888	feet
Separation	4	feet
Max. WQv ponding depth	18	inches
Proposed channel Length	1660	feet
Outlet control Elev.	889	feet
Slope	1.99	%
Bottom width, b	6	feet
Average ponding depth, d	9	inches
Max ponding depth, D	18	inches
Channel Side slopes, Z	4	ft/ft
Top width, t	12	feet
Max top width, T	18	feet
Cross Sectional Area, A	6.75	sq.ft
Swale Storage Volume	11,206	cu.ft
WQv	39,609	cu.ft

no more than 4% slope

2-6'

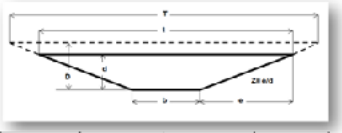
~12"

no more than 18"

recommend 4:1

If desired, re-size swale to hold all WQv

Trapezoidal Cross Sectional Shape



Cross Sectional Area, A	Wetted Perimeter, P	Hydraulic Radius, R = A/P	Top Width
$bd + Zd^2$	$b + 2d\sqrt{Z^2+1}$	$\frac{bd+Zd^2}{b+2d\sqrt{Z^2+1}}$	$t = b + 2dZ$ $T = b + 2DZ$

Page 1

4) Calculate number of check dams to detain WQv

Swale Length	1660	feet	
Swale Slope	0.0199	ft/ft	
Maximum Depth, D	18	inches	no more than 18"
Check Dam Spacing	75	feet	
Number of Check Dams	22	per check dam spacing length	

WQv stored for the dry swale can be subtracted from the site's total WQv. Use Volume Calculation Workbook for volume reduction crediting (and possible runoff reduction credits)

To Complete Design Procedure for an Enhanced Dry Swale, Remember To:

1) Calculate drawdown time (k= 1.5ft/day for dry swale)
2) Depending on Swale's drainage area, Check 10yr (if <40 acres) or 50 yr (if >40 acres) velocity erosion potential and freeboard (see CoC Drainage Ordinance for greater detail)
3) Overflow wier (Q= CLH^3/2)
4) Design low flow orifice at downstream headwall. Area of orfice from orifice eqn Q=CA(2gh)^0.5
5) Design inlets, sediment forebays, outlet structures (underdrain systems), maintenance access, and safety features
6) Prepare a Vegetation and Landscaping plan

Design Examples:

GBMM 3.2.8 Enhanced Swales <hyperlink>

GBMM Appendix D-5 Enhance Swale Design Example <hyperlink>

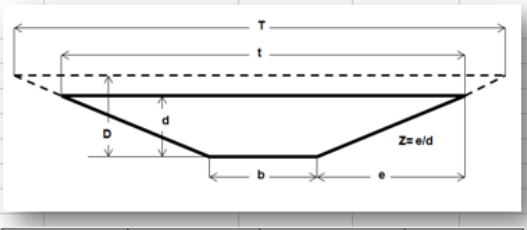
Page 2

Sizing DA2's Enhanced Dry Swale

Input DA2's area and impervious area
(Note: DA is flagged red b/c area draining to swale is greater than 5 acres)

	A	B	C	D
19				
20	**2) Water Quality Peak Discharge, Qwq**			
21	***for contributing BMP area**			
22	Drainage Area	38.22	acres	
23	Impervious Area	7.98	acres	
24	Rv	0.238		
25	WQv	39,609	cu.ft	
26	Qwv	0.29	inches	*Qwv = P * Rv, where P= 1.2 inches*
27	CN_{post}'	85		*CN = 1000/ [10 +5P +10Qwv - 10(Qwv^2 + 1.25QwvP)^1/2], where Qwv= P*Rv*
28	tc	47.4	min	
29	Ia	0.353	inches	*Ia = 0.2 (1000/CN -10)*
30	Ia/P	0.294		
31	Qu	354.4	csm/in	
32	**Qwq**	**6.04**	**cfs**	***Qwq = Qu*A*Qwv**, where A is in sq.mi*
33				
34	**3) Size of the dry swale**			
35	Existing Ground Elev.	922	feet	
36	Seasonally High Water Table Elev.	883	feet	
37	Separation	6	feet	min. 2 ft.
38	Max. WQv ponding depth	18	inches	no more than 18"
39	Proposed channel Length	1660	feet	
40	Outlet control Elev.	889	feet	
41	Slope	1.99	%	no more than 4% slope
42	Bottom width, b	6	feet	2-8'
43	Average ponding depth, d	9	inches	~12"
44	Max ponding depth, D	18	inches	
45	Channel Side slopes, Z	4	ft/ft	recommend 4:1
46	Top width, t	12	feet	
47	Max top width, T	18	feet	
48	Cross Sectional Area, A	6.75	sq.ft	
49	**Swale Storage Volume**	**11,205**	**cu.ft**	
50	WQv	39,609	cu.ft	
51		***If desired, resize swale to hold all WQv***		
52				
53				
54	**4) Calculate number of check dams to detain WQv**			
55	Swale Length	1660	feet	
56	Swale Slope	0.0199	ft/ft	
57	Maximum Depth, D	18	inches	no more than 18"
58	Check Dam Spacing	75	feet	
59	Number of Check Dams	22	per check dam spacing length	
60				
61				
62	*WQv stored for the dry swale can be subtracted from the site's total WQv. Use Volume Calculation Workbook for volume reduction crediting (and possible runoff reduction credits)*			

Trapezoidal Cross Sectional Shape



Cross Sectional Area, A	Wetted Perimeter, P	Hydraulic Radius, R = A/P	Top Width
$bd + Zd^2$	$b + 2d\sqrt{Z^2 + 1}$	$\frac{bd + Zd^2}{b + 2d\sqrt{Z^2 + 1}}$	$t = b + 2dZ$ $T = b + 2DZ$

Dry Enhanced Swale was sized for a proposed channel length of 1660' in DA2.

Therefore, swale storage does not hold the required WQv.
If desired and applicable, can resize swale to hold all WQv

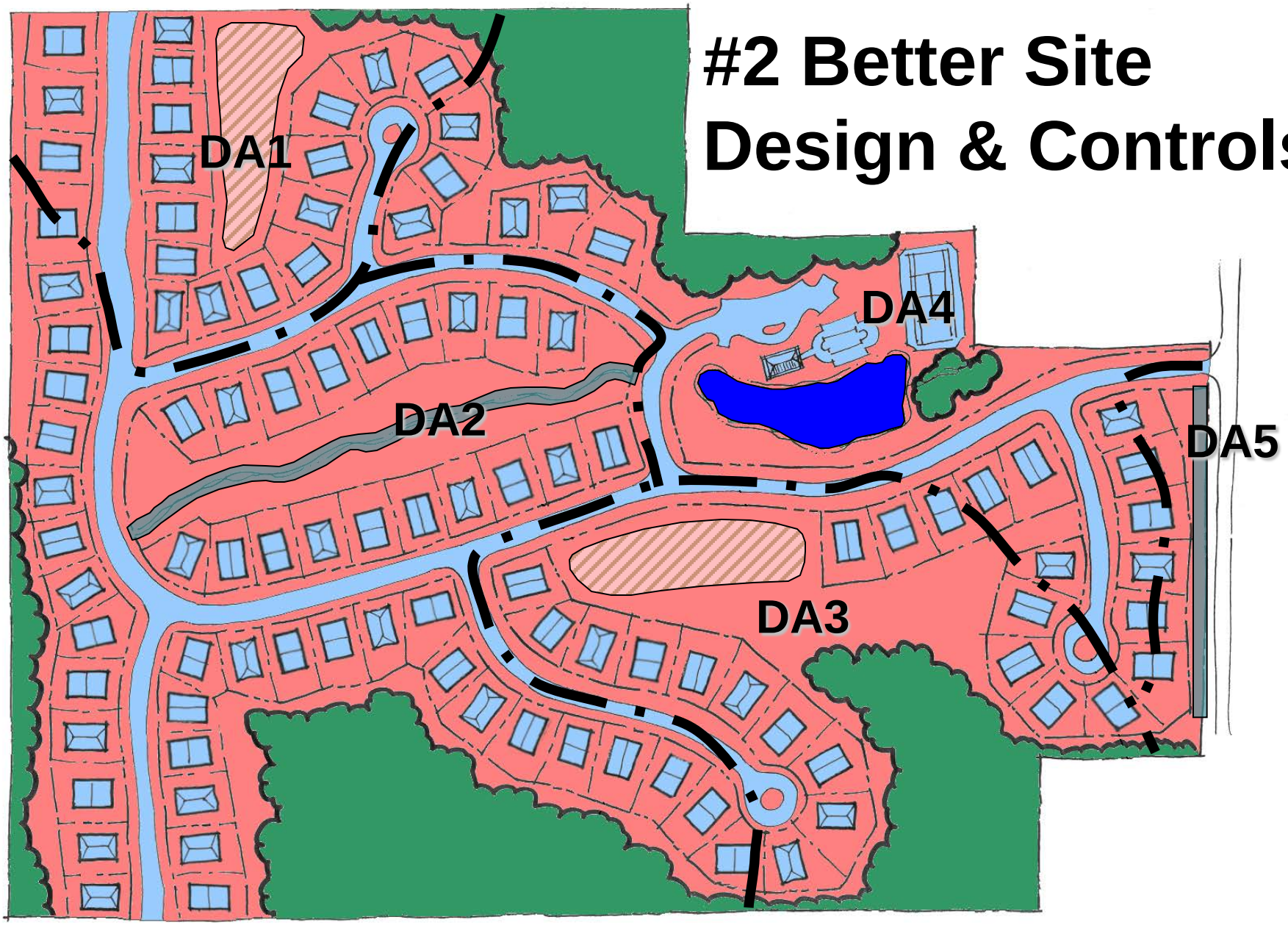
DA2's WQv = 39,609 cu.ft

Swale Storage Vol. = 11,205 cu.ft

***Volume stored in the Dry Swale can be subtracted from site's total WQv. Use CoC's Vol. Calc. Spreadsheet*

Design Tool calculates swale's number of check dams needed

#2 Better Site Design & Controls



RESIDENTIAL SUBDIVISION -- BETTER SITE DESIGN

#2 BSD & BMPs 'DA1 thru DA4'

Project Name:	Residential Example: #2 BSD & BMPs
Project Number:	-
Date:	7/24/2013
Site Location:	City of Columbia, SC
Drainage Area:	DA1, DA2, DA3 & DA4

data input cells

Site Hydrology

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Pre-Development	80.84	0	74	73.1
Post-Development	80.84	16.71	82	57.4

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Pre-Development	N/A	41.2	52.3	117.0	140.5	192.9
Post-Development		77.4	90.4	172.2	202.1	267.4

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Pre-Development	-	-	-	-	-	-
Post-Development	83,116	301,350	141,814	234,530	268,871	341,933

Better Site Design

Credited Practice	Area Draining to BMP [acres]	WQv Credit [cf]
Natural Area Conservation	14.14	14,538
Stream Buffer		-
Vegetated Channel		-
Overland Flow Filtration/Infiltration Zones		-
Environmentally Sensitive Large Lot		-
Total WQv stored with BSD practices [cf]		14,538

Applicable BSD Credits to Adjust Site's CN:		
Conservation Areas	14,538	cf
Stream Buffers	-	cf
Infiltration Zones	-	cf
Adjustment to Runoff Reduction Volume (BSD)	14,538	cf
Adjusted CN'$_{post}$	81	

* Adjusted CN'post is based off runoff reduction from the 100-yr event (most conservative)

Pre vs. Post Drainage Area Summary

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Post-Development	80.84	16.71	82	57.4
Post-Dev. with BSD	80.84	16.71	81	57.4

Pre vs. Post Peak Flow Summary

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Post-Development	N/A	77.4	90.4	172.2	202.1	267.4
Post-Dev. with BSD		74.0	86.8	167.5	197.2	262.0

Pre vs. Post Volume Summary

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Post-Development	83,116	301,350	141,814	234,530	268,871	341,933
Post-Dev. with BSD	68,578	288,379	131,822	221,839	255,404	327,069
% Reduction with BSD	17.49	4.30	7.05	5.41	5.01	4.35

Instructions | Input_Output | Pre | Post | BSD_Credits | BSD_Credits (form

Input Pre-Development parameters

Input Post-Development parameters

Input Natural Conservation Areas for DA1 thru DA4

Enough infiltration from cons. areas to lower site's CN

Summary of Pre Dev vs. Post Dev with BSD:

- Peak Flows
- Storage Volumes

% Volume Reduction Utilizing BSD Practices:

	WQv	CPv	2yr	10yr	25yr	100yr
% Red. w. BSD	17.49	4.30	7.05	5.41	5.01	4.35

#2 BSD & BMPs 'DA1 thru DA4'

Structural BMPs

Credited Practices in CoC BMP Manual	WQv Credit [cf]
Bioretention Area	24,438
Infiltration Trench	
Grass Filter Strip	
Dry Swale	11,205
Pervious Surfaces	

***Retrieve WQ Volumes from BMP Design Aid Worksheets*

Applicable BSD Credits to Adjust Site's CN:		
Conservation Areas	14,538	cf
Stream Buffers	-	cf
Infiltration Zones	-	cf

Credited Practices for Other Accepted Structural BMPs	WQv Credit [cf]
Wetlands	
Wet Swale	
Gravity Separator	
Commercial SW Controls	
Multi-Purpose Detention Area	
Underground Detention	
Rain Garden/Cistern	
***Provide Supporting Calcultions for WQ Volumes*	
Total WQv stored with BMPs [cf]	35,643

Applicable BMP Credits to Adjust Site's CN:		
Bioretention	24,438	cf
Infiltration Trench	-	cf
Porous Surfaces	-	cf
Dry Swale	11,205	cf
Rain Garden/Cistern	-	cf
Runoff Reduction Vol. Adjustment (BSD + BMP)	50,181	cf
Adjusted CN''_{post}	80	

* Adjusted CN''_{post} is based off runoff reduction from the 100-yr event (most conservative)

Pre vs. Post Drainage Area Summary

	Total Drainage Area [acres]	Imperv. Area [acres]	CN	tc [min]
Post-Development	80.84	16.71	82	57.4
Post-Dev. with BSD	80.84	16.71	81	57.4
Post-Dev. with BSD & BMPs	80.84	16.71	80	57.4

Pre vs. Post Peak Flow Summary

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Post-Development	N/A	77.4	90.4	172.2	202.1	267.4
Post-Dev. with BSD		74.0	86.8	167.5	197.2	262.0
Post-Dev. with BSD & BMPs		70.8	83.3	162.9	192.3	256.6

Pre vs. Post Volume Summary

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Post-Development	83,116	301,350	141,814	234,530	268,871	341,933
Post-Dev. with BSD	68,578	288,379	131,822	221,839	255,404	327,069
Post-Dev. with BSD & BMPs	32,935	275,753	122,183	209,238	241,966	312,129
% Reduction w. BSD & BMPs	60.37	8.49	13.84	10.78	10.01	8.72

Instructions | Input_Output | Pre | Post | BSD_Credits | BSD_Credits (form

Input DA1 and DA3's Bioretenion Cells' Storage Volumes (from CoC's Sizing Tools)

Input DA2's Dry Enhanced Swale Storage Volume (from CoC's Sizing Tools)

Enough infiltration from bioretention cell to lower site's CN from 82 to 80

Summary of Pre Dev vs.
Post Dev with BSD vs.
Post Dev with BSD & BMPs:

- Peak Flows
- Storage Volumes

% Volume Reduction Utilizing BSD & BMPs:

	WQv	CPv	2yr	10yr	25yr	100yr
% Red. w. BSD & BMPs	60.37	8.5	13.8	10.8	10.0	8.7

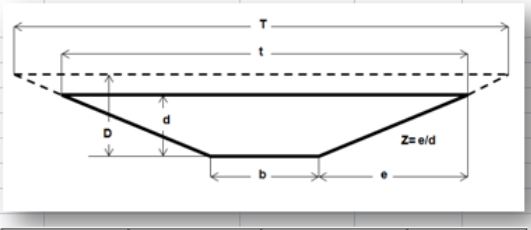
Sizing DA5's Enhanced Dry Swale

2) Water Quality Peak Discharge, Qwq				
***for contributing BMP area**				
Drainage Area	2.57	acres		
Impervious Area	0.10	acres		
Rv	0.085			
WQv	952	cu.ft		
Qwv	0.10	inches	*Qwv = P * Rv, where P= 1.2 inches*	
CN_{post}	77		*CN = 1000/ [10 +5P +10Qwv - 10(Qwv^2 + 1.25QwvP)^1/2], where Qwv= P*Rv*	
tc	27.7	min		
Ia	0.597	inches	*Ia = 0.2 (1000/CN -10)*	
Ia/P	0.498			
Qu	302.8	csm/in		
Qwq	**0.12**	**cfs**	***Qwq** = Qu*A*Qwv, where A is in sq.mi*	
3) Size of the dry swale				
Existing Ground Elev.	910	feet		
Seasonally High Water Table Elev.	883	feet		
Separation	6	feet	min. 2 ft.	
Max. WQv ponding depth	18	inches	no more than 18"	
Proposed channel Length	1200	feet		
Outlet control Elev.	889	feet		
Slope	1.75	%	no more than 4% slope	
Bottom width, b	2	feet	2-8'	
Average ponding depth, d	9	inches	~12"	
Max ponding depth, D	18	inches		
Channel Side slopes, Z	2	ft/ft	recommend 4:1	
Top width, t	5	feet		
Max top width, T	8	feet		
Cross Sectional Area, A	2.63	sq.ft		
Swale Storage Volume	**3,150**	**cu.ft**		
WQv	952	cu.ft		
	Swale V is greater than WQv -->Good			
4) Calculate number of check dams to detain WQv				
Swale Length	1200	feet		
Swale Slope	0.0175	ft/ft		
Maximum Depth, D	18	inches	no more than 18"	
Check Dam Spacing	86	feet		
Number of Check Dams	14	per check dam spacing length		

WQv stored for the dry swale can be subtracted from the site's total WQv. Use Volume Calculation Workbook for volume reduction crediting (and possible runoff reduction credits)

Input DA5's area and impervious area

Trapezoidal Cross Sectional Shape



Cross Sectional Area, A	Wetted Perimeter, P	Hydraulic Radius, R = A/P	Top Width
$bd + Zd^2$	$b + 2d\sqrt{Z^2 + 1}$	$\frac{bd + Zd^2}{b + 2d\sqrt{Z^2 + 1}}$	$t = b + 2dZ$ $T = b + 2DZ$

Dry Enhanced Swale was sized for a proposed channel length of 1200' in DA5.

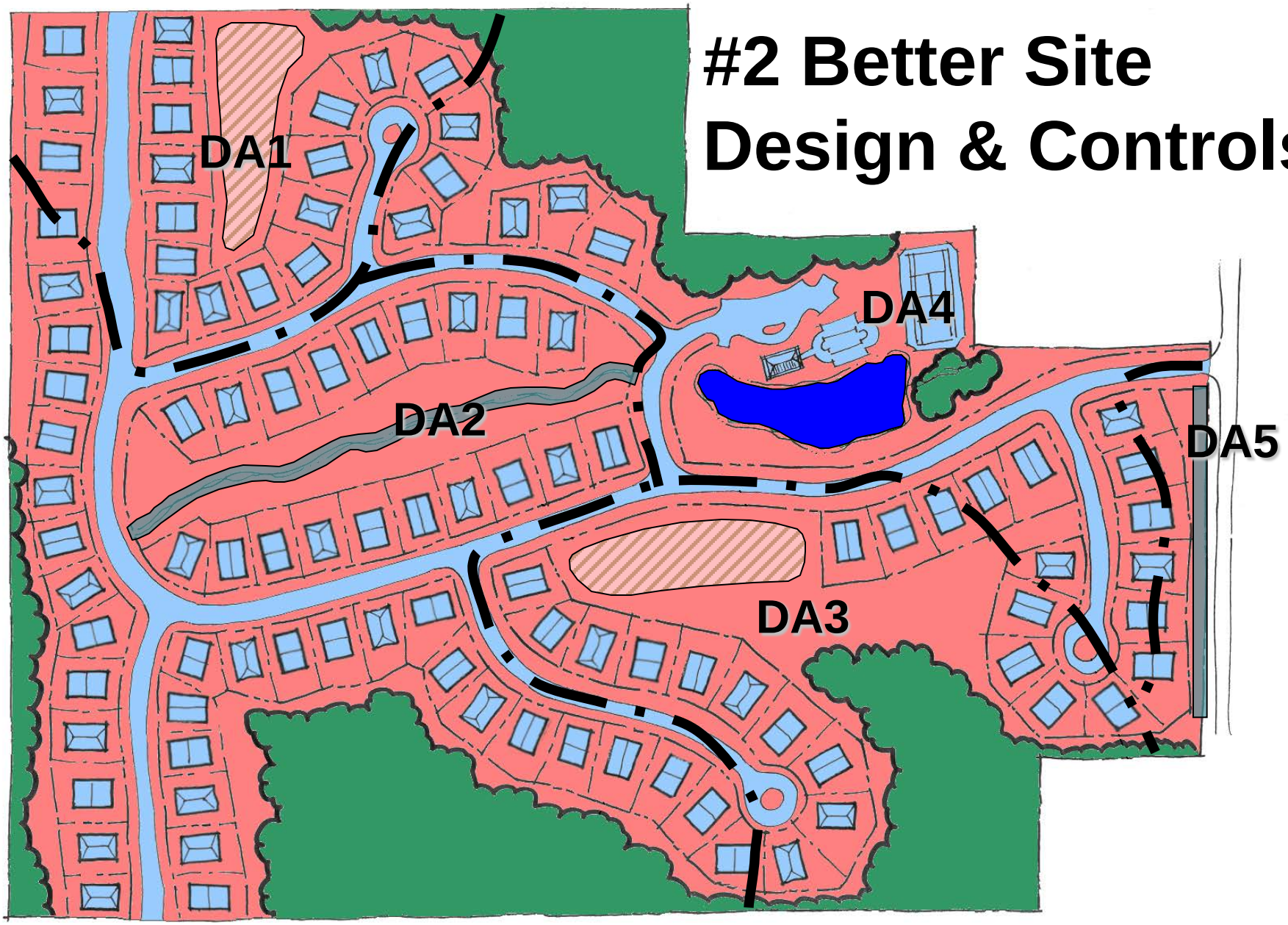
Swale storage volume is designed to address all of the WQv and more.

DA5's WQv = 952 cu.ft

Swale Storage Vol. = 3,150 cu.ft

***Volume stored in the Dry Swale can be subtracted from site's total WQv. Use CoC's Vol. Calc. Spreadsheet*

#2 Better Site Design & Controls



RESIDENTIAL SUBDIVISION -- BETTER SITE DESIGN

#2 BSD & BMPs 'DA5'

Project Name:	Residential Example: #2 BSD & BMPs
Project Number:	-
Date:	7/24/2013
Site Location:	City of Columbia, SC
Drainage Area:	DA5

data input cells

Site Hydrology

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Pre-Development	2.57	0	74	32.1
Post-Development	2.57	0.1	79	27.7

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Pre-Development	N/A	2.1	2.7	6.0	7.2	9.9
Post-Development		3.1	3.8	7.6	8.9	12.0

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Pre-Development	-	-	-	-	-	-
Post-Development	951	8,659	3,316	5,637	6,514	8,385

Better Site Design

Credited Practice	Area Draining to BMP [acres]	WQv Credit [cf]
Natural Area Conservation	0.07	26
Stream Buffer		-
Vegetated Channel		-
Overland Flow Filtration/Infiltration Zones		-
Environmentally Sensitive Large Lot		-
Total WQv stored with BSD practices [cf]		26

Applicable BSD Credits to Adjust Site's CN:		
Conservation Areas	26	cf
Stream Buffers	-	cf
Infiltration Zones	-	cf
Adjustment to Runoff Reduction Volume (BSD)	26	cf
Adjusted CN'_{post}	79	

* Adjusted CN'post is based off runoff reduction from the 100-yr event (most conservative)

Pre vs. Post Drainage Area Summary

	Drainage Area [ac]	Imperv. Area [ac]	CN	tc [min]
Post-Development	2.57	0.1	79	27.7
Post-Dev. with BSD	2.57	0.1	79	27.7

Pre vs. Post Peak Flow Summary

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Post-Development	N/A	3.1	3.8	7.6	8.9	12.0
Post-Dev. with BSD		3.1	3.8	7.6	8.9	12.0

Pre vs. Post Volume Summary

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Post-Development	951	8,659	3,316	5,637	6,514	8,385
Post-Dev. with BSD	925	8,659	3,316	5,637	6,514	8,385
% Reduction with BSD	2.73	-	-	-	-	-

Instructions | Input_Output | Pre | Post | BSD_Credits | BSD_Credits (format 2) | Post_BSD

Input Pre-Development parameters

Input Post-Development parameters

Input Natural Conservation Area for DA5

Not enough infiltration from cons. areas to lower site's CN

Summary of Pre Dev vs. Post Dev with BSD:

- Peak flows
- Storage Volumes

% Volume Reduction Utilizing BSD Practices:

	WQv	CPv	2yr	10yr	25yr	100yr
% Red. w. BSD	2.73	-	-	-	-	-

#2 BSD & BMPs 'DA5'

Structural BMPs

Credited Practices in CoC BMP Manual	WQv Credit [cf]
Bioretention Area	
Infiltration Trench	
Grass Filter Strip	
Dry Swale	3,150
Pervious Surfaces	

***Retrieve WQ Volumes from BMP Design Aid Worksheets*

Credited Practices for Other Accepted Structural BMPs	WQv Credit [cf]
Wetlands	
Wet Swale	
Gravity Separator	
Commercial SW Controls	
Multi-Purpose Detention Area	
Underground Detention	
Rain Garden/Cistern	

***Provide Supporting Calcultions for WQ Volumes*

Total WQv stored with BMPs [cf]	3,150

Applicable BSD Credits to Adjust Site's CN:		
Conservation Areas	26	cf
Stream Buffers	-	cf
Infiltration Zones	-	cf

Applicable BMP Credits to Adjust Site's CN:		
Bioretention	-	cf
Infiltration Trench	-	cf
Porous Surfaces	-	cf
Dry Swale	3,150	cf
Rain Garden/Cistern	-	cf
Runoff Reduction Vol. Adjustment (BSD + BMP)	3,176	cf
Adjusted $CN"_{post}$	76	

* Adjusted CN"post is based off runoff reduction from the 100-yr event (most conservative)

Pre vs. Post Drainage Area Summary

	Total Drainage Area [acres]	Imperv. Area [acres]	CN	tc [min]
Post-Development	2.57	0.1	79	27.7
Post-Dev. with BSD	2.57	0.1	79	27.7
Post-Dev. with BSD & BMPs	2.57	0.1	76	27.7

Pre vs. Post Peak Flow Summary

	Qpw [cfs]	1yr [cfs]	2yr [cfs]	10yr	25yr [cfs]	100yr
Post-Development	N/A	3.1	3.8	7.6	8.9	12.0
Post-Dev. with BSD		3.1	3.8	7.6	8.9	12.0
Post-Dev. with BSD & BMPs		2.7	3.2	6.9	8.2	11.2

Pre vs. Post Volume Summary

	WQv [cf]	CPv [cf]	2yr [cf]	10yr [cf]	25yr [cf]	100yr [cf]
Post-Development	951	8,659	3,316	5,637	6,514	8,385
Post-Dev. with BSD	925	8,659	3,316	5,637	6,514	8,385
Post-Dev. with BSD & BMPs	0	7,510	2,253	4,353	5,121	6,797
% Reduction w. BSD & BMPs	100.00	13.26	32.06	22.78	21.38	18.94

Input DA5's Dry Enhanced Swale Storage Volume (from CoC's Sizing Tools)

Enough infiltration from bioretention cell to lower site's CN from 79 to 76

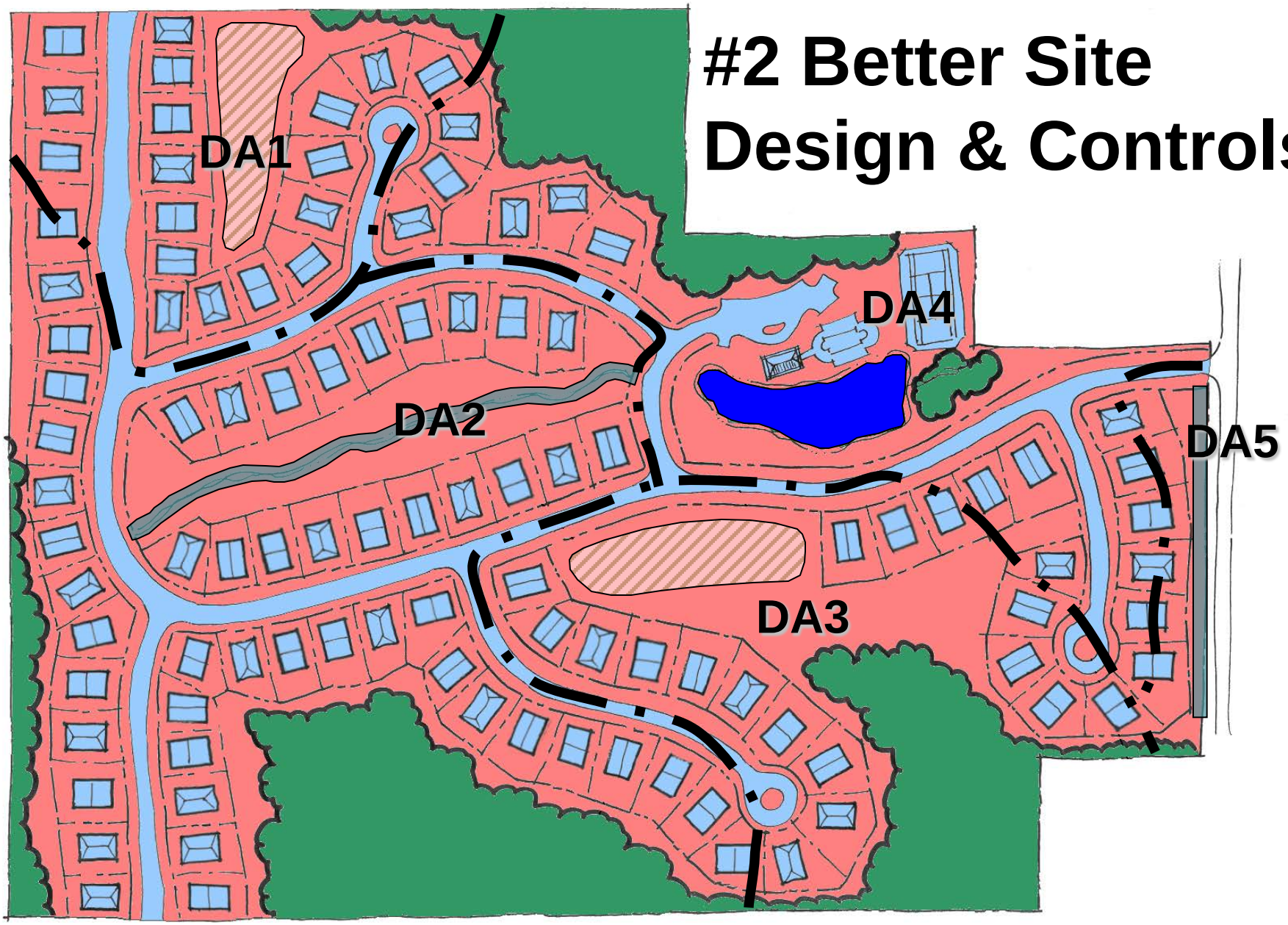
Summary of Pre Dev vs. Post Dev with BSD vs. Post Dev with BSD & BMPs:

- Peak flows
- Storage Volumes

% Volume Reduction Utilizing BSD & BMPs:

	WQv	CPv	2yr	10yr	25yr	100yr
% Red. w. BSD & BMPs	100	13.26	32.1	22.8	21.4	18.9

#2 Better Site Design & Controls



RESIDENTIAL SUBDIVISION -- BETTER SITE DESIGN

BMP Maintenance Agreements

Can we please have your input???

Columbia Stormwater Management
CITY OF COLUMBIA, SC

City of Columbia
Stormwater Management
Bioretention Maintenance Plan

Background

The bioretention cell (s) located on the _____ property/project site is designed to temporarily and/or permanently retain Stormwater to meet water quality criteria before discharging into _____. The bioretention cell routes the drainage to (Waters of the State) _____, which is the nearest receiving water body from the project.

Inspection and Maintenance

Frequency of inspections and maintenance for bioretention areas may include, but are not limited to:

As needed basis
- Pruning and weeding to maintain appearance
- Mulch replacement when erosion is evident
- Remove trash and debris

Semi-annually
- Inspect inflow points for clogging (offline systems). Remove any sediment.
- Inspect filter strip/grass channel for erosion or gullying. Re-seed or sod as necessary.
- Trees and shrubs should be inspected to evaluate their health and remove any dead or severely diseased vegetation.

Annually
- The planting soils should be tested for pH to establish acidic levels.
  - If the pH is below 5.2, limestone should be applied
  - If the pH is above 7.0 to 8.0, the iron sulfate plus sulfur can be added to reduce the pH

2 to 3 years
- Replace mulch over the entire area.
- Replace stone diaphragm if warranted.

Permament Stormwater System Maintenance and Responsibility Agreement

Under the South Carolina Stormwater Management and Sediment Reduction Act of 1991 (48-14-10, et. Seq.), Regulation 72-308 requires the Landowner, its successors and assigns, including any homeowners association, shall adequately maintain the Stormwater management/Best Management Practices (BMP) facilities. This includes all pipes and channels built to convey Stormwater to the facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the Stormwater. Adequate maintenance is herein defined as good working condition so that these facilities are performing their design functions.

The City of Columbia (City) recommends that The Landowner, its successors and assigns, shall inspect the Stormwater management/BMP facility regularly. The purpose of the inspection is to assure safe and proper functioning of the facilities. The inspection shall cover the entire facilities, berms, outlet structure, pond areas, access roads, etc.

The Landowner, its successors and assigns, herby grant permission to the City, its authorized agents and employees, to enter upon the Property and to inspect the stormwater management/BMP facilities whenever the City deems necessary. The purpose of inspection is to follow-up on reported deficiencies and/or to respond to citizen complaints. The City shall provide the Landowner, its successors and assigns, copies of the inspection findings and a directive to commence with the repairs if necessary.

The Landowner, its successors and assigns, will perform the work necessary to keep these facilities in good working order as appropriate. In the event a maintenance schedule for the stormwater management/BMP facilities (including sediment removal) is outlined on the approved plans, the schedule will be followed.

This Agreement imposes no liability of any kind whatsoever on the City and the Landowner agrees to hold the City harmless from any liability in the event the stormwater management/BMP facilities fail to operate properly.

I accept responsibility for the ownership and proper maintenance of the stormwater system (pond, swales, etc.) on the _____ site per the approved maintenance plan(s). I will complete any necessary repairs and/or preventive maintenance procedures in a timely manner to ensure proper functioning as a stormwater management device(s).

- It is my understanding that the maintenance plan may be amended/revised at any time by the City, and I will abide by any prescribed changes.
- I will continue to own and maintain the pond until the City is notified in writing of a transfer in ownership and maintenance responsibility. The notification will include a date for the transfer of responsibility and a letter of acceptance from the new owner.
- I understand that failure to adhere to the signed maintenance agreement may result in fines of up to $1,000.00 per day, per violation and/or the institution of a court action.

Signature of Owner/Agent	Printed Name of Owner/Agent	Date
Mailing Address	City/State/Zip	Phone Number

Notary Signature/Date/Stamp

Final Meeting

Currently scheduled for August 21, 2013

Questions?