



# Control Target for Post Development Flows

**Vermont Stormwater Management Manual Update, Meeting #4**

**Shelburne, Vermont Town Office**

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# Options for the Control Target

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## ■ Channel Protection Volume

- Current practice: 12 or 24 Extended Detention for runoff from the 1-year storm (2.1-2.3”).
- Possible new criteria: Runoff Reduction to reflect the “before development” runoff condition, such as woods or meadow in “good” hydrologic condition.

# CN Comparison

HSG	A	B	C	D
<u>Land Use</u>				
Woods	30 <sup>1</sup>	55	70	77
Meadow	30 <sup>1</sup>	58	71	78
Pasture	39	61	74	80

<sup>1</sup> Many Jurisdictions limit minimum CN to 38 (e.g., MD)



# Runoff Reduction Theory

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- Practices size to capture and retain enough rainfall so runoff leaving site is reduced to the equivalent of the desired target (e.g., woods in “good condition”)
- GI practices typically sized for only the  $WQ_v$
- Volume of  $Cp_v$  is then reduced (based on the  $WQ_v$  or other storage provided by up-gradient GI practices)
- Reduced curve numbers (CNs) calculated (or provided) based on amount of upstream storage

# CN Hydrology

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- Based on NRCS Methods and Rainfall Runoff Relationships

- $Q = (P - 0.2*S)^2 / (P + 0.8*S)$       and     $S = (1000/CN) - 10$

so

- $CN = 1000 / [(10 + 5P + 10Q) - 10(Q^2 + 1.25Q*P)^{1/2}]$

or

- $CN = 200 / [(P + 2Q + 2) - (5*P*Q + 4*Q^2)^{1/2}]$     where:

CN = curve number

P = Rainfall (in inches)

Q = Runoff Volume (in inches)

# CN Reduction Method

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- $Q_{adj} = Q_{cpv} - Q_{WQv}$

- $CN_{adj} = 200 / [ (P + 2Q_{adj} + 2) - (5 * P * Q_{adj} + 4 * Q_{adj}^2)^{1/2} ]$

where:

- $CN_{adj}$  = New CN used to test compliance or used in sizing
- $P$  = 1 year rainfall (in inches)
- $Q_{adj}$  = reduced CN



# Typical Runoff Reduction (Nashville)

GI Practice	% Rainfall Volume Removed/Captured - RR Credit							
	Level 1 Practices				Level 2 Practices			
Bioretention	60				80			
Urban bioretention	60				N/A			
Permeable Pavement	45				75			
Infiltration Trench	50				90			
Water Quality Swale	40				60			
Extended Detention	15				N/A			
Downspout Disconnection	25				50			
Grass Channel	10/20				20/30			
Sheet Flow	50				75			
Reforestation (A, B, C, D Soils)	96	94	92	90	98	97	96	95
Rain Tanks/Cisterns	Design dependant							
Green Roof	80				90			

Volume reductions based on 1" WQ<sub>v</sub>

# Maryland CN Tables (based on $P = 2.7''$ ) and some fuzzy math

Hydrologic Soil Group B										
%I	RCN*	$P_E = 1''$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	61									
5%	63									
10%	65									
15%	67	55								
20%	68	60	55	55						
25%	70	64	61	58						
30%	72	65	62	59	55					
35%	74	66	63	60	56					
40%	75	66	63	60	56					
45%	78	68	66	62	58					
50%	80	70	67	64	60					
55%	81	71	68	65	61	55				
60%	83	73	70	67	63	58				
65%	85	75	72	69	65	60	55			
70%	87	77	74	71	67	62	57			
75%	89	79	76	73	69	65	59			
80%	91	81	78	75	71	66	61			
85%	92	82	79	76	72	67	62	55		
90%	94	84	81	78	74	70	65	59	55	
95%	96	87	84	81	77	73	69	63	57	
100%	98	89	86	83	80	76	72	66	59	55

# Vermont CN Tables (based on P = 2.7") and using exact CN Hydrology methods

HydroGroup B											
Predevelopment CN		55									
		Storm Depth Treated by Runoff Reduction/ESD Practices (inches)									
%I	CN	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	
0%	61	57.1	56.0	54.8	53.3	51.1	48.8	48.8	48.8	48.8	
5%	63	55.4	52.6	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
10%	65	54.0	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
15%	67	52.9	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
20%	68	52.4	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
25%	70	52.9	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
30%	72	54.1	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
35%	74	55.7	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
40%	76	57.6	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
45%	78	59.5	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
50%	80	61.6	50.9	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
55%	81	63.8	55.7	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
60%	83	66.0	59.0	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
65%	85	68.3	62.0	48.8	48.8	48.8	48.8	48.8	48.8	48.8	
70%	87	70.7	65.0	55.2	48.8	48.8	48.8	48.8	48.8	48.8	
75%	89	73.1	67.8	60.1	48.8	48.8	48.8	48.8	48.8	48.8	
80%	91	75.6	70.7	64.0	48.8	48.8	48.8	48.8	48.8	48.8	
85%	92	78.1	73.6	67.7	58.4	48.8	48.8	48.8	48.8	48.8	
90%	94	80.7	76.5	71.2	63.8	48.8	48.8	48.8	48.8	48.8	
95%	96	83.3	79.4	74.6	68.4	58.3	48.8	48.8	48.8	48.8	
100%	98	86.0	82.4	78.1	72.6	65.0	48.8	48.8	48.8	48.8	

**Questions?**

