How Does this Affect Storm Water Runoff Calculations?

- It changes "Potential maximum retention after runoff begins" (inches)
- It changes "Initial Abstraction" (inches)
- It changes "Runoff" (inches)

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
I_a = initial abstraction (in)

$$I_a = 0.2S$$

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \frac{1000}{CN} - 10$$

$$Q = \frac{(P - 0.2*(1000/RCN-10))^2}{P + 0.8*(1000/RCN-10)}$$

NRCS Technical Release 55, Urban Hydrology for Small Watersheds, June 1986

Table 4-1 TR-55 Manual

Table 4-1 I_a values for runoff curve numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

Equation 2-3 (Figure 2-1) TR-55 Manual

Figure 2-1 Solution of runoff equation.

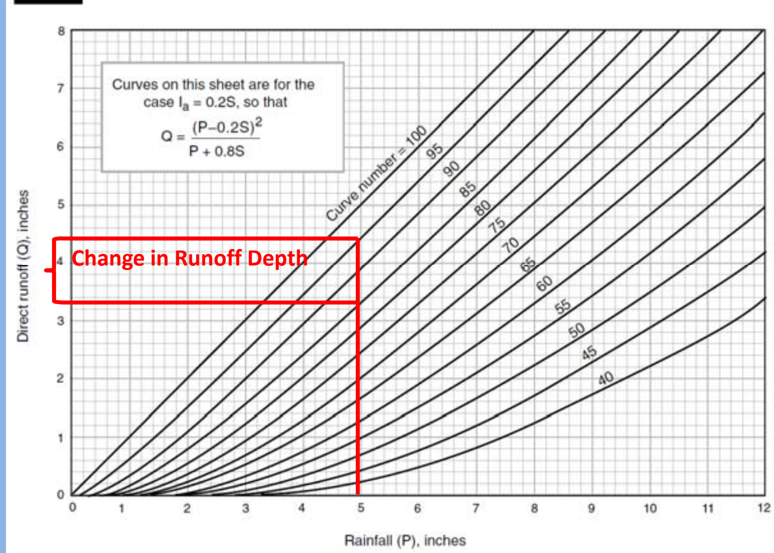


Table 2.1 TR-55 Manual

Table 2-1 Runoff depth for selected CN's and rainfall amounts 1/

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

What Happens When Adjusted HSGs Are Compared to Non-Adjusted

- These are only hydrologic models, but they show substantial differences from the what is considered "acceptable" engineering practices today
  - Overall runoff volume increases
  - Peak flow rates increase
- How Much More?
  - Depends on what is being modeled
  - Example 1
    - 10 Acre Developed Residential Lots (1/4 Acre)
      - C to D
  - Example 2
    - 10 Acre Developed Residential Lots (1/4 Acre)
      - B to D
  - Example 3
    - 10 Acre Commercial Development
      - B to D

Adjusted Hydrologic Soil Group for Construction Examples

Example 1 C to D

Examples 2&3 B to D

Soil Map Unit Component	HSG[1]	Post-Const HSG
Aaron	C	D
Abscota Variant (Warren)	A	No Eval.
Adrian	A/D	D
Aetna	B/D	D
Alexandria	C	D
Alford	B	D
Algansee	A/D	D
Algiers	B/D	D
Allegheny	B	C
Allegheny Variant (Belmont, Pike)	B	No Eval.
Allis	D	D
Alvada	B/D	D
Amanda	C	D
Amanda Variant (Licking)	B	No Eval.
Arkport	A	A
Ashton	B	D
Atlas	D	D
Aurand	C/D	D
Ava	C	D
Avonburg	D	D
Barkcamp	A	No Eval.
Barkcamp (CL surface)	A	A
Barkcamp (L surface)	A	B
Beasley	C	No Eval.
Beaucoup	C/D	D
Belmore	B	C
Belpre	C	No Eval.
Bennington	C/D	D
Berks	B	D
Bethesda	C	D
Biglick	D	D
Birkbeck	B	D
Bixler	B	D
Blairton	C	No Eval.
Blakeslee	B/D	D
Blanchester	C/D	D
Blount	C/D	D
Bogart	B/D	D
Bogart Variant (Mahoning)	C	No Eval.
Bonnell	C	D
Bonnie	C/D	D
Bono	C/D	D

Ohio's Standards for Stormwater Management Land Development and Urban Stream Protection * Third Edition 2006 (Appendix 9 *Updated 2012)

Example 1

Cover Description	Condition	A	CN	B	CN	C	CN	D	CN
		Area (Acres) for Hydrologic Soil Groups							
Residential districts (by average lot size)	Avg % Imperv								
1/8 acre (town houses)	65		77		85		90		92
1/4 acre	38		61		75	10.000	83	10.000	87
1/3 acre	30		57		72		81		86
1/2 acre	25		54		70		80		85
1 acre	20		51		68		79		84
2 acre	12		46		65		77		82

HSG Adjustment on Runoff Volume Totals Example 1

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
I_a = initial abstraction (in)

$$I_a = 0.2S$$

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \frac{1000}{CN} - 10$$

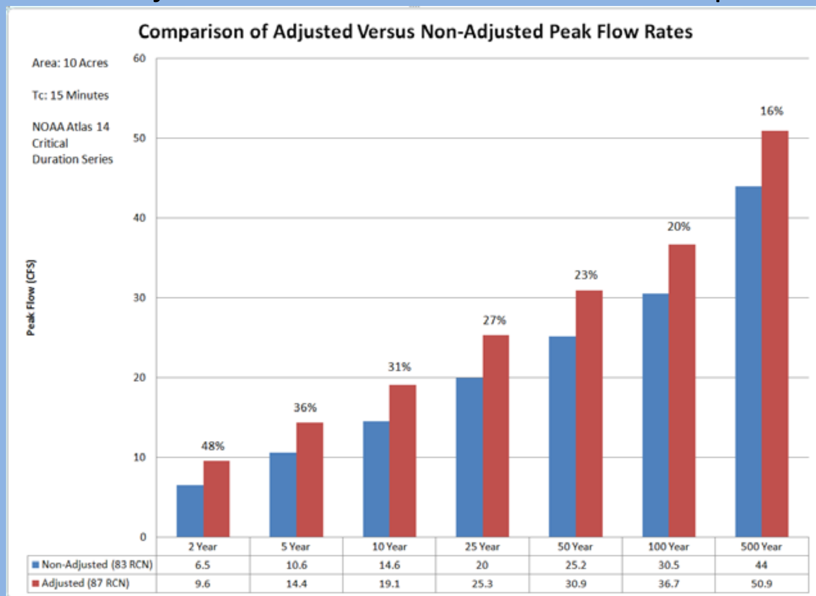
$$Q = \frac{(P - 0.2*(1000/RCN-10))^2}{P + 0.8*(1000/RCN-10)}$$

1.
- 6.5”, 83RCN
  - 4.55” runoff
- 6.5”, 87RCN
  - 5” runoff
- 10% More

2.
- 4.0”, 83RCN
  - 2.3” runoff
- 4.0”, 87RCN
  - 2.6” runoff
- 13% More

3.
- 1.5”, 83RCN
  - 0.4” runoff
- 1.5”, 87RCN
  - 0.5” runoff
- 25% More

HSG Adjustment on Runoff Peak Flows Example 1



Example 2

		Area (Acres) for Hydrologic Soil Groups							
Cover Description	Condition	A	CN	B	CN	C	CN	D	CN
Residential districts (by average lot size)	Avg % Imperv								
1/8 acre (town houses)	65		77		85		90		92
1/4 acre	38		61	10.000	75		83	10.000	87
1/3 acre	30		57		72		81		86
1/2 acre	25		54		70		80		85
1 acre	20		51		68		79		84
2 acre	12		46		65		77		82

HSG Adjustment on Runoff Volume Totals Example 2

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
I_a = initial abstraction (in)

$$I_a = 0.2S$$

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \frac{1000}{CN} - 10$$

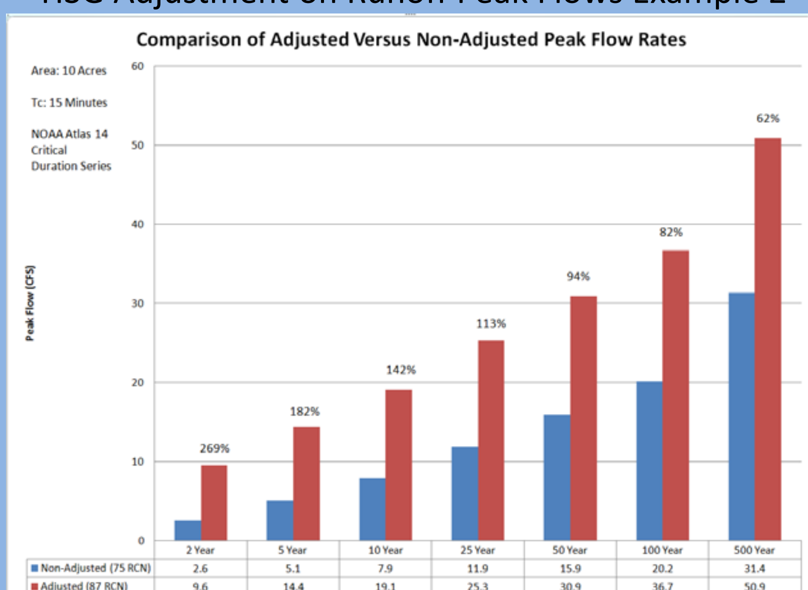
$$Q = \frac{(P - 0.2*(1000/RCN-10))^2}{P + 0.8*(1000/RCN-10)}$$

1.
   - 6.5”, 75RCN
     - 3.7” runoff
   - 6.5”, 87RCN
     - 5” runoff
   - 35% More

2.
   - 4.0”, 75RCN
     - 1.7” runoff
   - 4.0”, 87RCN
     - 2.6” runoff
   - 53% More

3.
   - 1.5”, 75RCN
     - 0.2” runoff
   - 1.5”, 87RCN
     - 0.5” runoff
   - 150% More

HSG Adjustment on Runoff Peak Flows Example 2



Example 3

		Area (Acres) for Hydrologic Soil Groups								
Cover Description	Condition		A	CN	B	CN	C	CN	D	CN
Urban Districts	Avg % Imperv									
Commercial & business	85			89	10.000	92		94	10.000	95
Industrial	72			81		88		91		93

HSG Adjustment on Runoff Volume Totals Example 3

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
I_a = initial abstraction (in)

$$I_a = 0.2S$$

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \frac{1000}{CN} - 10$$

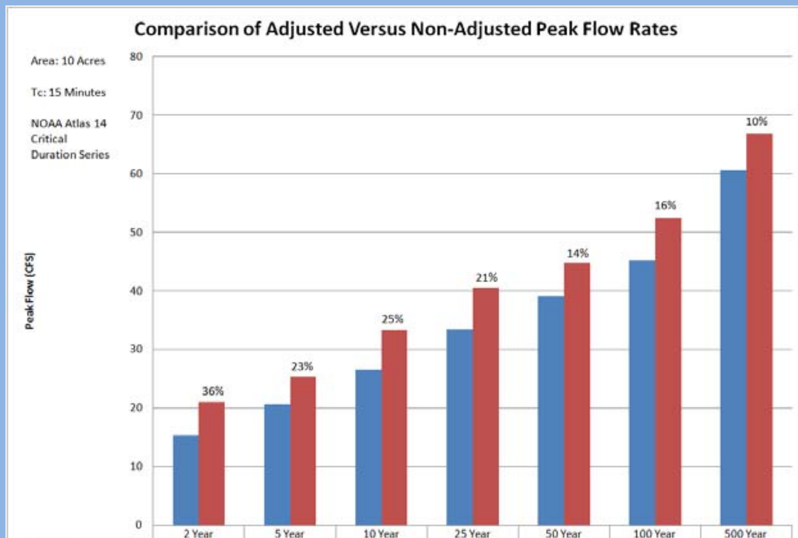
$$Q = \frac{(P - 0.2*(1000/RCN-10))^2}{P + 0.8*(1000/RCN-10)}$$

1.
  - 6.5”, 92RCN
    - 5.55” runoff
  - 6.5”, 95RCN
    - 5.9” runoff
  - 6% More

2.
  - 4.0”, 92RCN
    - 3.1” runoff
  - 4.0”, 95RCN
    - 3.4” runoff
  - 10% More

3.
  - 1.5”, 92RCN
    - 0.8” runoff
  - 1.5”, 95RCN
    - 1.0” runoff
  - 25% More

HSG Adjustment on Runoff Peak Flows Example 3



	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Non-Adjusted (92 RCN)	15.4	20.7	26.6	33.4	39.1	45.3	60.6
Adjusted (95 RCN)	21	25.4	33.3	40.5	44.7	52.4	66.8