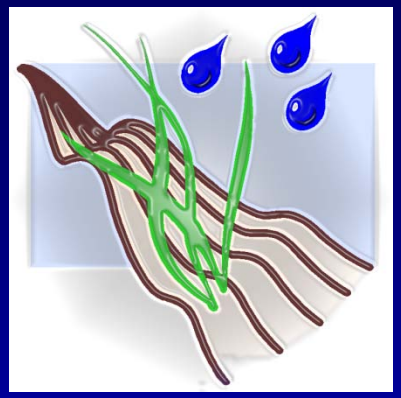


Revisions to the Delaware Sediment & Stormwater Regulations

Technical Subcommittee Meeting
July 7, 2010

Delaware Urban Runoff Management Model (DURMM)

"A Little History"

“Green Technology”

GREEN TECHNOLOGY

Conservation Site Design

Conservation Site Design focuses on site design standards that reduce the extent of impervious (non-porous) surfaces like pavement and increase the extent of wooded and natural areas.

Filter Strips

Filter strips spread runoff uniformly over a filtering surface of vegetation, providing infiltration and pollutant removal. Filter strips can provide substantial treatment if not overloaded by sediment and runoff.

Source Area Disconnection

Disconnection is the process of directing runoff from impervious surfaces like rooftops or pavement over adjacent vegetated surfaces, providing infiltration and pollutant removal.

GREEN TECHNOLOGY

The following information describes the Green Technology BMPs that are commonly being implemented to manage stormwater quality in the State of Delaware.

Bioretention

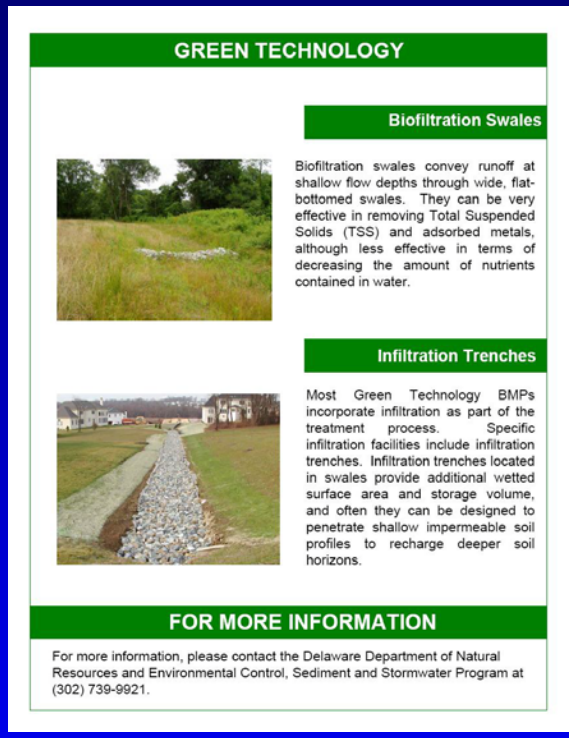
Bioretention facilities are landscaped depressions filled with a special soil media that are designed to infiltrate and clean stormwater runoff. Incorporated into the urban landscape, they can provide substantial filtering and nutrient removal before runoff is discharged into the conveyance system.

Buffers

Buffers are areas along a waterway specifically designed to treat runoff before it enters into a stream, wetlands, or bay. They are effective at removing sediment, nutrients (such as Nitrogen and Phosphorus), and other pollutants from the water.

Rain Gardens

Rain gardens are typically used in yards to absorb water that runs off rooftops and other impervious surfaces. Similar to bioretention facilities, they are depressed into the ground in order to encourage infiltration.



GREEN TECHNOLOGY

Biofiltration Swales

Biofiltration swales convey runoff at shallow flow depths through wide, flat-bottomed swales. They can be very effective in removing Total Suspended Solids (TSS) and adsorbed metals, although less effective in terms of decreasing the amount of nutrients contained in water.

Infiltration Trenches

Most Green Technology BMPs incorporate infiltration as part of the treatment process. Specific infiltration facilities include infiltration trenches. Infiltration trenches located in swales provide additional wetted surface area and storage volume, and often they can be designed to penetrate shallow impermeable soil profiles to recharge deeper soil horizons.

FOR MORE INFORMATION

For more information, please contact the Delaware Department of Natural Resources and Environmental Control, Sediment and Stormwater Program at (302) 739-9921.

Issues:

- Stds. & Specs
- Modeling

NRCS Runoff Equation

$$Q = (P - 0.2S)^2 / (P + 0.8S)$$

Limitations of NRCS Methodology

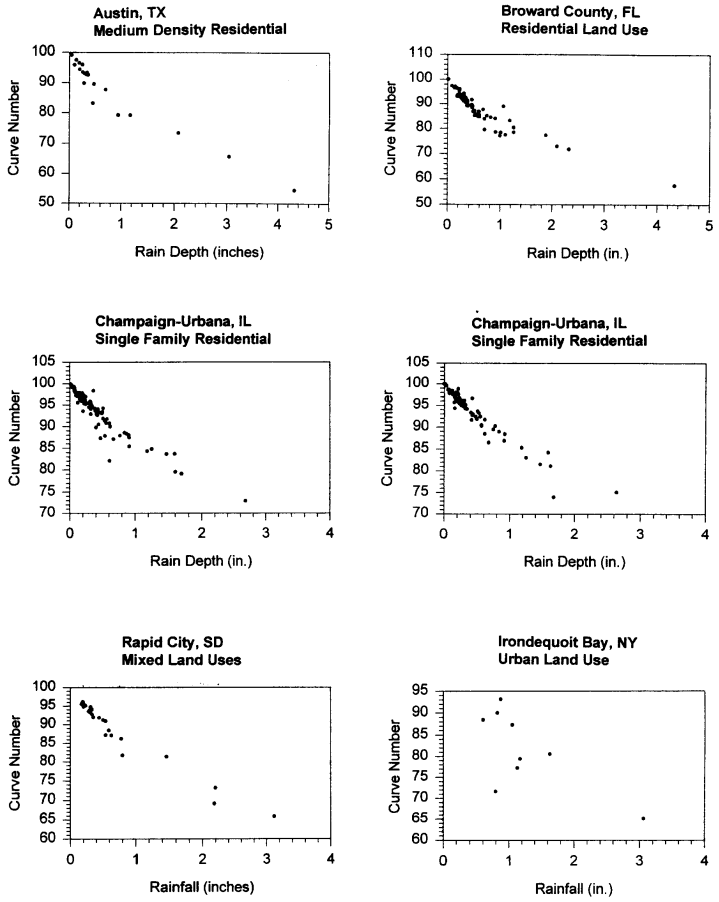
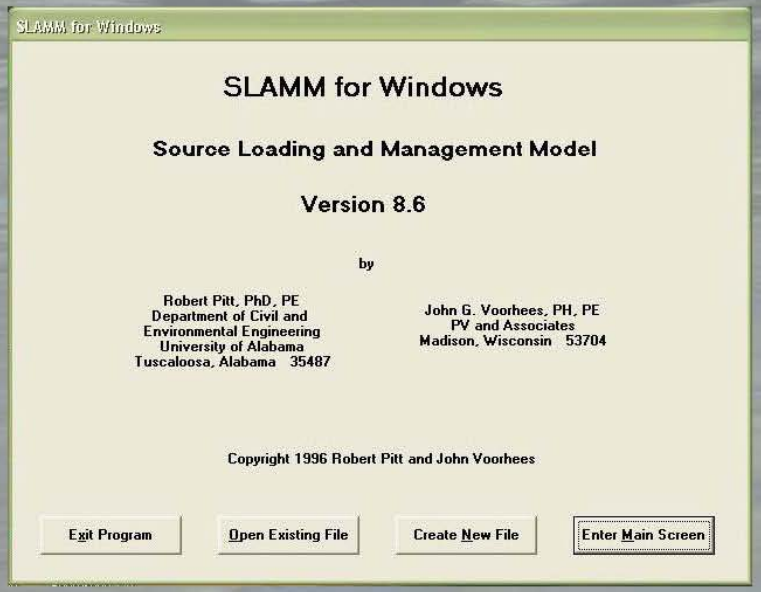


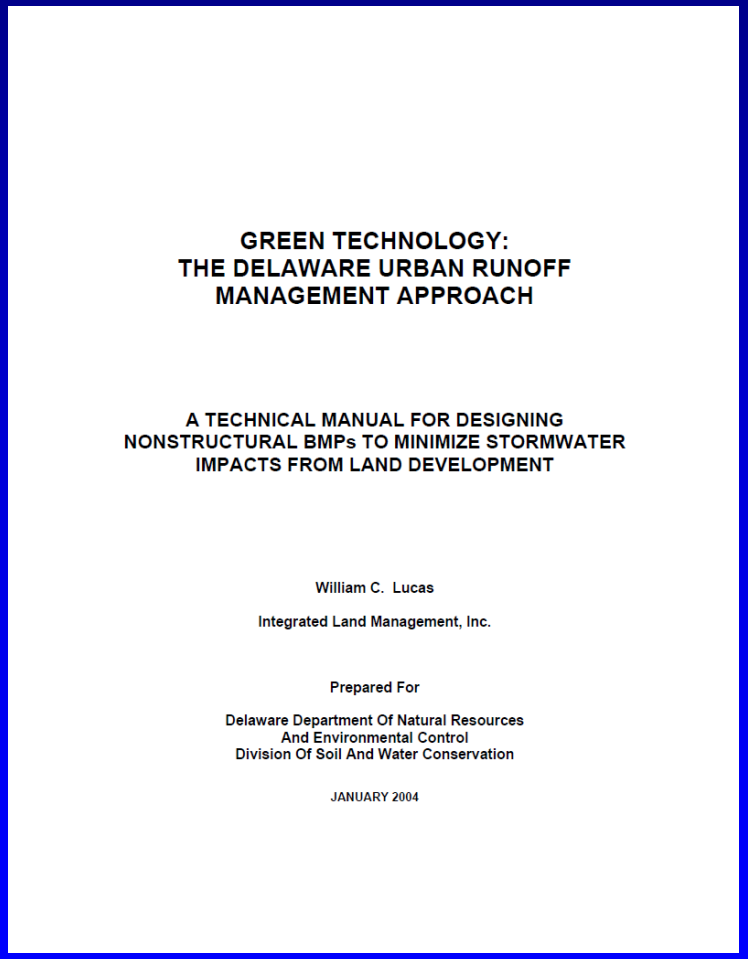
Figure 4. Medium density land use area observed CN vs. rain depth plots.

Source: Pitt & James (1998)

WinSLAMM
(Source Loading And Management Model for Windows)



DURMM, 2004



GREEN TECHNOLOGY:
THE DELAWARE URBAN RUNOFF MANAGEMENT APPROACH

A TECHNICAL MANUAL FOR DESIGNING NONSTRUCTURAL BMPs TO MINIMIZE STORMWATER IMPACTS FROM LAND DEVELOPMENT

William C. Lucas

Integrated Land Management, Inc.

Prepared For

Delaware Department Of Natural Resources
And Environmental Control
Division Of Soil And Water Conservation

JANUARY 2004

DURMM Runoff Equations

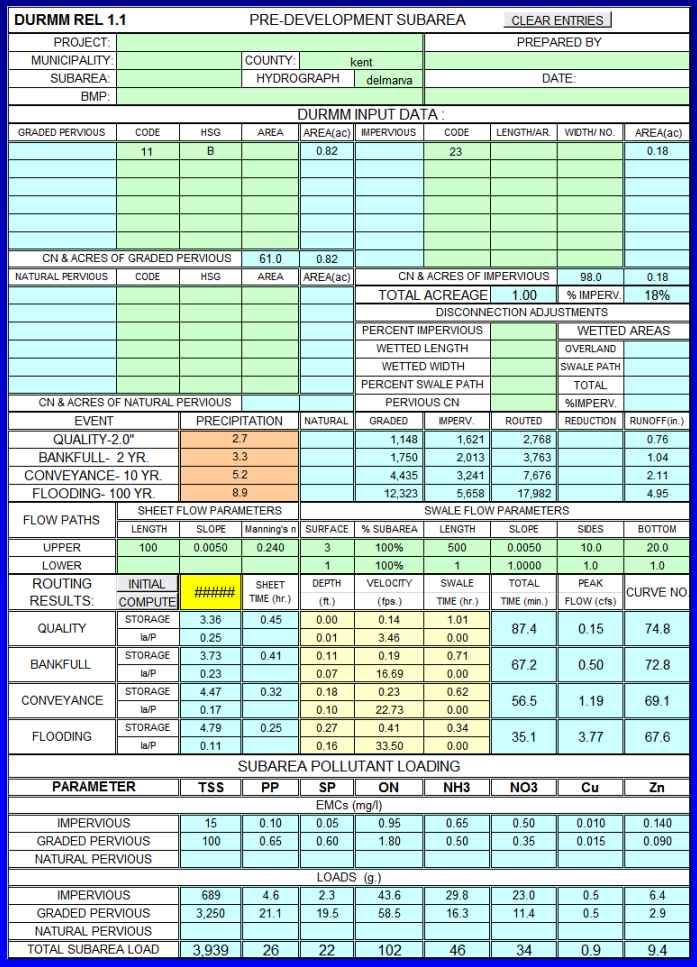
$$Q = P - S'(1 - e^{-gP}) \quad (4)$$

$$g = Ae^{B(CN)} + \frac{Ce^{D(CN-B)}}{10{,}000{,}000} \quad (5)$$

A	B	C	D	E
0.00065	0.0364	155	0.49	80

(Source: DURMM Technical Manual, 2004)

DURMM REL 1.1



DURMM REL 1.1 PRE-DEVELOPMENT SUBAREA [CLEAR ENTRIES]

PROJECT:				PREPARED BY	
MUNICIPALITY:		COUNTY:	kent		
SUBAREA:		HYDROGRAPH	delmarva	DATE:	
BMP:					

DURMM INPUT DATA :

GRADED PERVIOUS	CODE	HSG	AREA	AREA(ac)	IMPERVIOUS	CODE	LENGTH/AR.	WIDTH/ NO.	AREA(ac)
	11	B		0.82		23			0.18
CN & ACRES OF GRADED PERVIOUS			61.0	0.82					
NATURAL PERVIOUS	CODE	HSG	AREA	AREA(ac)	CN & ACRES OF IMPERVIOUS			98.0	0.18
					TOTAL ACREAGE		1.00	% IMPERV.	18%
					DISCONNECTION ADJUSTMENTS				
					PERCENT IMPERVIOUS			WETTED AREAS	
					WETTED LENGTH			OVERLAND	
					WETTED WIDTH			SWALE PATH	
					PERCENT SWALE PATH			TOTAL	
CN & ACRES OF NATURAL PERVIOUS					PERVIOUS CN			%IMPERV.	

EVENT	PRECIPITATION	NATURAL	GRADED	IMPERV.	ROUTED	REDUCTION	RUNOFF(in.)
QUALITY-2.0"	2.7		1,148	1,621	2,768		0.76
BANKFULL- 2 YR.	3.3		1,750	2,013	3,763		1.04
CONVEYANCE- 10 YR.	5.2		4,435	3,241	7,676		2.11
FLOODING- 100 YR.	8.9		12,323	5,658	17,982		4.95

FLOW PATHS	SHEET FLOW PARAMETERS			SWALE FLOW PARAMETERS					
	LENGTH	SLOPE	Manning's n	SURFACE	% SUBAREA	LENGTH	SLOPE	SIDES	BOTTOM
UPPER	100	0.0050	0.240	3	100%	500	0.0050	10.0	20.0
LOWER				1	100%	1	1.0000	1.0	1.0

ROUTING RESULTS:	INITIAL / COMPUTE	#####	SHEET TIME (hr.)	DEPTH (ft.)	VELOCITY (fps.)	SWALE TIME (hr.)	TOTAL TIME (min.)	PEAK FLOW (cfs)	CURVE NO
QUALITY	STORAGE	3.36	0.45	0.00	0.14	1.01	87.4	0.15	74.8
	Ia/P	0.25		0.01	3.46	0.00			
BANKFULL	STORAGE	3.73	0.41	0.11	0.19	0.71	67.2	0.50	72.8
	Ia/P	0.23		0.07	16.69	0.00			
CONVEYANCE	STORAGE	4.47	0.32	0.18	0.23	0.62	56.5	1.19	69.1
	Ia/P	0.17		0.10	22.73	0.00			
FLOODING	STORAGE	4.79	0.25	0.27	0.41	0.34	35.1	3.77	67.6
	Ia/P	0.11		0.16	33.50	0.00			

SUBAREA POLLUTANT LOADING

PARAMETER	TSS	PP	SP	ON	NH3	NO3	Cu	Zn
EMCs (mg/l)								
IMPERVIOUS	15	0.10	0.05	0.95	0.65	0.50	0.010	0.140
GRADED PERVIOUS	100	0.65	0.60	1.80	0.50	0.35	0.015	0.090
NATURAL PERVIOUS								
LOADS (g.)								
IMPERVIOUS	689	4.6	2.3	43.6	29.8	23.0	0.5	6.4
GRADED PERVIOUS	3,250	21.1	19.5	58.5	16.3	11.4	0.5	2.9
NATURAL PERVIOUS								
TOTAL SUBAREA LOAD	3,939	26	22	102	46	34	0.9	9.4

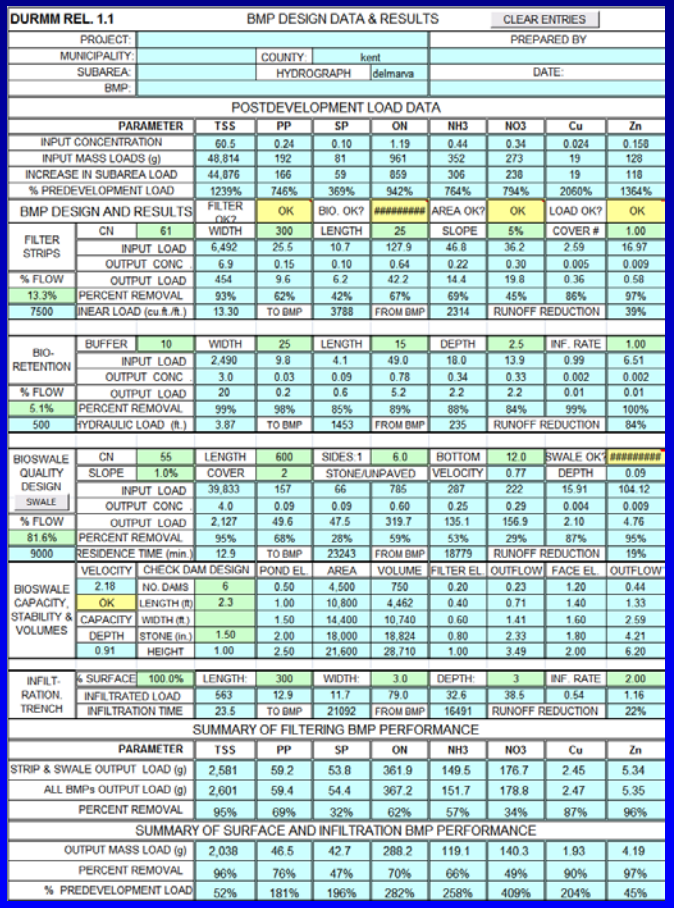
- Event-based methodology
- WQ Event: 2” Rainfall
- Pre-developed vs. post-developed comparison

DURMM REL 1.1

DURMM REL. 1.1			POST-DEVELOPMENT SUBAREA		CLEAR ENTRIES				
PROJECT:					PREPARED BY				
MUNICIPALITY:			COUNTY:	kent					
SUBAREA:			HYDROGRAPH	delmarva	DATE:				
BMP:									
DURMM INPUT DATA :									
GRADED PERVIOUS	CODE	HSG	AREA	AREA(ac)	IMPERVIOUS		LENGTH/AR.	WIDTH/ NO.	AREA(ac)
MEADOW	3	B	33,491	0.77	PARKING LOT	21	96,063	1	2.21
LANDSCAPE-GD	9	B	6,754	0.16	SLOPE ROOF	22	3,354	4	0.31
LAWNS-GD	11	B	11,521	0.26	FLAT ROOF	23	18,034	1	0.41
LAWNS-GD	11	B	27,039	0.62	SIDEWALKS	26	10,275	1	0.24
LAWNS-GD	11	B	15,678	0.36					
LAWNS-GD	11	B	1,125	0.03					
CN & ACRES OF GRADED PERVIOUS			59.9	2.19	CN & ACRES OF IMPERVIOUS			99.2	3.16
NATURAL PERVIOUS	CODE	HSG	AREA	AREA(ac)	TOTAL ACREAGE		5.44	% IMPERV.	58%
WOODS-GD	1	B	3,558	0.08	DISCONNECTION ADJUSTMENTS				
					PERCENT IMPERVIOUS		35.4%	WETTED AREAS	
					WETTED LENGTH		1200	IN SOURCE	0.36
					WETTED WIDTH		10	IN BMPs	0.39
					PERCENT SWALE PATH		100%	TOTAL	0.75
CN & ACRES OF NATURAL PERVIOUS			55.0	0.08	PERVIOUS CN		60.0	%IMPERV.	24%
EVENT	PRECIP.		NATURAL	GRADED	IMPERV.	TO BMPs	FROM BMPs	REDUCTION	RUNOFF(in.)
QUALITY	2.7		36	2,817	30,009	28,484	16,726	49%	0.85
BANKFULL	3.3		83	4,352	36,898	36,905	25,575	38%	1.30
CONVEYANCE	5.2		320	11,234	58,560	66,807	57,702	18%	2.92
FLOODING	8.9		1,014	31,949	101,045	131,342	126,756	5%	6.42
FLOW PATHS	SHEET FLOW PARAMETERS				SWALE FLOW PARAMETERS				
	LENGTH	SLOPE	Manning's n	SURF. CODE	% SUBAREA	LENGTH	SLOPE	SIDE SLOPE	BOTTOM
UPPER SEGMENT	70	0.0100	0.011	4	25%	380	0.0100	4.0	6.0
LOWER SEGMENT				4	35%	180	0.0100	4.0	8.0
% RUNOFF IMPERV.	91%	Tc Path	IMPERV	2	82%	600	0.0100	6.0	12.0
ROUTING RESULTS:	INITIAL / COMPUT	########	SHEET TIME (hr.)	DEPTH (ft.)	VELOCITY (fps.)	SWALE TIME (hr.)	TOTAL TIME (min.)	PEAK FLOW (cfs)	CURVE NO
QUALITY	STORAGE	3.06	0.022	0.10	0.21	0.50	44.7	2.80	76.6
	la/P	0.227		0.14	0.22	0.23			
	BIOSWALE RESULTS			0.09	0.77	0.22	57.6	2.40	-14%
BANKFULL	STORAGE	2.96	0.020	0.27	0.23	0.46	38.9	4.85	77.2
	la/P	0.179		0.36	0.29	0.17			
	BIOSWALE RESULTS			0.17	1.37	0.12	46.2	4.39	-9%
CONVEYANCE	STORAGE	2.75	0.016	0.43	0.40	0.26	21.4	10.35	78.4
	la/P	0.106		0.50	0.63	0.08			
	BIOSWALE RESULTS			0.31	2.18	0.08	26.0	14.06	36%
FLOODING	STORAGE	2.57	0.012	0.59	0.82	0.13	10.8	33.57	79.6
	la/P	0.058		0.68	1.29	0.04			
	BIOSWALE RESULTS			0.52	3.39	0.05	13.7	41.41	23%
SUBAREA POLLUTANT LOADING									
PARAMETER		*TSS*	*PP*	*SP*	*ON*	*NH3*	*NO3*	*Cu*	*Zn*
IMPERVIOUS EMCs (mg/l)		59	0.19	0.06	1.14	0.43	0.34	0.026	0.168
RADED PERVIOUS EMCs (mg/l)		75	0.69	0.55	1.78	0.46	0.31	0.010	0.057
ATURAL PERVIOUS EMCs (mg/l)		15	0.65	0.35	1.75	0.40	0.25	0.001	0.005
IMPERVIOUS LOADS (g.)		50,282	165.5	48.8	965.5	369.1	289.6	21.7	142.7
RADED PERVIOUS LOADS (g.)		6,018	55.3	43.7	141.9	36.8	24.6	0.8	4.5
ATURAL PERVIOUS LOADS (g.)		15	0.7	0.4	1.8	0.4	0.3	0.0	0.0
TOTAL SUBAREA LOAD		56,315	221	93	1,109	406	314	22.5	147.2

- Post-developed runoff calculated separately for pervious & impervious areas

DURMM REL 1.1

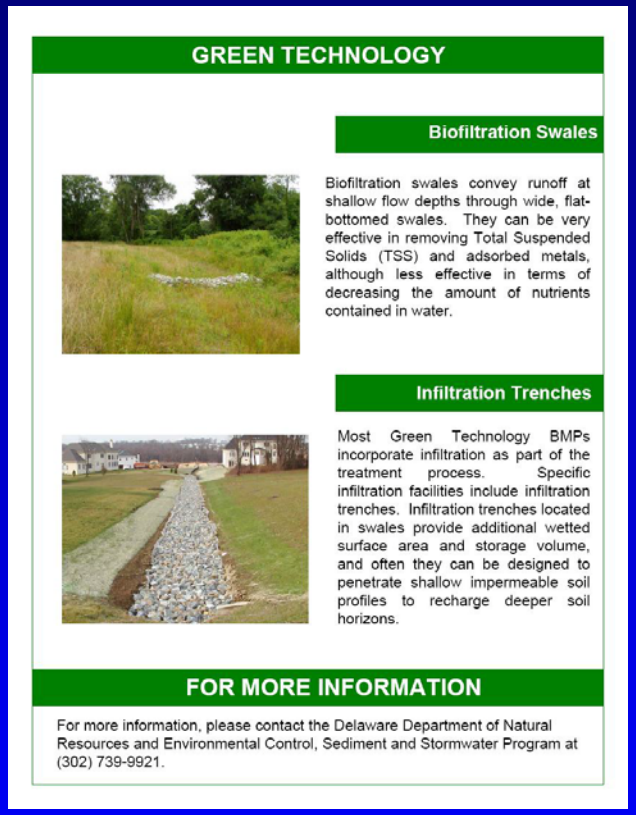


DURMM REL. 1.1			BMP DESIGN DATA & RESULTS			CLEAR ENTRIES				
PROJECT:						PREPARED BY				
MUNICIPALITY:				COUNTY:	kent					
SUBAREA:				HYDROGRAPH	delmarva	DATE:				
BMP:										
POSTDEVELOPMENT LOAD DATA										
PARAMETER			TSS	PP	SP	ON	NH3	NO3	Cu	Zn
INPUT CONCENTRATION			60.5	0.24	0.10	1.19	0.44	0.34	0.024	0.158
INPUT MASS LOADS (g)			48,814	192	81	961	352	273	19	128
INCREASE IN SUBAREA LOAD			44,876	166	59	859	306	238	19	118
% PREDEVELOPMENT LOAD			1239%	746%	369%	942%	764%	794%	2060%	1364%
BMP DESIGN AND RESULTS			FILTER OK?	OK	BIO. OK?	#########	AREA OK?	OK	LOAD OK?	OK
FILTER STRIPS	CN	61	WIDTH	300	LENGTH	25	SLOPE	5%	COVER #	1.00
	INPUT LOAD		6,492	25.5	10.7	127.9	46.8	36.2	2.59	16.97
	OUTPUT CONC		6.9	0.15	0.10	0.64	0.22	0.30	0.005	0.009
% FLOW	OUTPUT LOAD		454	9.6	6.2	42.2	14.4	19.8	0.36	0.58
13.3%	PERCENT REMOVAL		93%	62%	42%	67%	69%	45%	86%	97%
7500	INEAR LOAD (cu.ft./ft.)		13.30	TO BMP	3788	FROM BMP	2314	RUNOFF REDUCTION		39%
BIO-RETENTION	BUFFER	10	WIDTH	25	LENGTH	15	DEPTH	2.5	INF. RATE	1.00
	INPUT LOAD		2,490	9.8	4.1	49.0	18.0	13.9	0.99	6.51
	OUTPUT CONC		3.0	0.03	0.09	0.78	0.34	0.33	0.002	0.002
% FLOW	OUTPUT LOAD		20	0.2	0.6	5.2	2.2	2.2	0.01	0.01
5.1%	PERCENT REMOVAL		99%	98%	85%	89%	88%	84%	99%	100%
500	HYDRAULIC LOAD (ft.)		3.87	TO BMP	1453	FROM BMP	235	RUNOFF REDUCTION		84%
BIOSWALE QUALITY DESIGN SWALE	CN	55	LENGTH	600	SIDES:1	6.0	BOTTOM	12.0	SWALE OK?	#########
	SLOPE	1.0%	COVER	2	STONE/UNPAVED		VELOCITY	0.77	DEPTH	0.09
	INPUT LOAD		39,833	157	66	785	287	222	15.91	104.12
	OUTPUT CONC		4.0	0.09	0.09	0.60	0.25	0.29	0.004	0.009
% FLOW	OUTPUT LOAD		2,127	49.6	47.5	319.7	135.1	156.9	2.10	4.76
81.6%	PERCENT REMOVAL		95%	68%	28%	59%	53%	29%	87%	95%
9000	RESIDENCE TIME (min.)		12.9	TO BMP	23243	FROM BMP	18779	RUNOFF REDUCTION		19%
BIOSWALE CAPACITY, STABILITY & VOLUMES	VELOCITY	CHECK DAM DESIGN		POND EL.	AREA	VOLUME	FILTER EL.	OUTFLOW	FACE EL.	OUTFLOW
	2.18	NO. DAMS	6	0.50	4,500	750	0.20	0.23	1.20	0.44
	OK	LENGTH (ft)	2.3	1.00	10,800	4,462	0.40	0.71	1.40	1.33
	CAPACITY	WIDTH (ft.)		1.50	14,400	10,740	0.60	1.41	1.60	2.59
	DEPTH	STONE (in.)	1.50	2.00	18,000	18,824	0.80	2.33	1.80	4.21
	0.91	HEIGHT	1.00	2.50	21,600	28,710	1.00	3.49	2.00	6.20
INFILT-RATION TRENCH	% SURFACE	100.0%	LENGTH:	300	WIDTH:	3.0	DEPTH:	3	INF. RATE	2.00
	INFILTRATED LOAD		563	12.9	11.7	79.0	32.6	38.5	0.54	1.16
	INFILTRATION TIME		23.5	TO BMP	21092	FROM BMP	16491	RUNOFF REDUCTION		22%
SUMMARY OF FILTERING BMP PERFORMANCE										
PARAMETER			TSS	PP	SP	ON	NH3	NO3	Cu	Zn
STRIP & SWALE OUTPUT LOAD (g)			2,581	59.2	53.8	361.9	149.5	176.7	2.45	5.34
ALL BMPs OUTPUT LOAD (g)			2,601	59.4	54.4	367.2	151.7	178.8	2.47	5.35
PERCENT REMOVAL			95%	69%	32%	62%	57%	34%	87%	96%
SUMMARY OF SURFACE AND INFILTRATION BMP PERFORMANCE										
OUTPUT MASS LOAD (g)			2,038	46.5	42.7	288.2	119.1	140.3	1.93	4.19
PERCENT REMOVAL			96%	76%	47%	70%	66%	49%	90%	97%
% PREDEVELOPMENT LOAD			52%	181%	196%	282%	258%	409%	204%	45%

- BMP design aid
- Limited ability to link GTBMPs in a “treatment train”
- Compliance goal: 80% TSS removal

So why DURMM v.2????

Resource Protection Event BMPs



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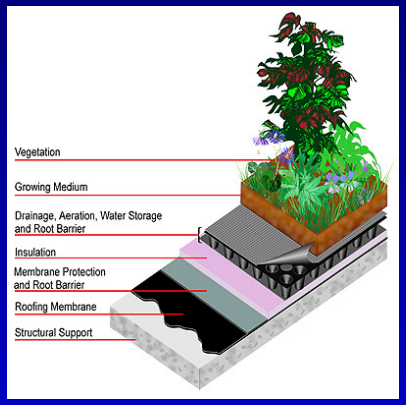
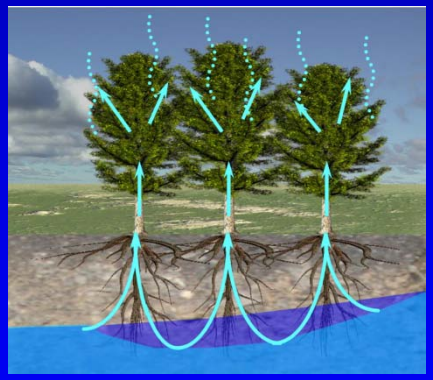
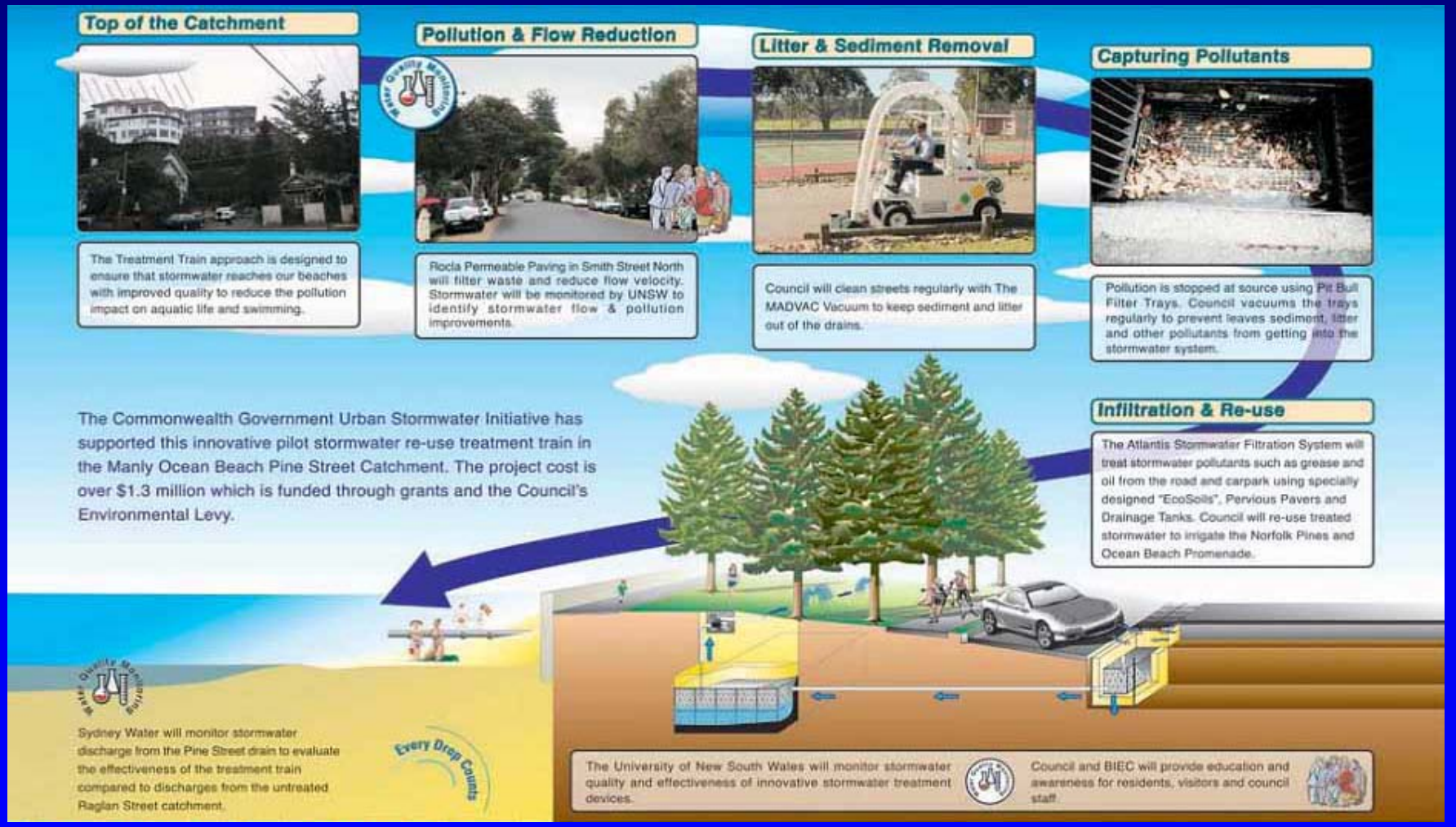




- Runoff Retention Practices (i.e., storage)
- Runoff Reduction Practices (i.e., surface recharge)

“Treatment Train” Approach



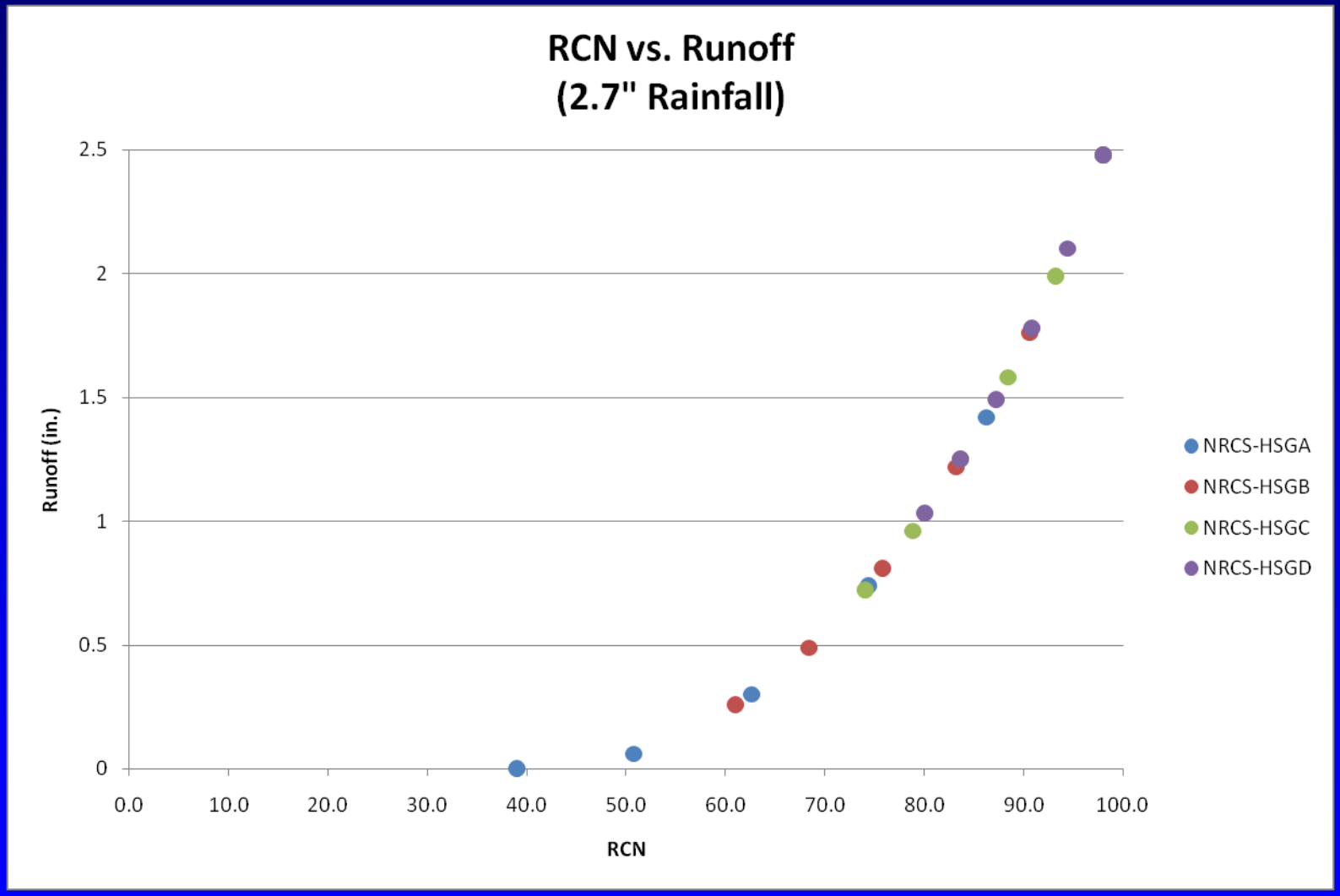
Retention: Event-Based Modeling

	Pervious		Impervious		
Soil HSG	%	CN	%	CN	Composite CN
HSG A	100%	39	0%	98	39.0
	80%	39	20%	98	50.8
	60%	39	40%	98	62.6
	40%	39	60%	98	74.4
	20%	39	80%	98	86.2
	0%	39	100%	98	98.0
HSG B	100%	61	0%	98	61.0
	80%	61	20%	98	68.4
	60%	61	40%	98	75.8
	40%	61	60%	98	83.2
	20%	61	80%	98	90.6
	0%	61	100%	98	98.0
HSG C	100%	74	0%	98	74.0
	80%	74	20%	98	78.8
	60%	74	40%	98	83.6
	40%	74	60%	98	88.4
	20%	74	80%	98	93.2
	0%	74	100%	98	98.0
HSG D	100%	80	0%	98	80.0
	80%	80	20%	98	83.6
	60%	80	40%	98	87.2
	40%	80	60%	98	90.8
	20%	80	80%	98	94.4
	0%	80	100%	98	98.0

Retention: Event-Based Modeling

	Pervious		Impervious			NRCS (2.7" Rainfall)
Soil HSG	%	CN	%	CN	Composite CN	RO (in.)
HSG A	100%	39	0%	98	39.0	0
	80%	39	20%	98	50.8	0.06
	60%	39	40%	98	62.6	0.3
	40%	39	60%	98	74.4	0.74
	20%	39	80%	98	86.2	1.42
	0%	39	100%	98	98.0	2.48
HSG B	100%	61	0%	98	61.0	0.26
	80%	61	20%	98	68.4	0.49
	60%	61	40%	98	75.8	0.81
	40%	61	60%	98	83.2	1.22
	20%	61	80%	98	90.6	1.76
	0%	61	100%	98	98.0	2.48
HSG C	100%	74	0%	98	74.0	0.72
	80%	74	20%	98	78.8	0.96
	60%	74	40%	98	83.6	1.25
	40%	74	60%	98	88.4	1.58
	20%	74	80%	98	93.2	1.99
	0%	74	100%	98	98.0	2.48
HSG D	100%	80	0%	98	80.0	1.03
	80%	80	20%	98	83.6	1.25
	60%	80	40%	98	87.2	1.49
	40%	80	60%	98	90.8	1.78
	20%	80	80%	98	94.4	2.1
	0%	80	100%	98	98.0	2.48

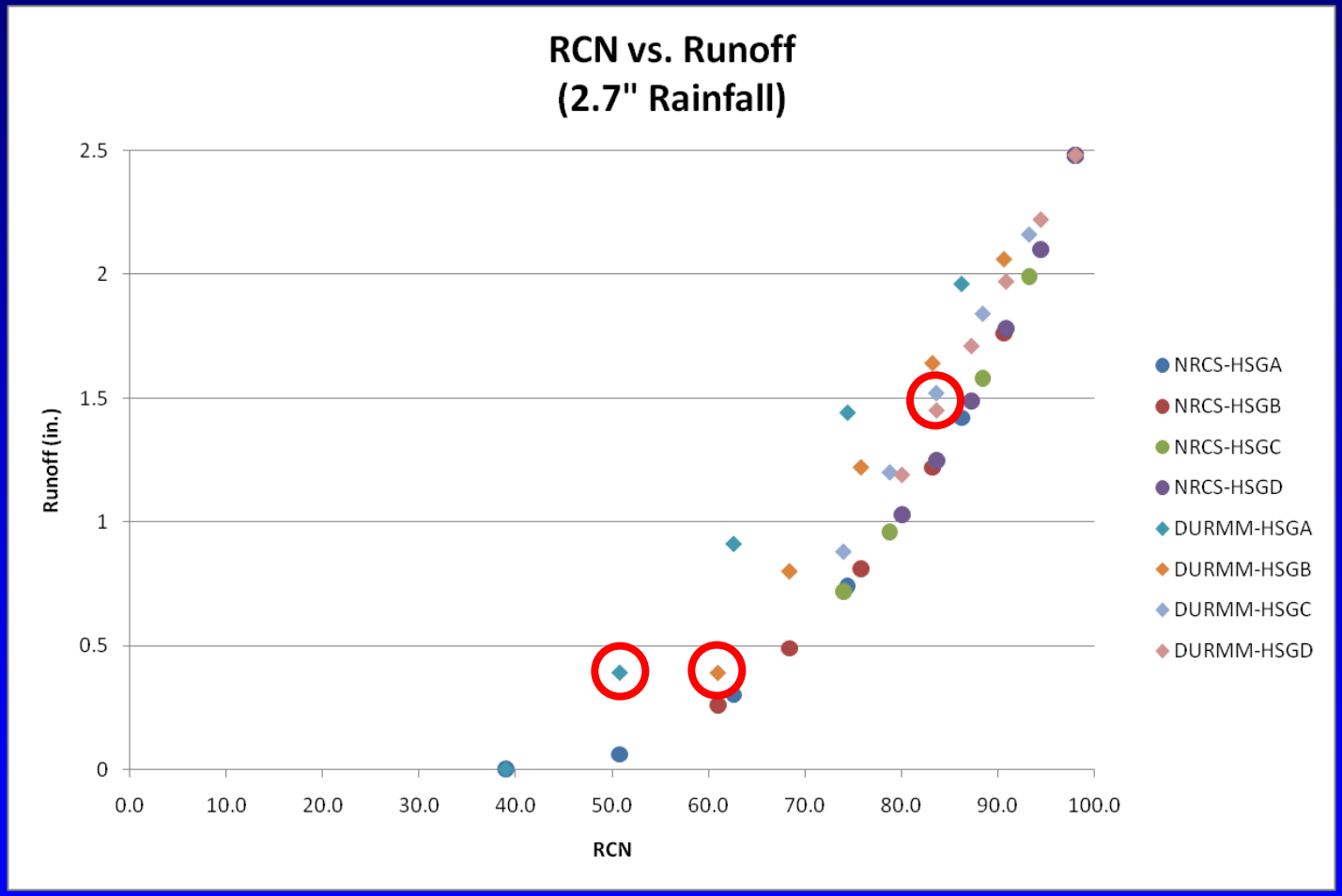
Retention: Event-Based Modeling



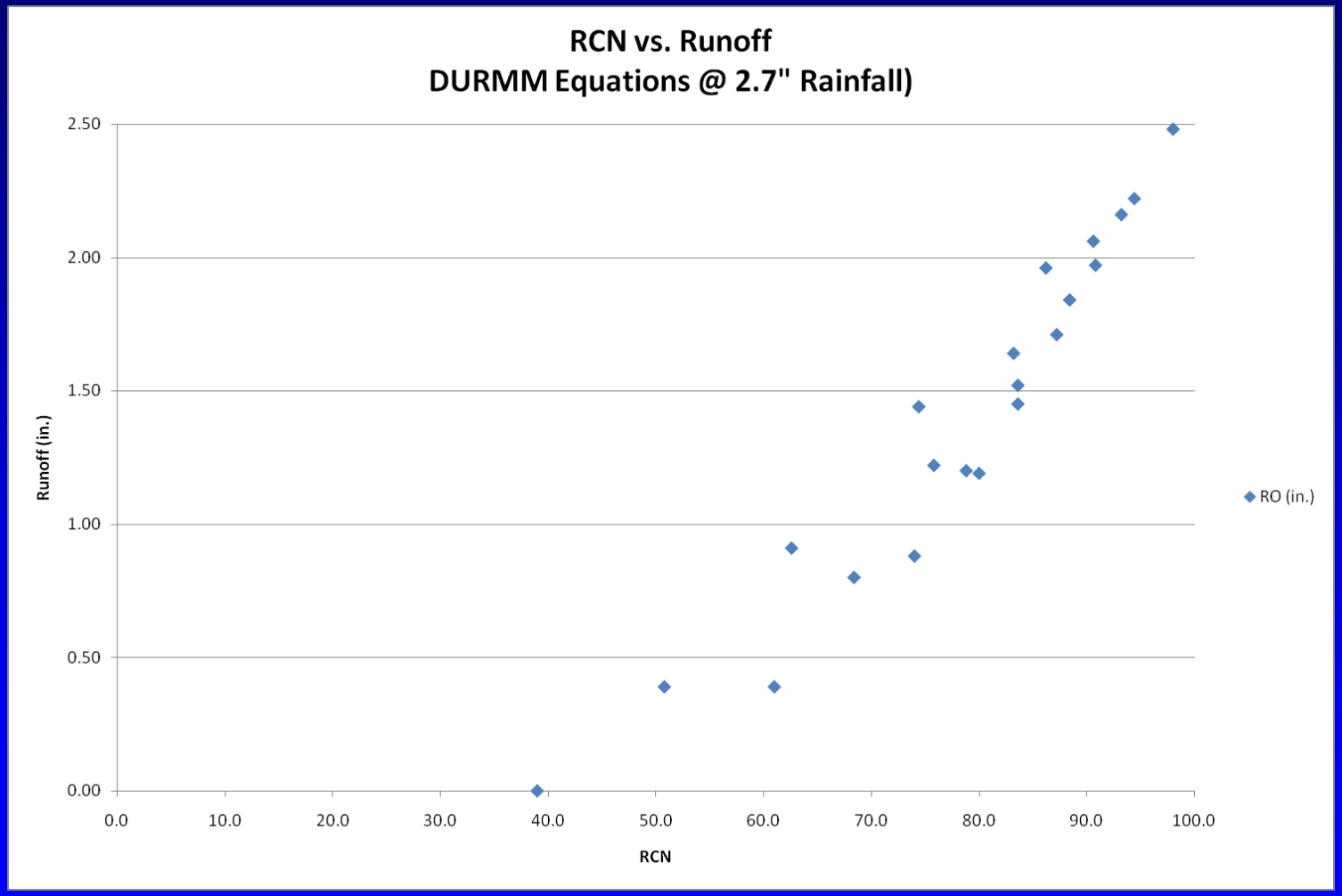
Retention: Event-Based Modeling

	Pervious		Impervious			NRCS (2.7" Rainfall)	DURMM (2.7" Rainfall)
Soil HSG	%	CN	%	CN	Composite CN	RO (in.)	RO (in.)
HSG A	100%	39	0%	98	39.0	0	0.00
	80%	39	20%	98	50.8	0.06	0.39
	60%	39	40%	98	62.6	0.3	0.91
	40%	39	60%	98	74.4	0.74	1.44
	20%	39	80%	98	86.2	1.42	1.96
	0%	39	100%	98	98.0	2.48	2.48
HSG B	100%	61	0%	98	61.0	0.26	0.39
	80%	61	20%	98	68.4	0.49	0.80
	60%	61	40%	98	75.8	0.81	1.22
	40%	61	60%	98	83.2	1.22	1.64
	20%	61	80%	98	90.6	1.76	2.06
	0%	61	100%	98	98.0	2.48	2.48
HSG C	100%	74	0%	98	74.0	0.72	0.88
	80%	74	20%	98	78.8	0.96	1.20
	60%	74	40%	98	83.6	1.25	1.52
	40%	74	60%	98	88.4	1.58	1.84
	20%	74	80%	98	93.2	1.99	2.16
	0%	74	100%	98	98.0	2.48	2.48
HSG D	100%	80	0%	98	80.0	1.03	1.19
	80%	80	20%	98	83.6	1.25	1.45
	60%	80	40%	98	87.2	1.49	1.71
	40%	80	60%	98	90.8	1.78	1.97
	20%	80	80%	98	94.4	2.1	2.22
	0%	80	100%	98	98.0	2.48	2.48

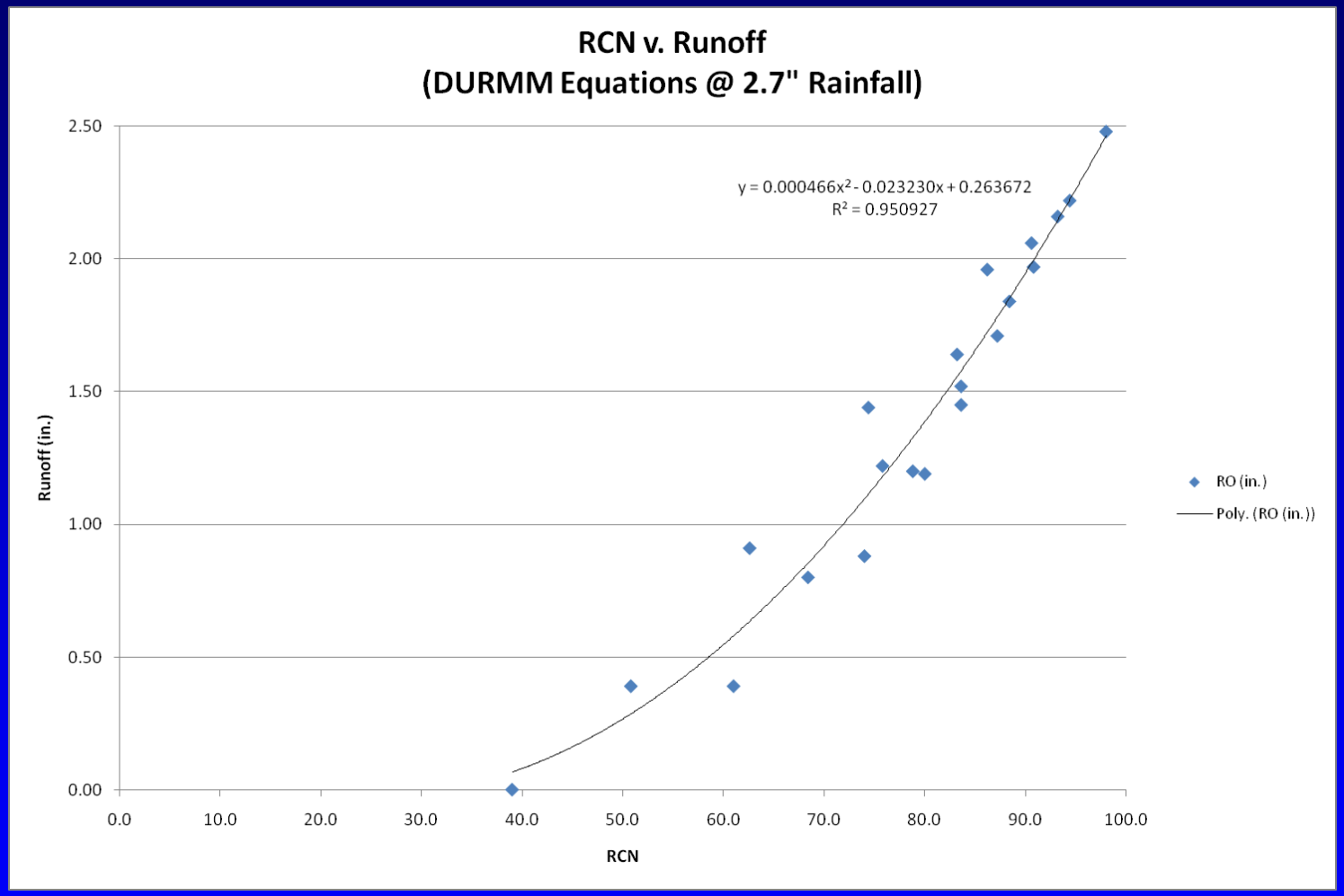
Retention: Event-Based Modeling



Retention: Event-Based Modeling

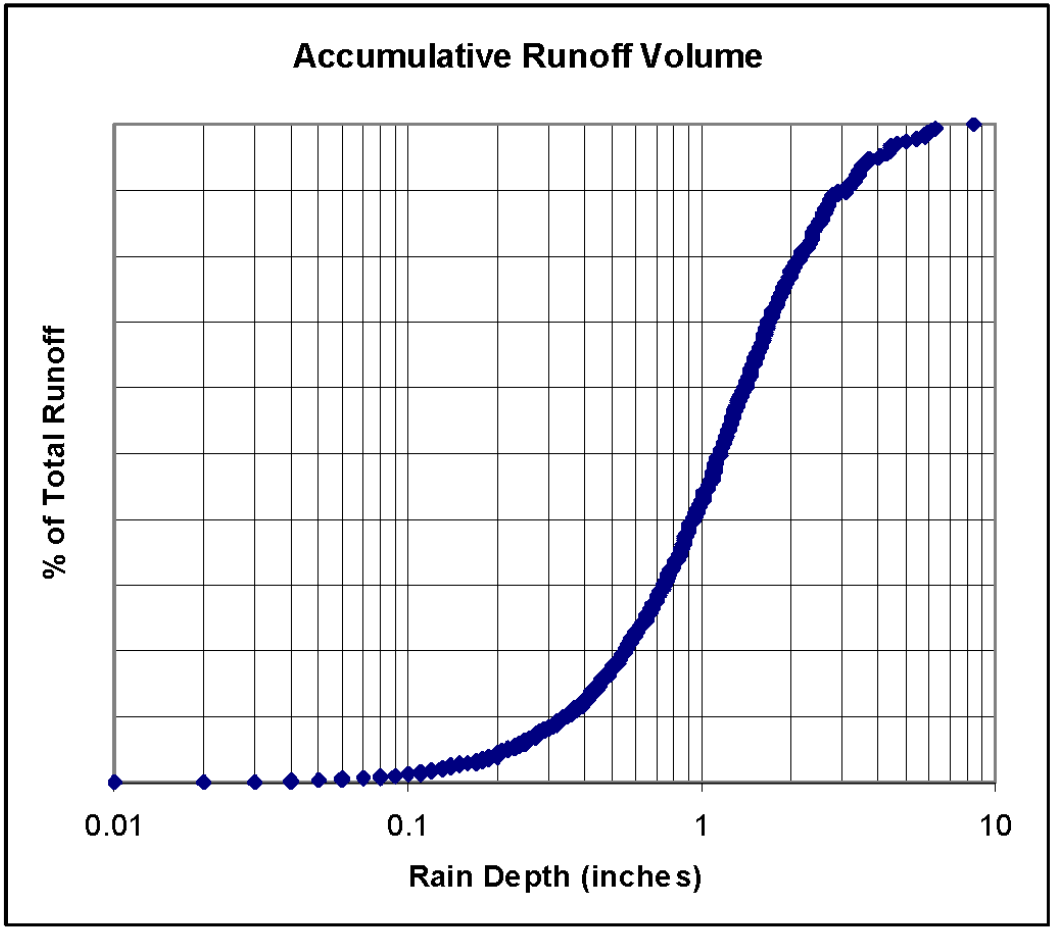


DURMM v.2 – Event RO Equation



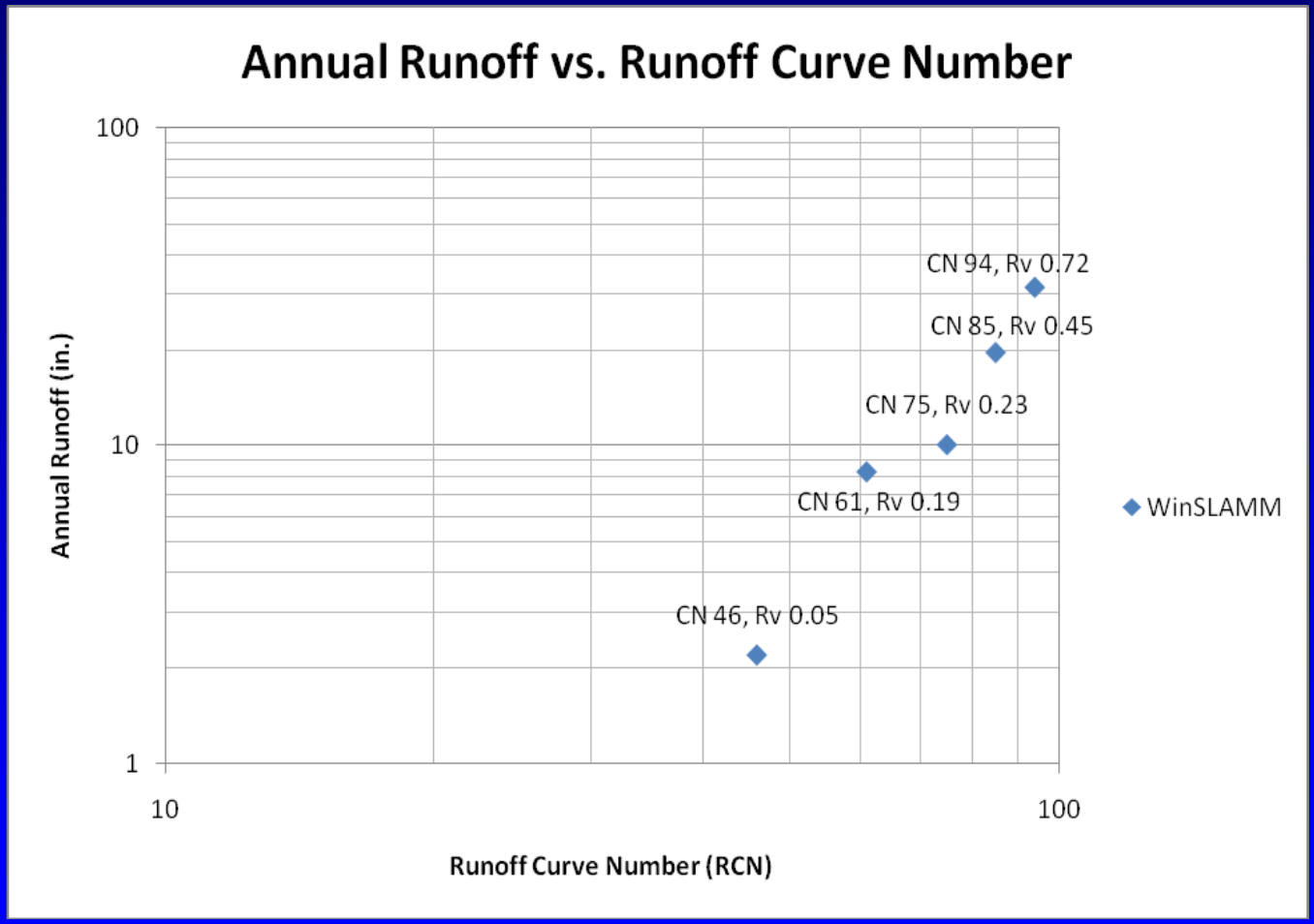
- **1-YR Runoff = $0.000466(RCN)^2 - 0.023230(RCN) + 0.263672$**

Reduction: Annual Runoff Modeling

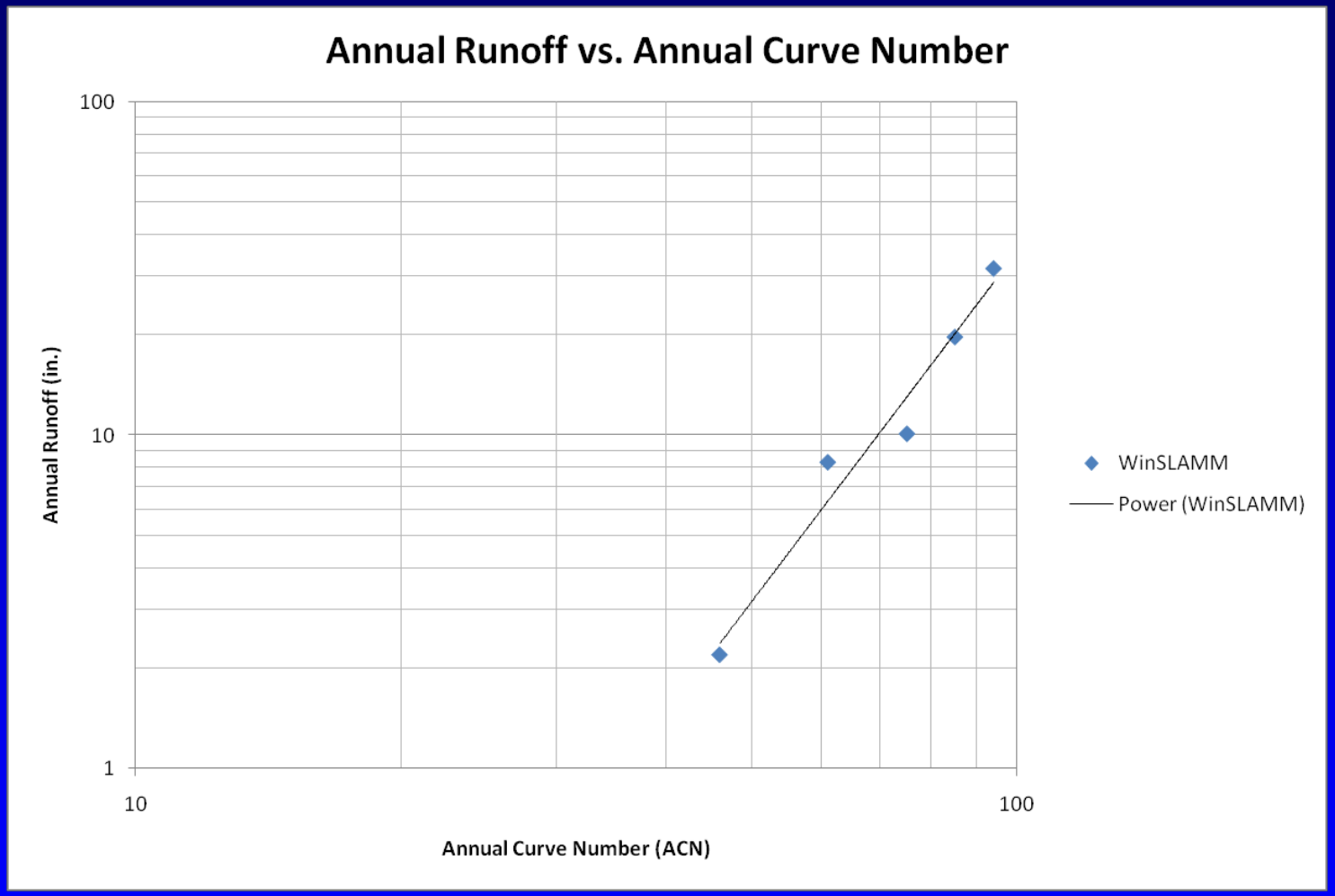


Plot showing accumulative runoff (100% full scale) against rain depth (Baltimore rains and typical medium density residential areas with silty soils).

Reduction: Annual Runoff Modeling

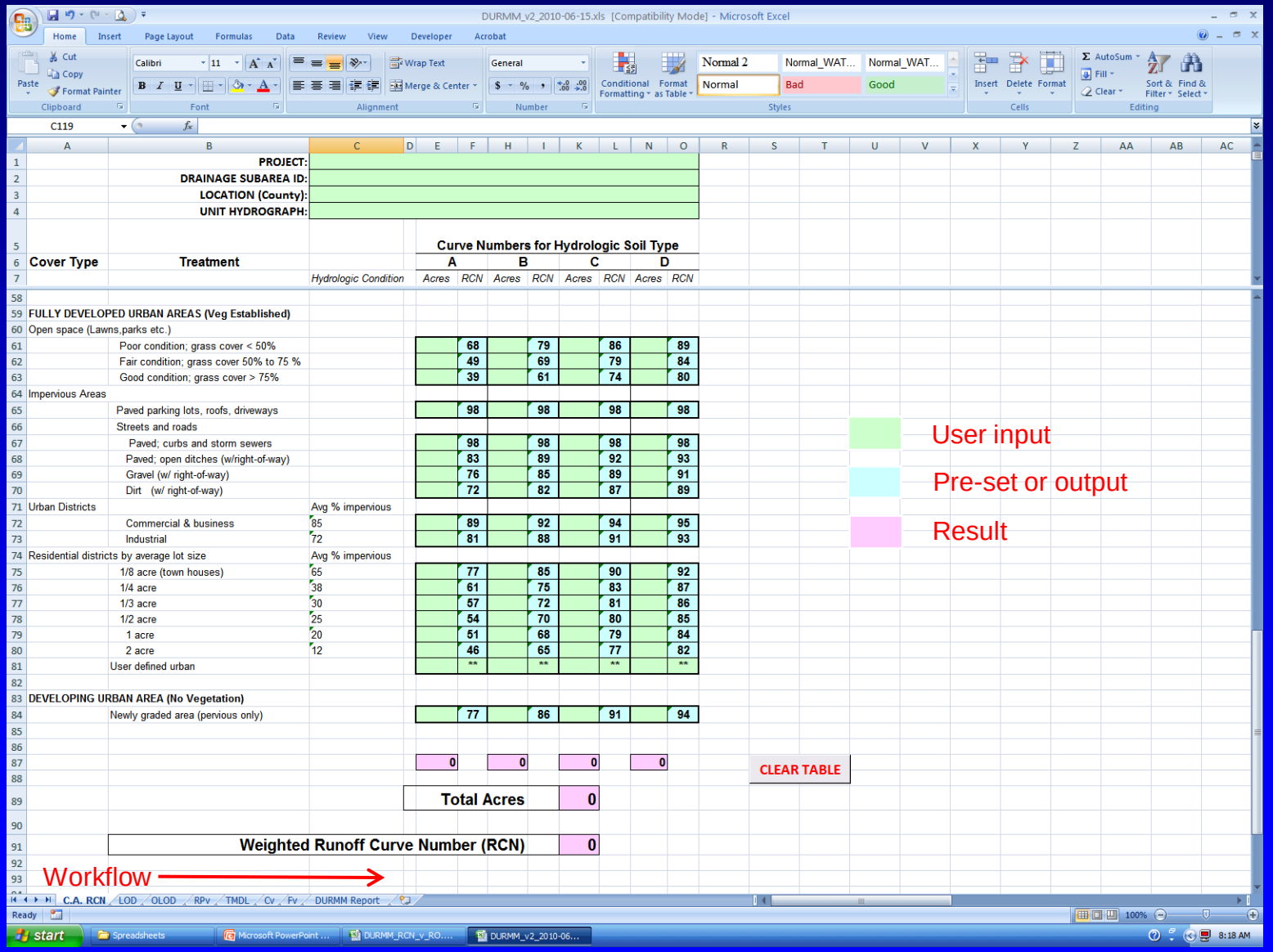


DURMM v.2 – Annual RO Equation



- **Annual Runoff = $0.000004(ACN)^{3.5}$**

DURMM v.2 Layout



DURMM v.2

Explanation of Worksheets

Summary: DURMM REL 1.1 vs. DURMM v.2

DURMM REL 1.1

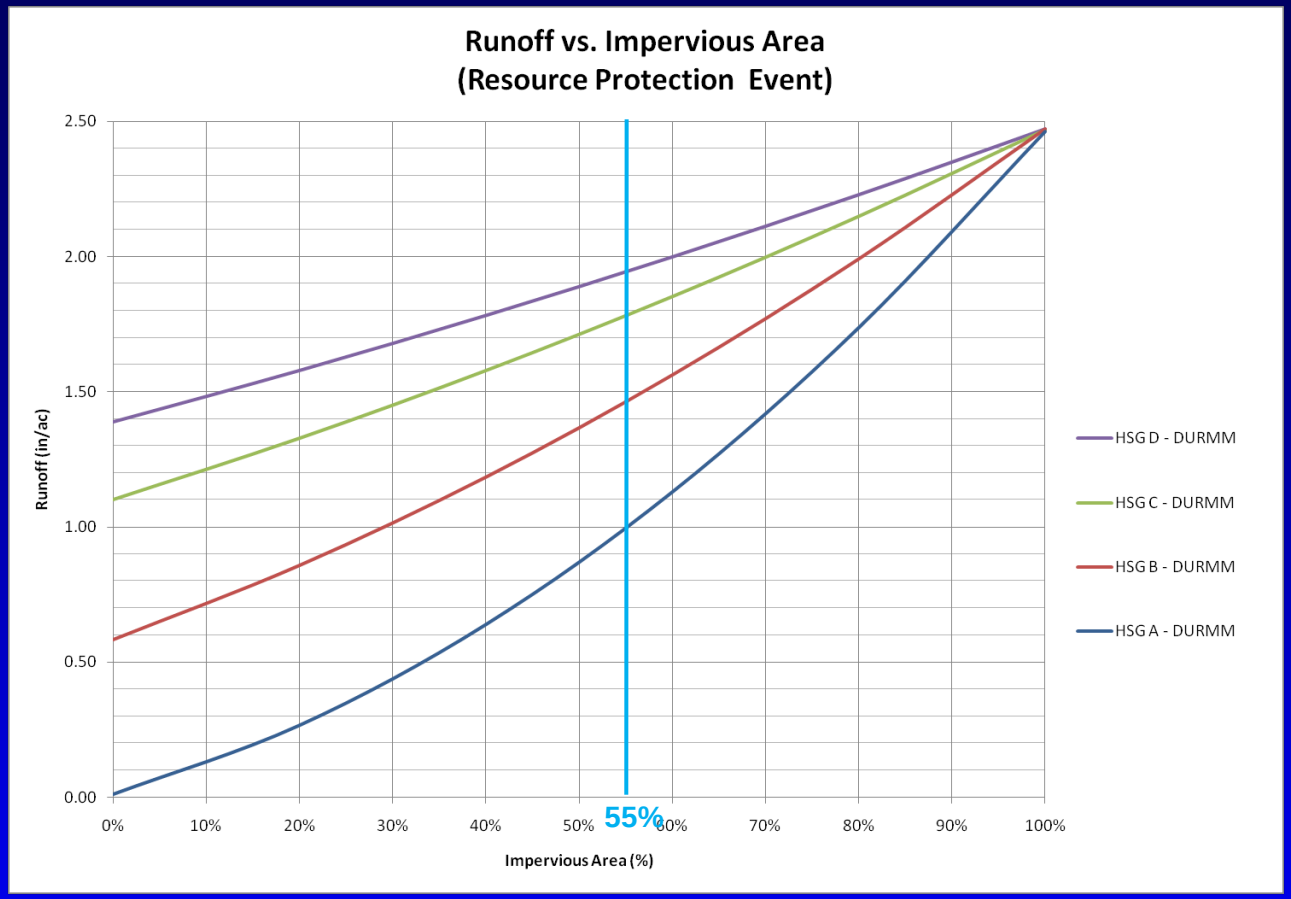
- Event-based only
- Pre- vs. Post-developed comparison
- Impervious runoff & pervious runoff calculated separately
- BMP designer
- No ability to link BMPs
- Compliance based on 80% reduction of TSS

DURMM v.2

- Capable of estimating event & annual runoff
- Post-dev. condition only
- Single regression curve used to calculate runoff using composite RCN
- Compliance tool only
- “Treatment train”
- Compliance based on:
  - 0% Effective Imp.
  - TMDL Reduction

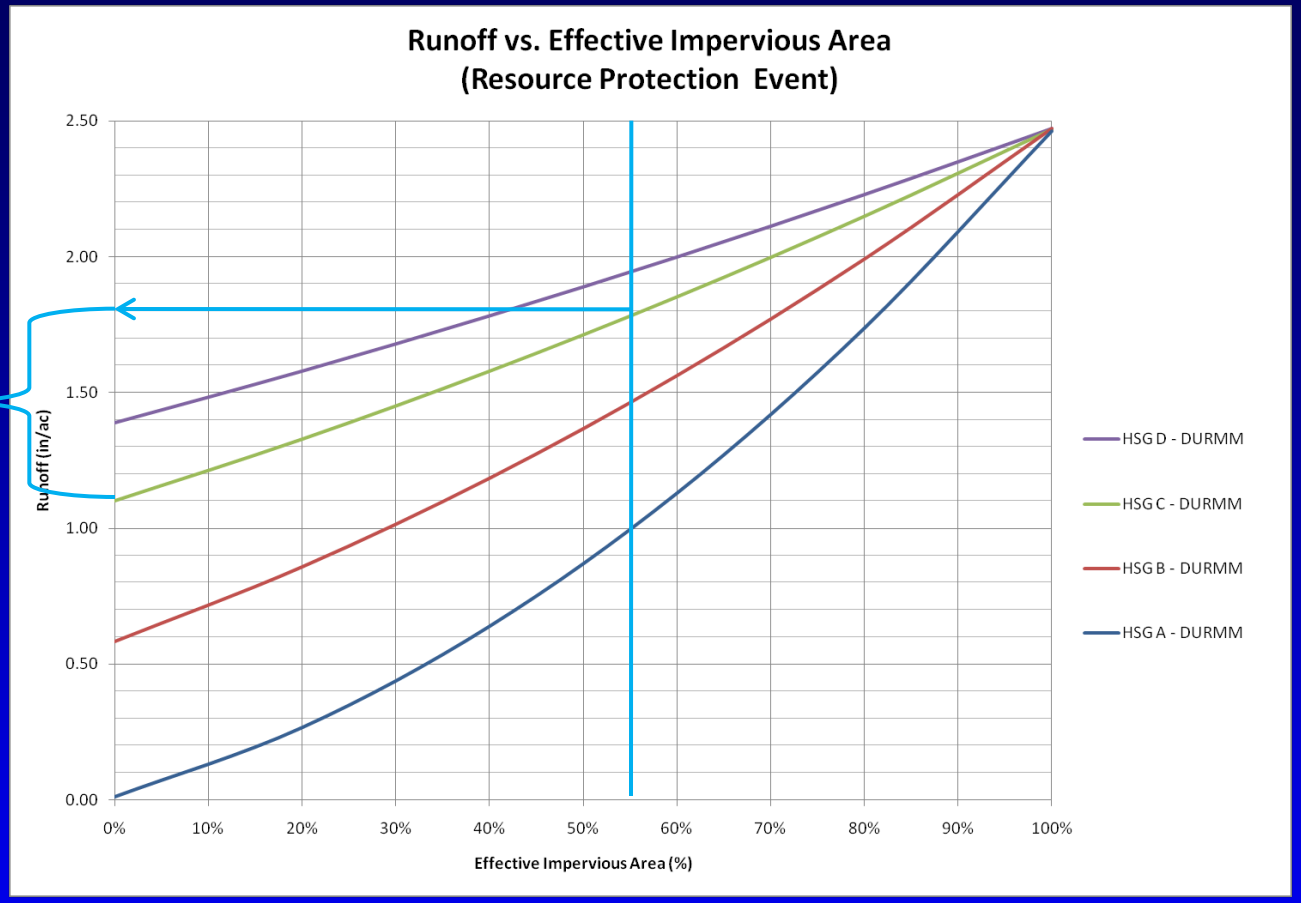
DURMM v.2

Basic Workflow & Data Input



Site 2: 55% Impervious, HSG C Soil

Site 2

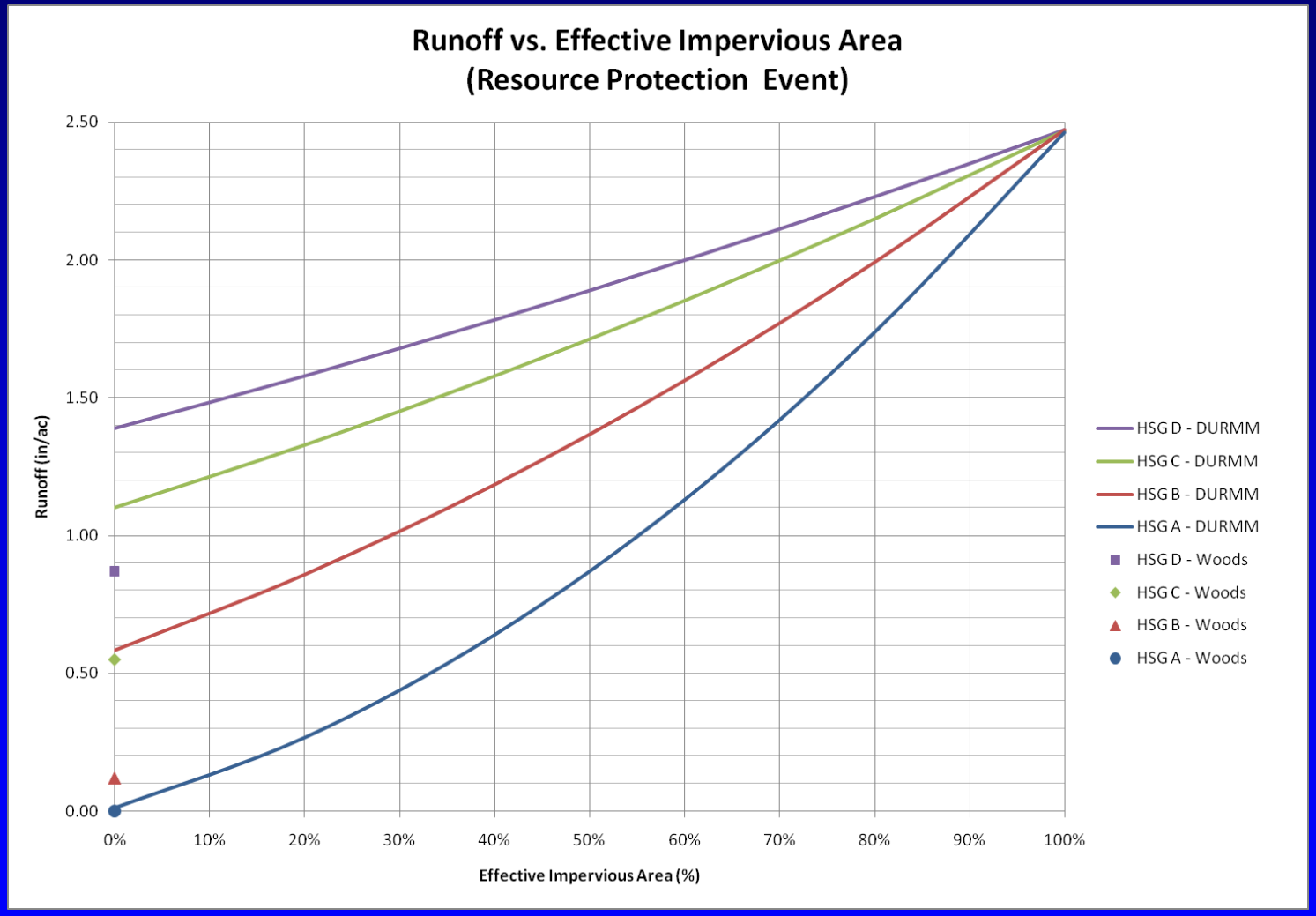


Site 2: 55% Impervious, HSG C Soil

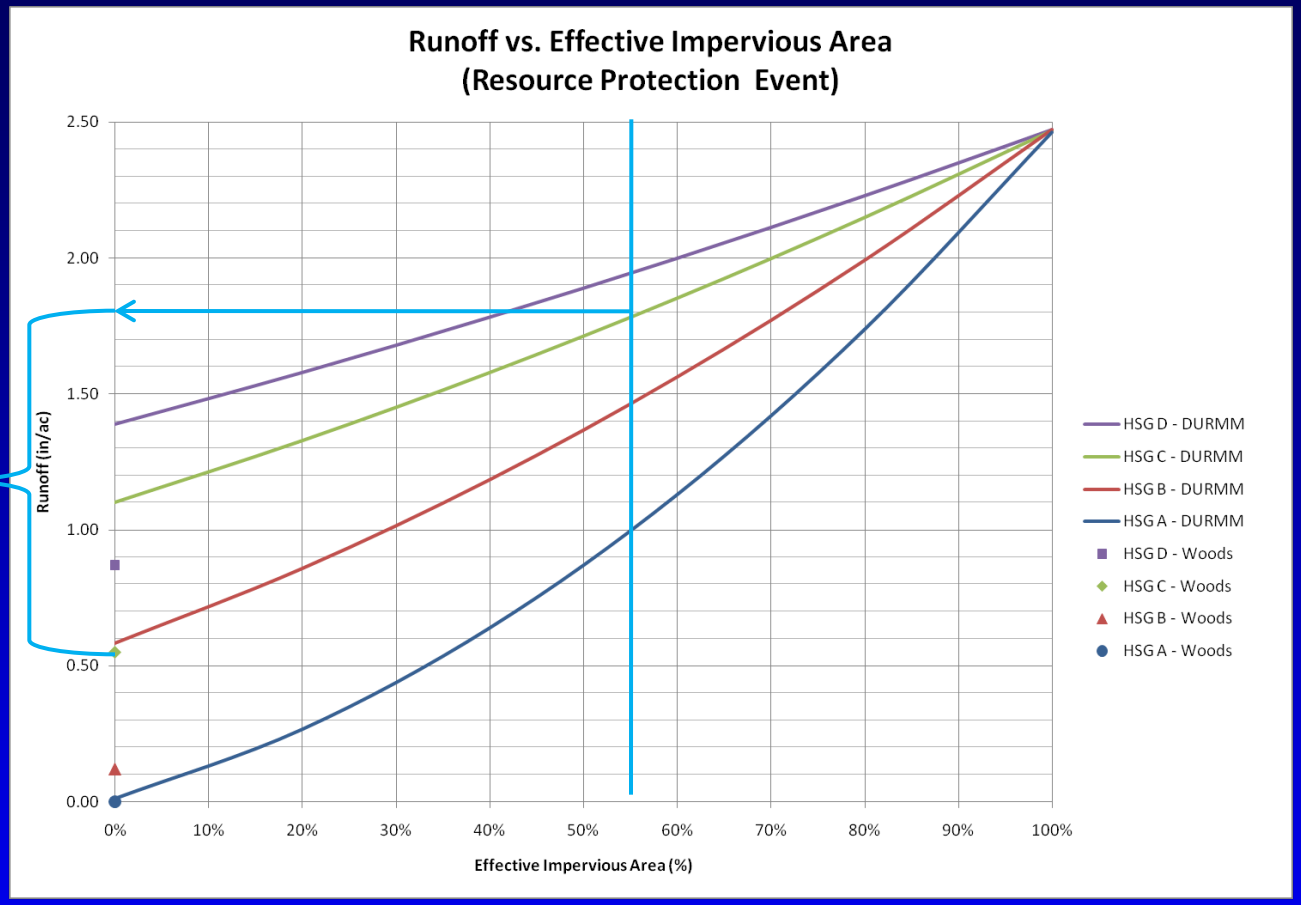
Runoff 1.8”

Minimum RR = 1.8” – 1.1” = 0.7” (38% Reduction)

Existing Woods/Meadow?



Site 2



Site 2: 55% Impervious, HSG C Soil, Existing Woods

Runoff 1.8”

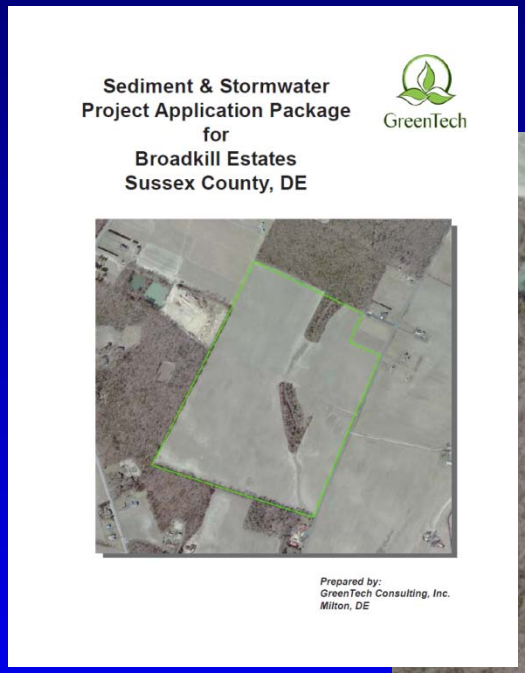
Minimum RR = 1.8” – 0.55” = 1.25” (69% Reduction)

DURMM v.2

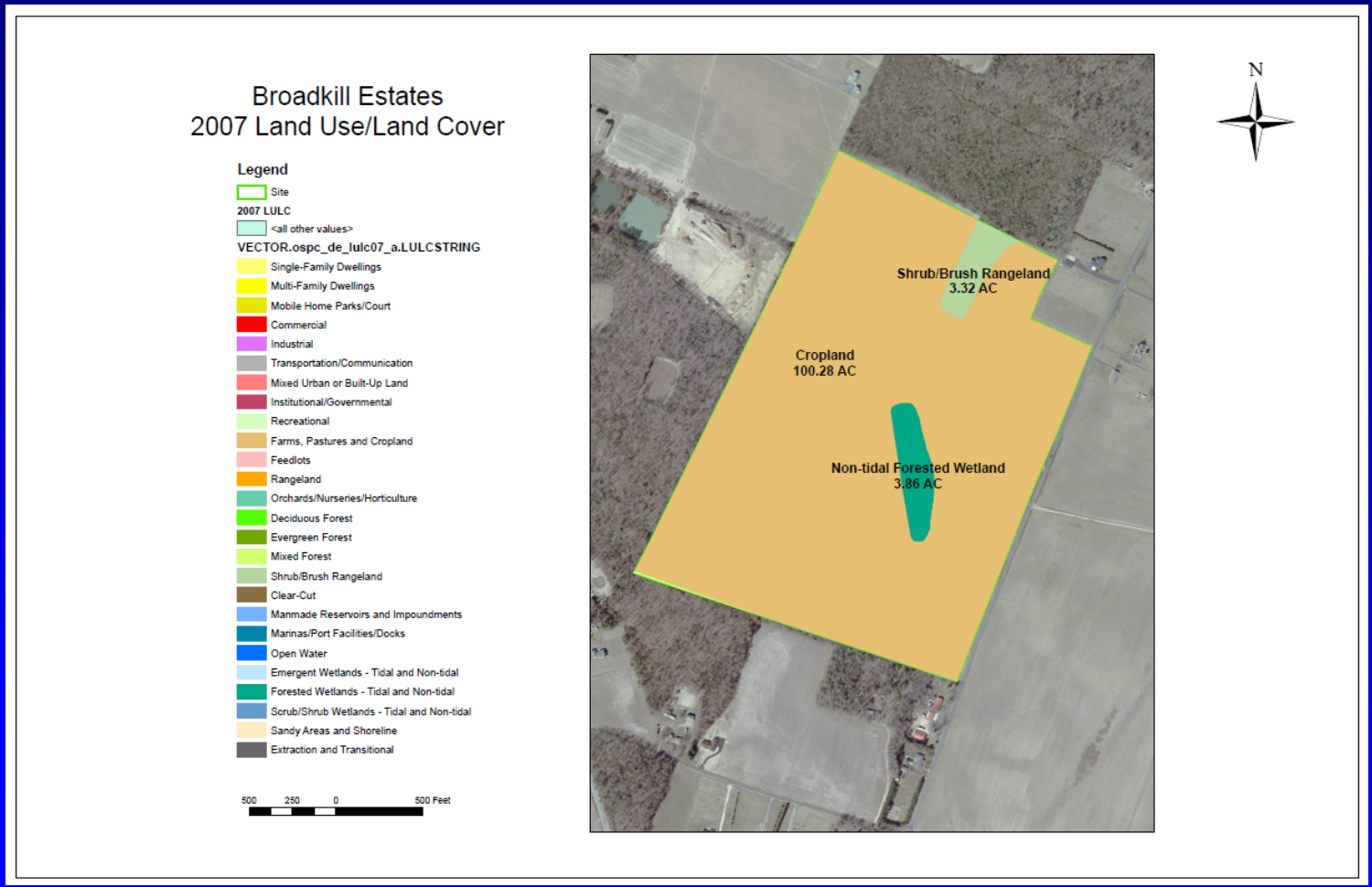
"Broadkill Estates" Example Site

Ex. #1: Concept Level Analysis

Concept Level Analysis



Concept Level Analysis



Concept Level Analysis

United States Department of Agriculture
NRCS
Natural Resources Conservation Service

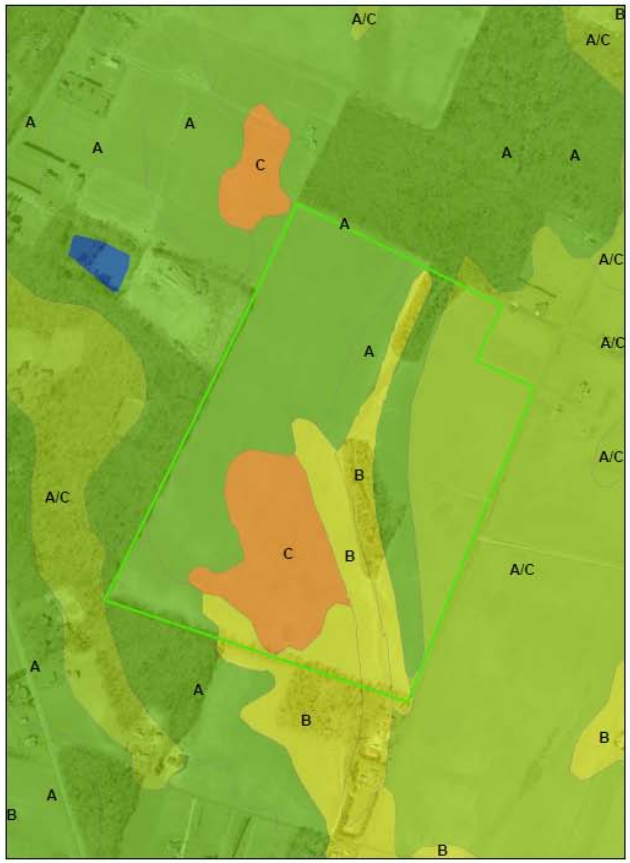
A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

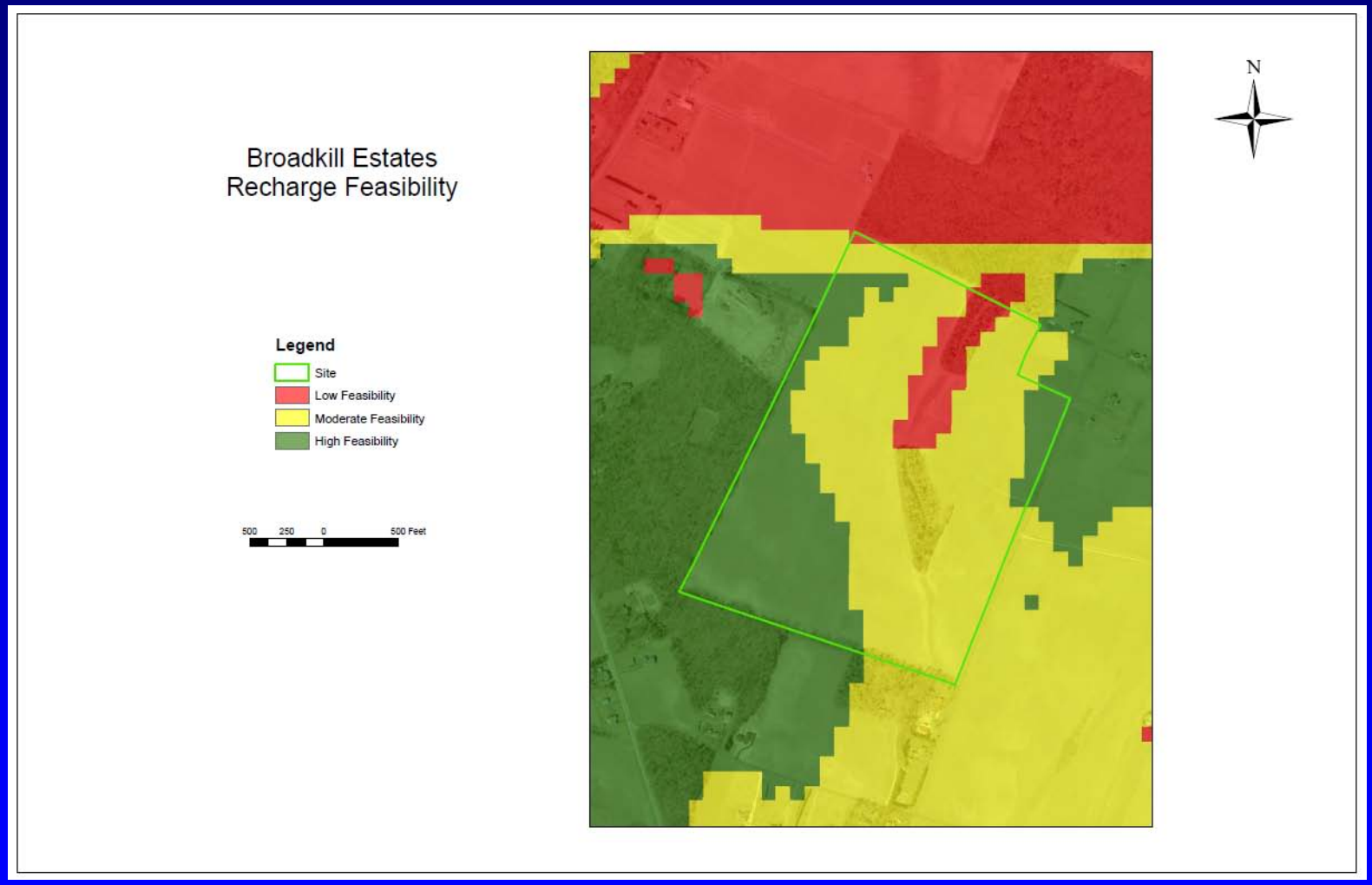
Sussex County, Delaware

SWM Soils Report for Broadkill Estates

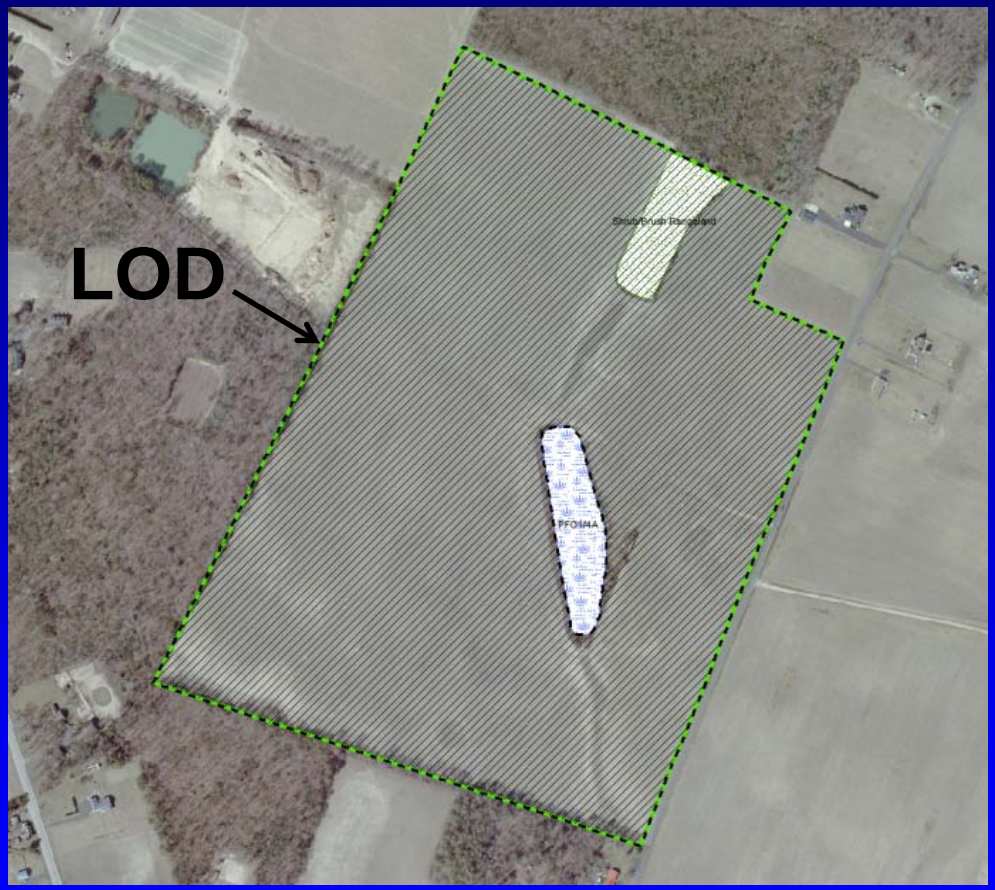
May 8, 2009



Concept Level Analysis

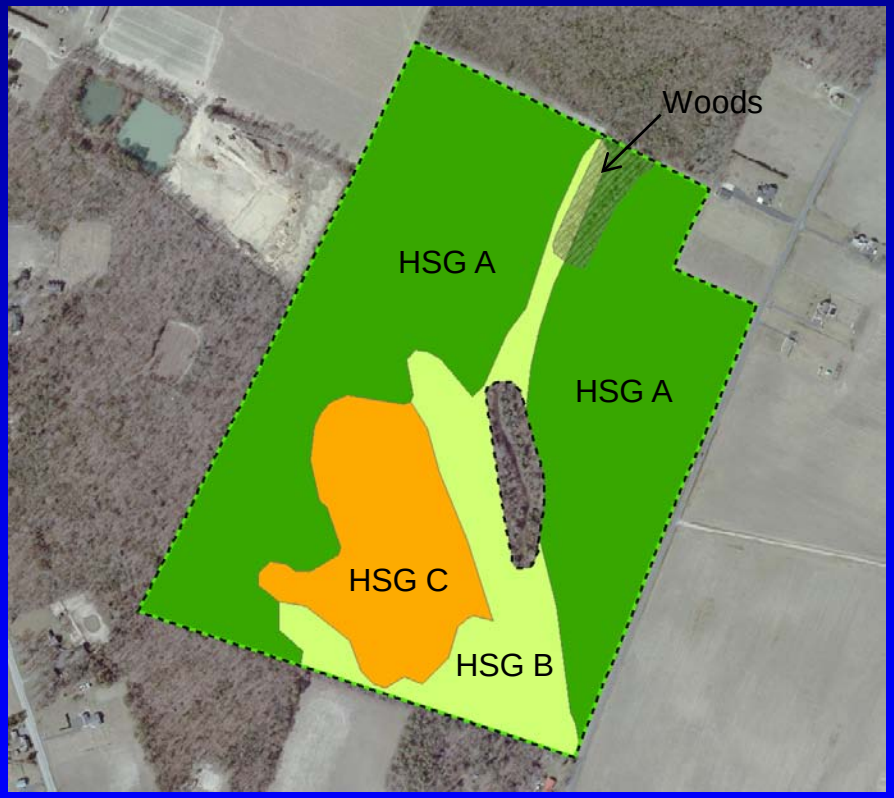


Concept Level Analysis



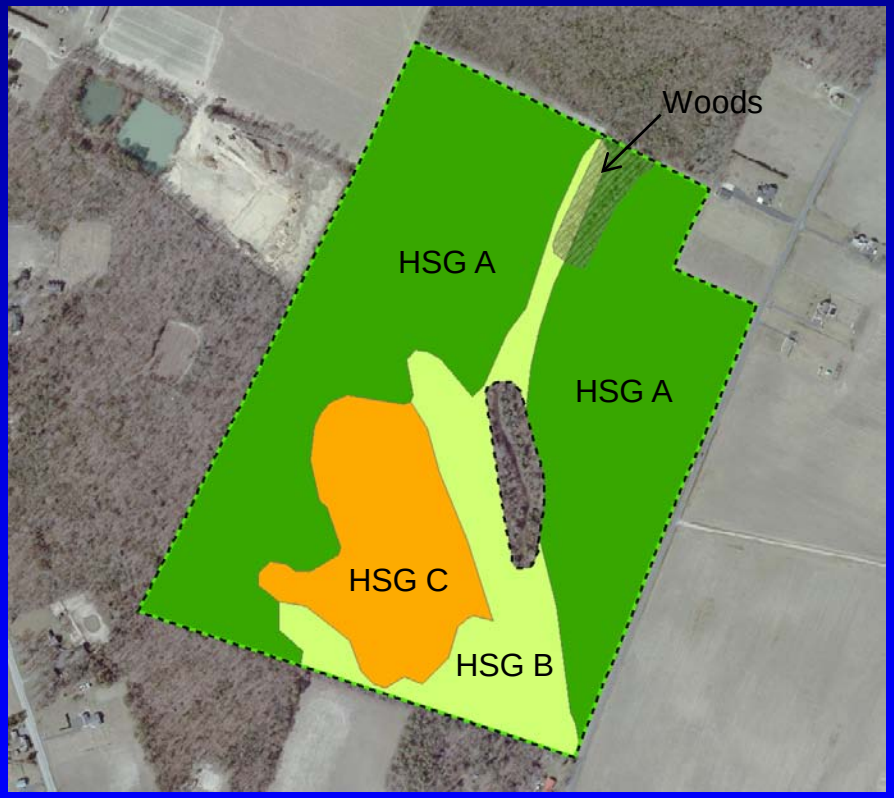
Proposed LU: Residential, 1 ac. lots

Concept Level Analysis
Site Data



- C.A. RCN Tab
  - Residential, 1-ac. (20% imperv.)
    - HSG A: 70.07 ac.
    - HSG B: 17.10 ac.
    - HSG C: 15.56 ac.

Concept Level Analysis
Site Data



- LOD Tab
  - HSG A
    - LOD Area: 70.07 ac.
    - Pre-Dev. Woods: 1.55 ac.
    - Post-Dev. Impervious: 20%
  - HSG B
    - LOD area: 17.10 ac.
    - Pre-Dev. Woods: 0.80 ac.
    - Post-Dev. Impervious: 20%
  - HSG C
    - LOD Area: 15.56 ac.
    - Pre-Dev. Woods: 0 ac.
    - Post-Dev. Impervious: 20%

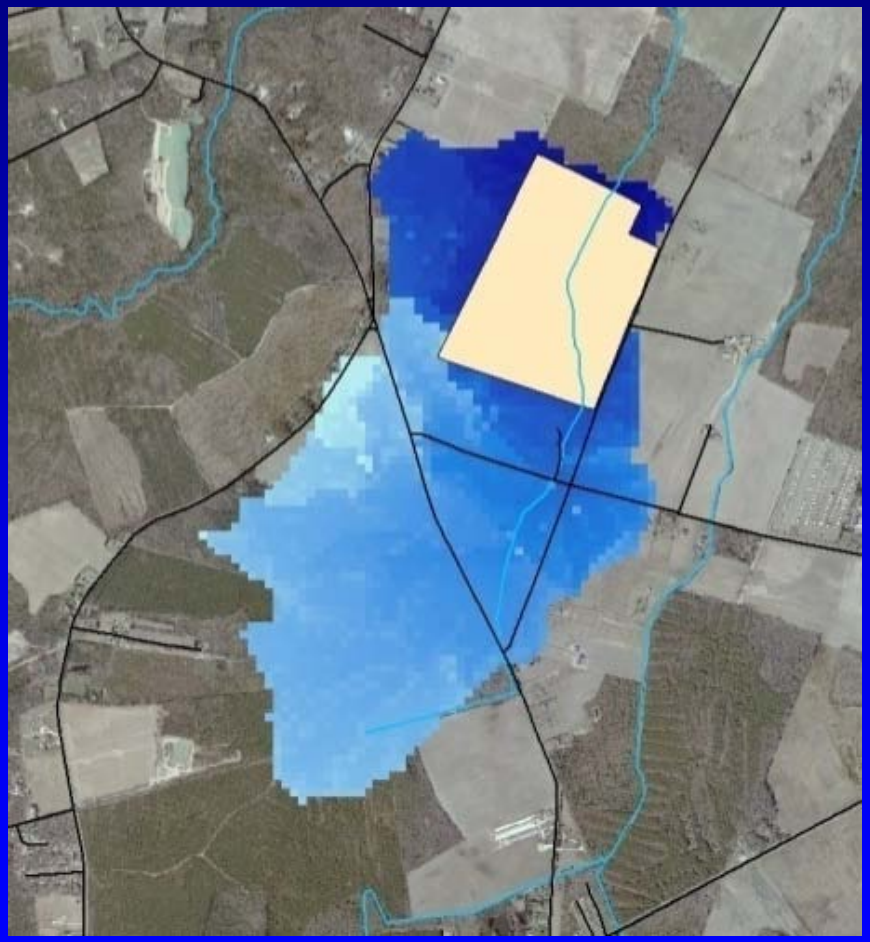
DURMM v.2

"Broadkill Estates" Example Site

Ex. #2: Design Level Analysis

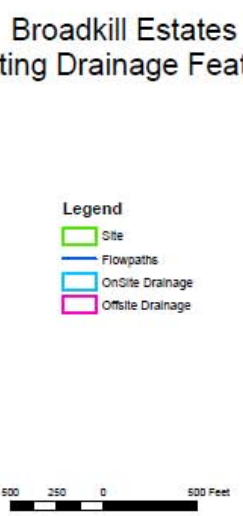
Design Level Analysis

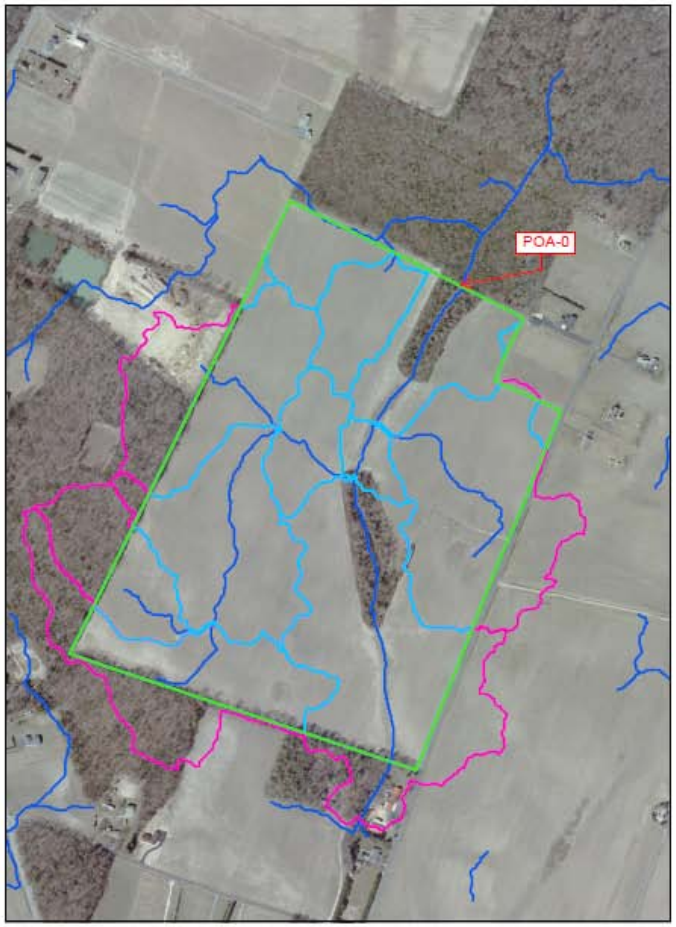
Design Level Analysis



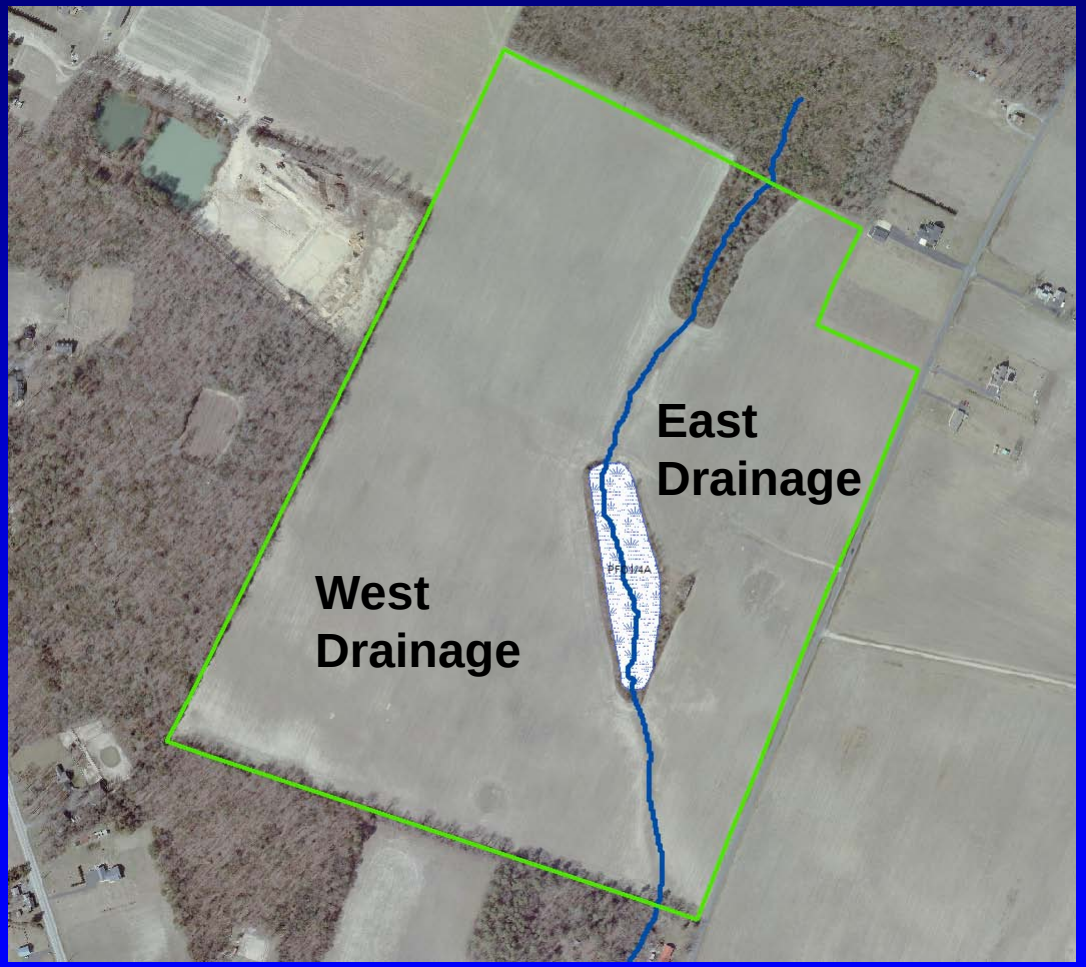
Design Level Analysis

Broadkill Estates
Existing Drainage Features



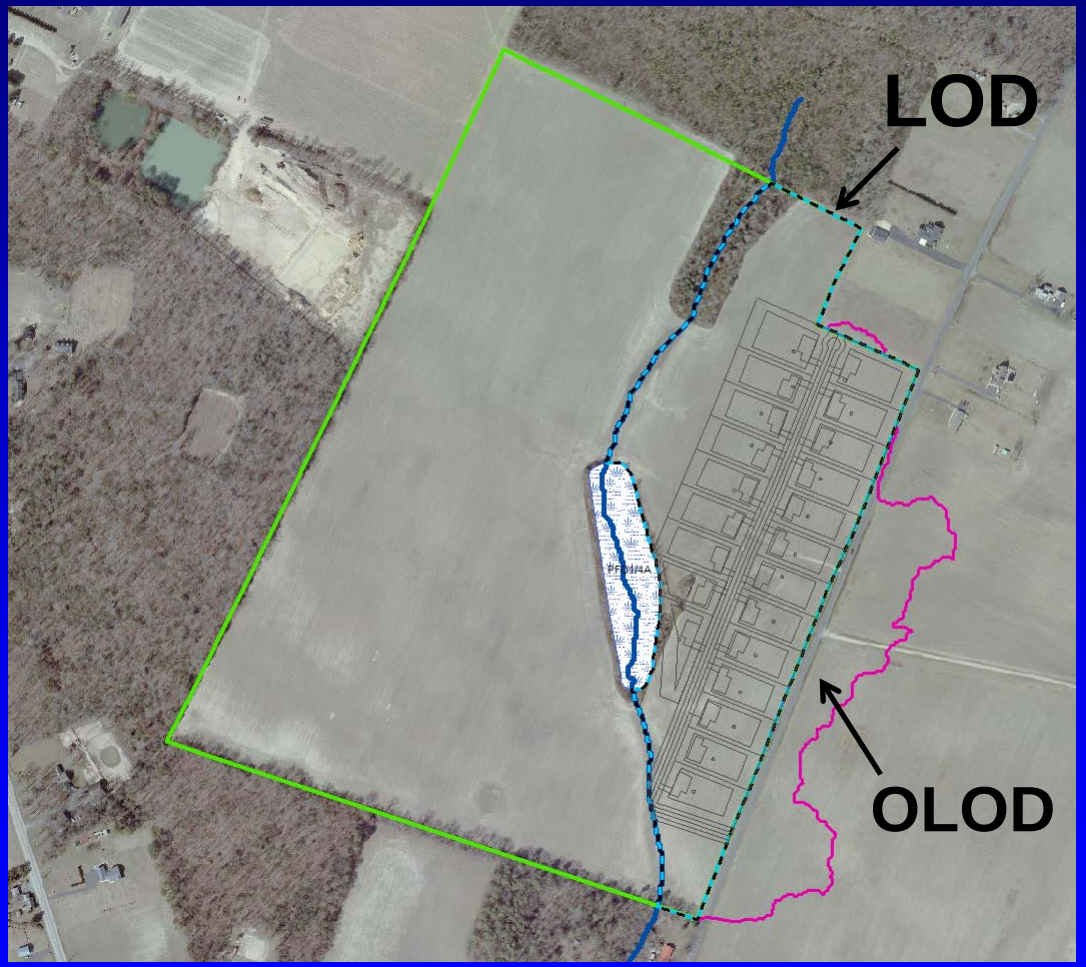


Design Level Analysis



Design Level Analysis

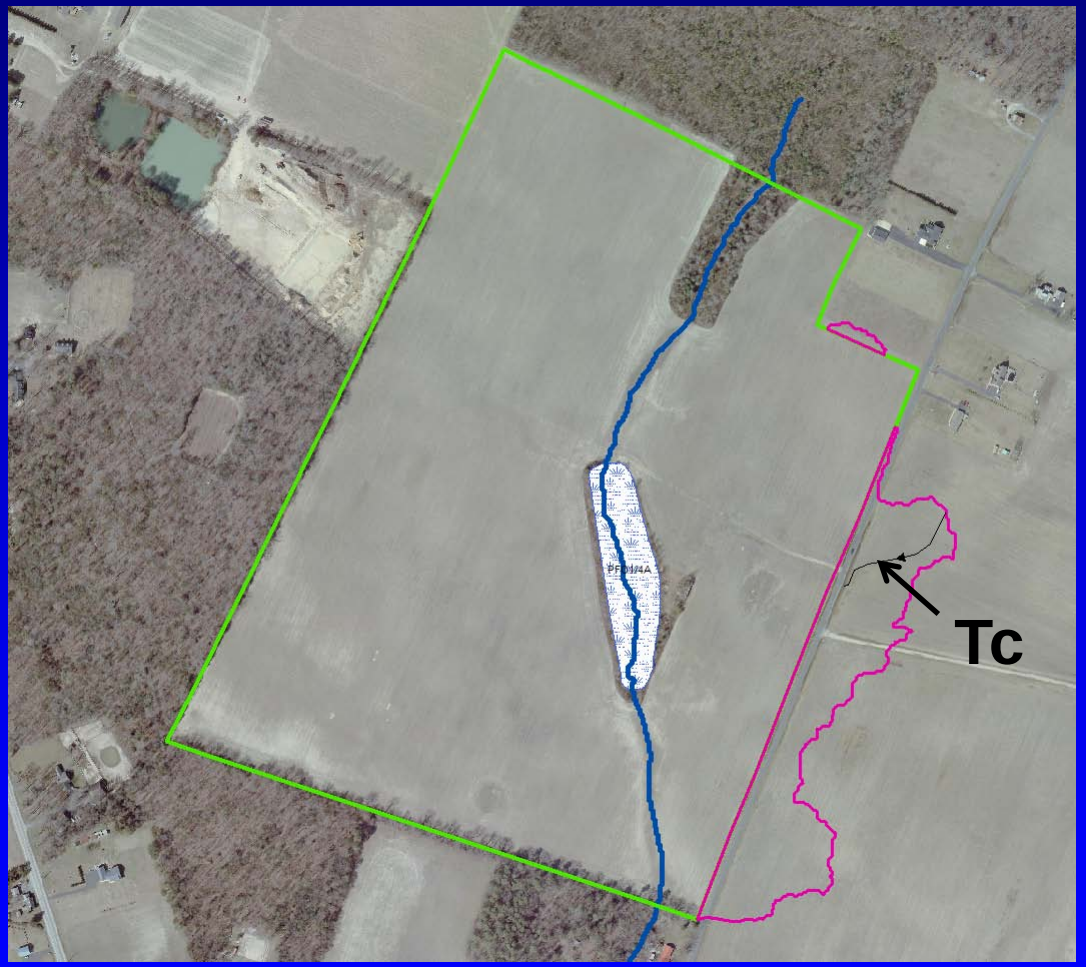
Design Level Analysis



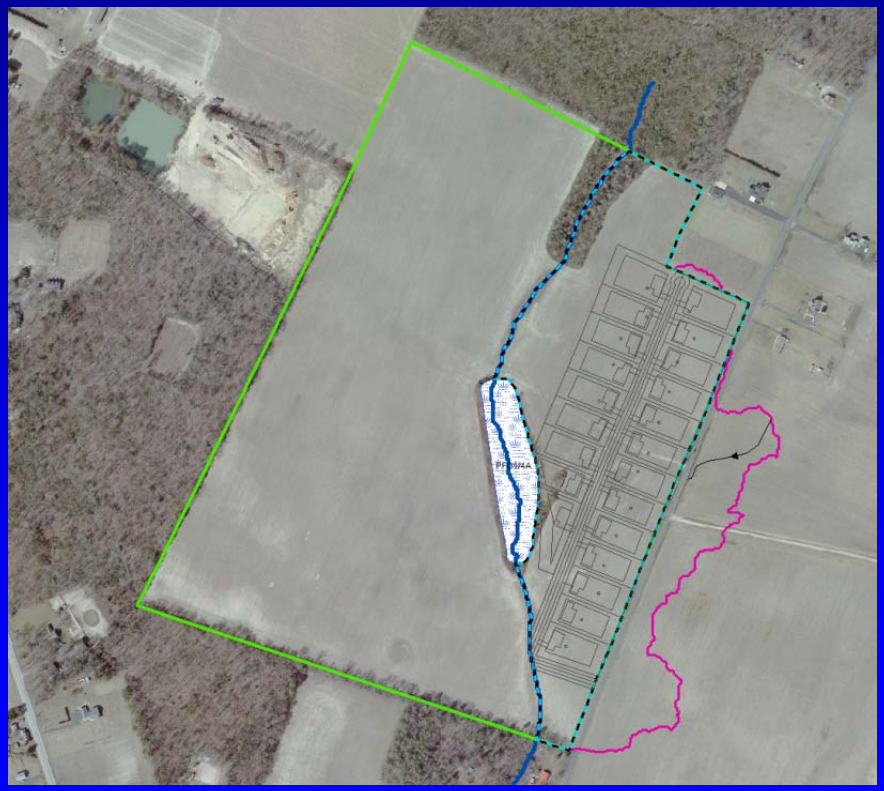
Design Level Analysis

Design Level Analysis

Design Level Analysis

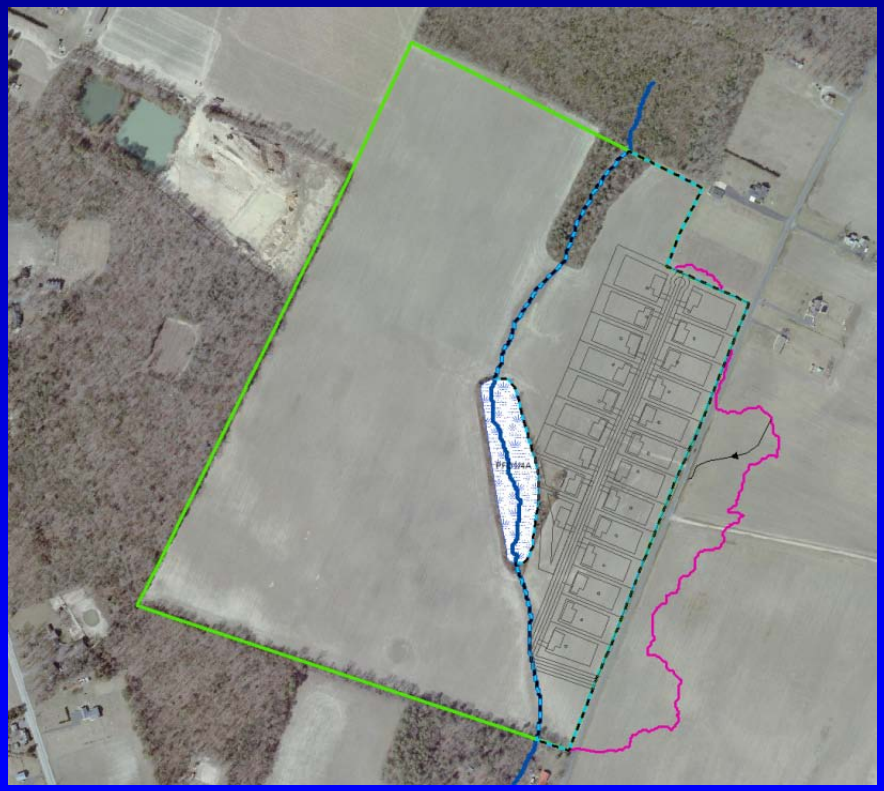


Design Level Analysis
Site Data



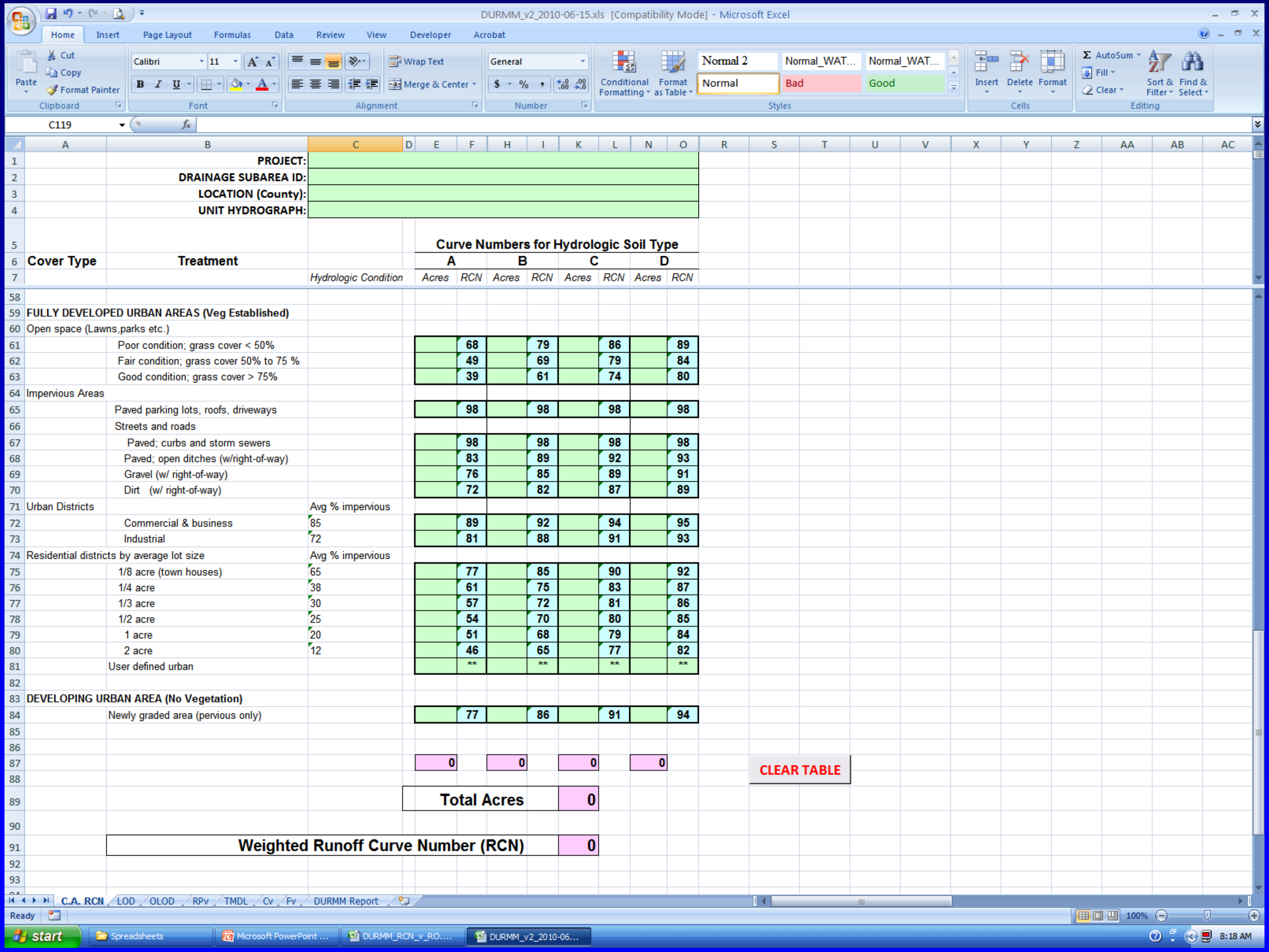
- C.A. RCN Tab
  - 1-ac. residential (20 % imperv.)
    - HSG A: 21.17 ac.
    - HSG B: 0.73 ac
  - Open space
    - HSG A: 8.06 ac.
    - HSG B: 2.26 ac
  - Row Crops, SR + Crop Residue
    - HSG A: 9.68 ac.

Design Level Analysis
Site Data (cont.)



- LOD Tab
  - HSG A
    - LOD area: 29.22 ac.
    - Pre-Dev. Woods: 1.55 ac.
    - Post-Dev. Impervious: 4.23 ac.
  - HSG B
    - LOD area: 2.99 ac.
    - Pre-Dev. Woods: 0 ac.
    - Post-Dev. Impervious: 0.15 ac.
- OLOD Tab
  - Sheet Flow, 100 ft, 0.001 ft/ft, “d”
  - Shallow Conc., 300 ft, 0.002 ft/ft, “u”

Questions?



DURMM_v2_2010-06-15.xls [Compatibility Mode] - Microsoft Excel

Row	Cover Type	Treatment	Hydrologic Condition	A Acres	A RCN	B Acres	B RCN	C Acres	C RCN	D Acres	D RCN
1		PROJECT:									
2		DRAINAGE SUBAREA ID:									
3		LOCATION (County):									
4		UNIT HYDROGRAPH:									
5				Curve Numbers for Hydrologic Soil Type							
58											
59	FULLY DEVELOPED URBAN AREAS (Veg Established)										
60	Open space (Lawns,parks etc.)										
61		Poor condition; grass cover < 50%			68		79		86		89
62		Fair condition; grass cover 50% to 75 %			49		69		79		84
63		Good condition; grass cover > 75%			39		61		74		80
64	Impervious Areas										
65		Paved parking lots, roofs, driveways			98		98		98		98
66		Streets and roads									
67		Paved; curbs and storm sewers			98		98		98		98
68		Paved; open ditches (w/right-of-way)			83		89		92		93
69		Gravel (w/ right-of-way)			76		85		89		91
70		Dirt (w/ right-of-way)			72		82		87		89
71	Urban Districts		Avg % impervious								
72		Commercial & business	85		89		92		94		95
73		Industrial	72		81		88		91		93
74	Residential districts by average lot size		Avg % impervious								
75		1/8 acre (town houses)	65		77		85		90		92
76		1/4 acre	38		61		75		83		87
77		1/3 acre	30		57		72		81		86
78		1/2 acre	25		54		70		80		85
79		1 acre	20		51		68		79		84
80		2 acre	12		46		65		77		82
81		User defined urban			**		**		**		**
82											
83	DEVELOPING URBAN AREA (No Vegetation)										
84		Newly graded area (pervious only)			77		86		91		94
87				0		0		0		0	

CLEAR TABLE

Total Acres 0

Weighted Runoff Curve Number (RCN) 0

Sheets: C.A. RCN, LOD, OLOD, RPv, TMDL, Cv, Fv, DURMM Report

Discussion