PROPOSED CONDITIONS

100 YEAR STORM

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 10S: Overland runoff to the northwest Runoff Area=3.210 ac Runoff Depth>4.91"
Flow Length=625' Tc=15.8 min CN=88 Runoff=13.98 cfs 1.313 af

Subcatchment 20S: Overland runoff to grass channel Runoff Area=1.410 ac Runoff Depth>5.34"
Flow Length=190' Tc=5.0 min CN=92 Runoff=8.77 cfs 0.628 af

Subcatchment 30S: Overland runoff to south Runoff Area=3.020 ac Runoff Depth>4.91"
Flow Length=521' Tc=16.2 min CN=88 Runoff=13.04 cfs 1.235 af

Subcatchment 40S: Roof Runoff to Grass Channel Runoff Area=0.380 ac Runoff Depth>5.87"
Flow Length=300' Tc=5.0 min CN=98 Runoff=2.48 cfs 0.186 af

Subcatchment 50S: Overland runoff to southwest Runoff Area=0.300 ac Runoff Depth>3.45"
Flow Length=110' Tc=5.0 min CN=74 Runoff=1.30 cfs 0.086 af

Reach 12R: Driveway Crossing Peak Depth=1.15' Max Vel=6.0 fps Inflow=13.98 cfs 1.313 af
D=15.0" n=0.013 L=100.0' S=0.0100 '/' Capacity=12.92 cfs Outflow=13.88 cfs 1.312 af

Link DP1: Design Point 1 Inflow=33.27 cfs 3.448 af
Primary=33.27 cfs 3.448 af

Total Runoff Area = 8.320 ac Runoff Volume = 3.448 af Average Runoff Depth = 4.97"

Subcatchment 10S: Overland runoff to the northwest

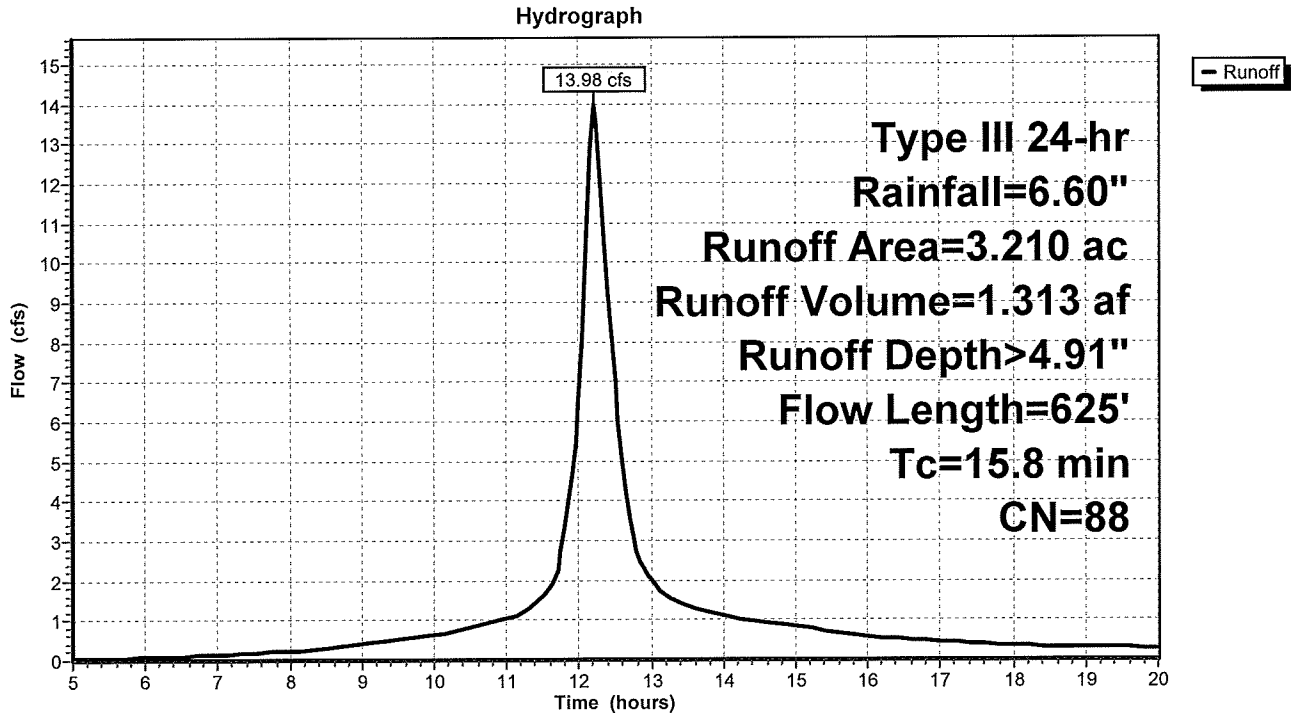
Runoff = 13.98 cfs @ 12.21 hrs, Volume= 1.313 af, Depth> 4.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=6.60"

Area (ac)	CN	Description
1.920	98	Paved parking & roofs
0.740	74	>75% Grass cover, Good, HSG C
0.550	70	Woods, Good, HSG C
3.210	88	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	50	0.0200	0.1		**Sheet Flow, Path 1** Woods: Light underbrush n= 0.400 P2= 3.00"
1.9	275	0.0146	2.5		**Shallow Concentrated Flow, Path 2** Paved Kv= 20.3 fps
1.2	300	0.0133	4.0	32.08	**Channel Flow, Path 3** Area= 8.0 sf Perim= 13.6' r= 0.59' n= 0.030 Earth, grassed & winding
15.8	625	Total			

Subcatchment 10S: Overland runoff to the northwest



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Hydrograph for Subcatchment 10S: Overland runoff to the northwest

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.37	0.01	0.03
5.25	0.40	0.01	0.04
5.50	0.42	0.02	0.05
5.75	0.45	0.02	0.06
6.00	0.48	0.03	0.07
6.25	0.50	0.03	0.08
6.50	0.53	0.04	0.10
6.75	0.56	0.05	0.12
7.00	0.60	0.06	0.14
7.25	0.63	0.08	0.16
7.50	0.67	0.09	0.18
7.75	0.71	0.11	0.20
8.00	0.75	0.12	0.23
8.25	0.80	0.15	0.26
8.50	0.85	0.17	0.30
8.75	0.90	0.20	0.34
9.00	0.96	0.23	0.40
9.25	1.03	0.27	0.45
9.50	1.10	0.31	0.51
9.75	1.17	0.36	0.57
10.00	1.25	0.41	0.63
10.25	1.33	0.46	0.70
10.50	1.43	0.53	0.81
10.75	1.53	0.61	0.92
11.00	1.65	0.69	1.05
11.25	1.79	0.80	1.23
11.50	1.97	0.94	1.61
11.75	2.34	1.25	2.71
12.00	3.30	2.09	**6.49**
12.25	4.26	2.97	**13.51**
12.50	4.63	3.32	7.00
12.75	4.81	3.49	3.09
13.00	4.95	3.62	1.99
13.25	5.07	3.73	1.54
13.50	5.17	3.83	1.36
13.75	5.27	3.92	1.24
14.00	5.35	4.00	1.12
14.25	5.43	4.08	1.01
14.50	5.50	4.15	0.94
14.75	5.57	4.22	0.88
15.00	5.64	4.28	0.83
15.25	5.70	4.34	0.77
15.50	5.75	4.39	0.71
15.75	5.80	4.44	0.65
16.00	5.85	4.48	0.59
16.25	5.89	4.52	0.54
16.50	5.93	4.56	0.51
16.75	5.97	4.59	0.48
17.00	6.00	4.63	0.46
17.25	6.04	4.66	0.43
17.50	6.07	4.69	0.41
17.75	6.10	4.72	0.38
18.00	6.12	4.75	0.35
18.25	6.15	4.77	0.33
18.50	6.18	4.80	0.32
18.75	6.20	4.82	0.31
19.00	6.23	4.84	0.31
19.25	6.25	4.87	0.30
19.50	6.27	4.89	0.29
19.75	6.29	4.91	0.28
20.00	**6.32**	**4.93**	0.28

Subcatchment 20S: Overland runoff to grass channel

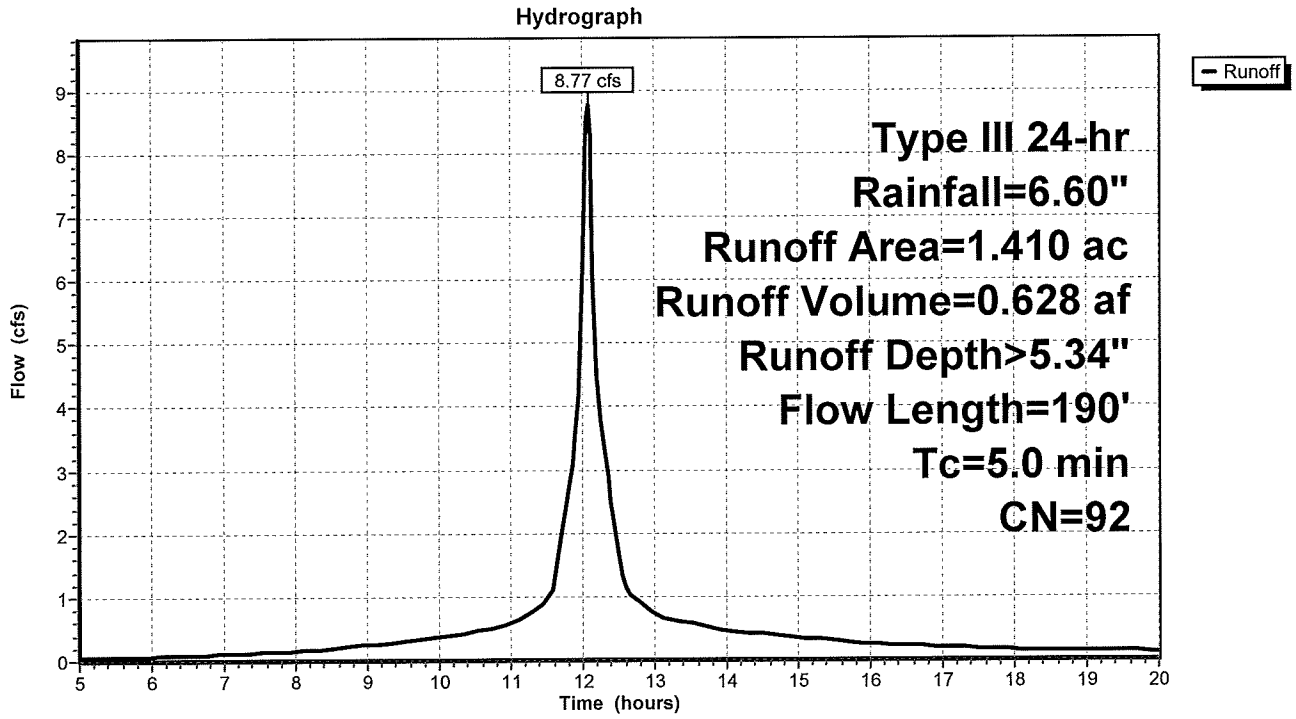
Runoff = 8.77 cfs @ 12.07 hrs, Volume= 0.628 af, Depth> 5.34"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=6.60"

Area (ac)	CN	Description
1.070	98	Paved parking & roofs
0.340	74	>75% Grass cover, Good, HSG C
1.410	92	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	190		0.6		**Direct Entry, Path 1**

Subcatchment 20S: Overland runoff to grass channel



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Hydrograph for Subcatchment 20S: Overland runoff to grass channel

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.37	0.04	0.04
5.25	0.40	0.05	0.05
5.50	0.42	0.06	0.06
5.75	0.45	0.07	0.06
6.00	0.48	0.08	0.07
6.25	0.50	0.09	0.07
6.50	0.53	0.10	0.08
6.75	0.56	0.12	0.09
7.00	0.60	0.14	0.10
7.25	0.63	0.16	0.12
7.50	0.67	0.18	0.13
7.75	0.71	0.20	0.14
8.00	0.75	0.23	0.15
8.25	0.80	0.26	0.17
8.50	0.85	0.29	0.20
8.75	0.90	0.33	0.22
9.00	0.96	0.37	0.25
9.25	1.03	0.42	0.27
9.50	1.10	0.47	0.30
9.75	1.17	0.53	0.33
10.00	1.25	0.59	0.36
10.25	1.33	0.66	0.40
10.50	1.43	0.74	0.46
10.75	1.53	0.83	0.52
11.00	1.65	0.93	0.57
11.25	1.79	1.05	0.73
11.50	1.97	1.21	0.93
11.75	2.34	1.55	2.31
12.00	3.30	2.45	**6.08**
12.25	4.26	3.36	**3.78**
12.50	4.63	3.73	1.71
12.75	4.81	3.90	0.94
13.00	4.95	4.04	0.73
13.25	5.07	4.15	0.63
13.50	5.17	4.26	0.58
13.75	5.27	4.35	0.52
14.00	5.35	4.43	0.47
14.25	5.43	4.51	0.43
14.50	5.50	4.58	0.41
14.75	5.57	4.65	0.38
15.00	5.64	4.71	0.35
15.25	5.70	4.77	0.33
15.50	5.75	4.83	0.30
15.75	5.80	4.88	0.27
16.00	5.85	4.92	0.25
16.25	5.89	4.96	0.23
16.50	5.93	5.00	0.22
16.75	5.97	5.04	0.21
17.00	6.00	5.07	0.20
17.25	6.04	5.11	0.19
17.50	6.07	5.14	0.17
17.75	6.10	5.17	0.16
18.00	6.12	5.19	0.15
18.25	6.15	5.22	0.15
18.50	6.18	5.24	0.14
18.75	6.20	5.27	0.14
19.00	6.23	5.29	0.13
19.25	6.25	5.31	0.13
19.50	6.27	5.34	0.13
19.75	6.29	5.36	0.12
20.00	**6.32**	**5.38**	0.12

Subcatchment 30S: Overland runoff to south

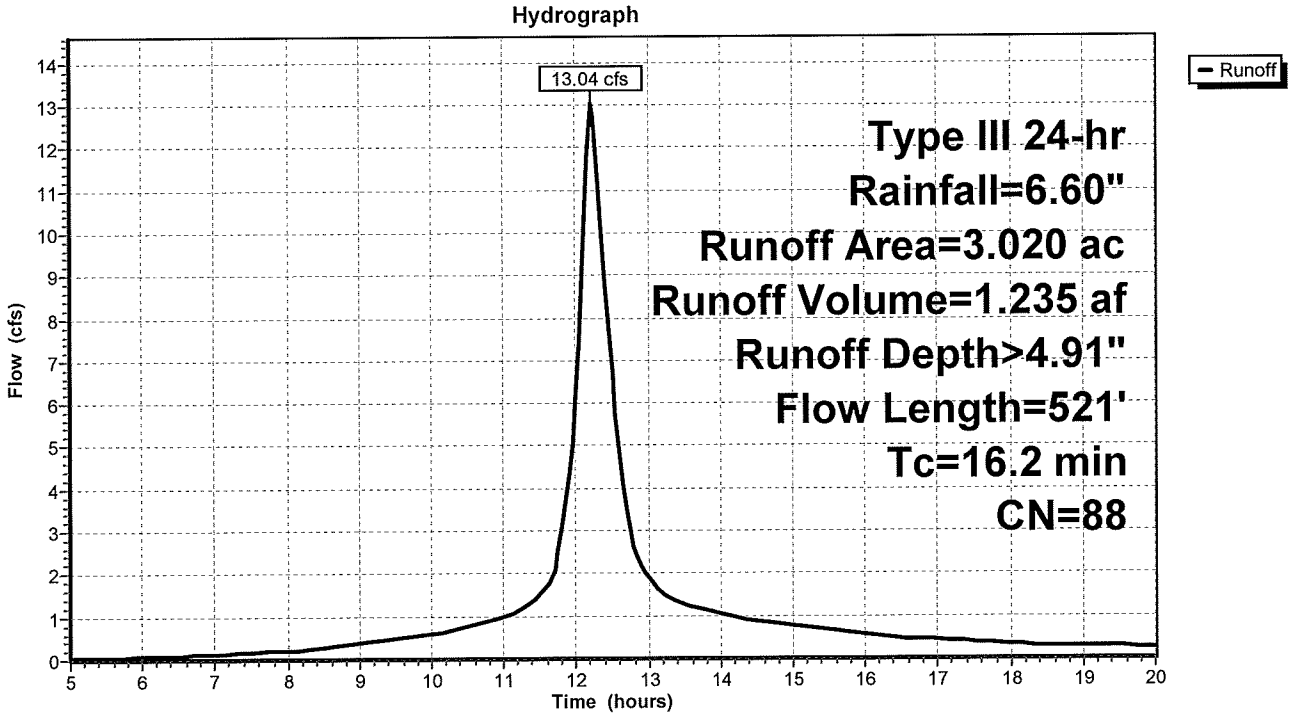
Runoff = 13.04 cfs @ 12.22 hrs, Volume= 1.235 af, Depth> 4.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=6.60"

Area (ac)	CN	Description
1.860	98	Paved parking & roofs
0.490	74	>75% Grass cover, Good, HSG C
0.670	70	Woods, Good, HSG C
3.020	88	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	50	0.0200	0.1		**Sheet Flow, Path 1** Woods: Light underbrush n= 0.400 P2= 3.00"
2.7	421	0.0162	2.6		**Shallow Concentrated Flow, Path 2** Paved Kv= 20.3 fps
0.2	25	0.0600	1.7		**Shallow Concentrated Flow, Path 3** Short Grass Pasture Kv= 7.0 fps
0.6	25	0.0200	0.7		**Shallow Concentrated Flow, Path 4** Woodland Kv= 5.0 fps
16.2	521	Total			

Subcatchment 30S: Overland runoff to south



Hydrograph for Subcatchment 30S: Overland runoff to south

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.37	0.01	0.03
5.25	0.40	0.01	0.04
5.50	0.42	0.02	0.05
5.75	0.45	0.02	0.06
6.00	0.48	0.03	0.07
6.25	0.50	0.03	0.08
6.50	0.53	0.04	0.09
6.75	0.56	0.05	0.11
7.00	0.60	0.06	0.13
7.25	0.63	0.08	0.15
7.50	0.67	0.09	0.17
7.75	0.71	0.11	0.19
8.00	0.75	0.12	0.21
8.25	0.80	0.15	0.24
8.50	0.85	0.17	0.28
8.75	0.90	0.20	0.32
9.00	0.96	0.23	0.37
9.25	1.03	0.27	0.42
9.50	1.10	0.31	0.48
9.75	1.17	0.36	0.53
10.00	1.25	0.41	0.59
10.25	1.33	0.46	0.66
10.50	1.43	0.53	0.76
10.75	1.53	0.61	0.87
11.00	1.65	0.69	0.98
11.25	1.79	0.80	1.15
11.50	1.97	0.94	1.50
11.75	2.34	1.25	2.51
12.00	3.30	2.09	**6.00**
12.25	4.26	2.97	**12.71**
12.50	4.63	3.32	6.71
12.75	4.81	3.49	2.98
13.00	4.95	3.62	1.89
13.25	5.07	3.73	1.45
13.50	5.17	3.83	1.29
13.75	5.27	3.92	1.17
14.00	5.35	4.00	1.05
14.25	5.43	4.08	0.95
14.50	5.50	4.15	0.89
14.75	5.57	4.22	0.83
15.00	5.64	4.28	0.78
15.25	5.70	4.34	0.72
15.50	5.75	4.39	0.67
15.75	5.80	4.44	0.61
16.00	5.85	4.48	0.56
16.25	5.89	4.52	0.51
16.50	5.93	4.56	0.48
16.75	5.97	4.59	0.45
17.00	6.00	4.63	0.43
17.25	6.04	4.66	0.41
17.50	6.07	4.69	0.38
17.75	6.10	4.72	0.36
18.00	6.12	4.75	0.33
18.25	6.15	4.77	0.31
18.50	6.18	4.80	0.30
18.75	6.20	4.82	0.30
19.00	6.23	4.84	0.29
19.25	6.25	4.87	0.28
19.50	6.27	4.89	0.27
19.75	6.29	4.91	0.27
20.00	**6.32**	**4.93**	0.26

Subcatchment 40S: Roof Runoff to Grass Channel

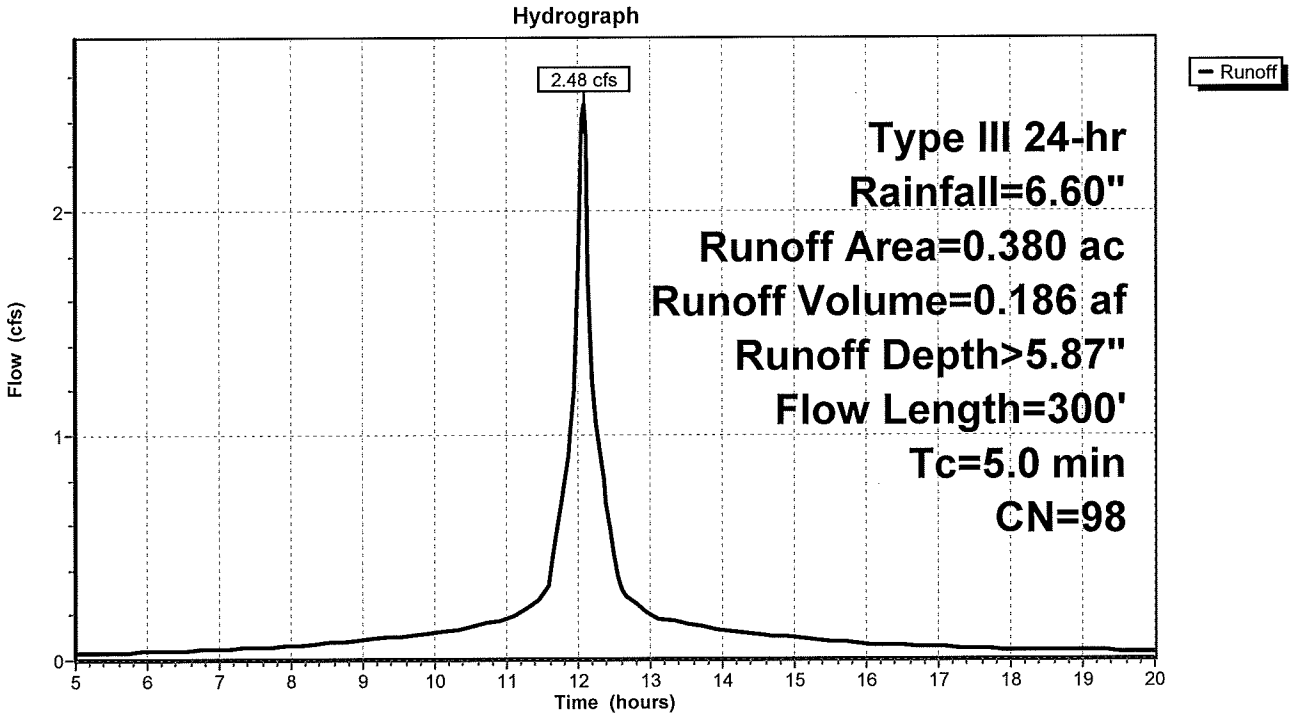
Runoff = 2.48 cfs @ 12.07 hrs, Volume= 0.186 af, Depth> 5.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=6.60"

Area (ac)	CN	Description
0.380	98	Roof Runoff

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	300		1.0		**Direct Entry, Path 1**

Subcatchment 40S: Roof Runoff to Grass Channel



Hydrograph for Subcatchment 40S: Roof Runoff to Grass Channel

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.37	0.21	0.03
5.25	0.40	0.23	0.03
5.50	0.42	0.25	0.03
5.75	0.45	0.27	0.03
6.00	0.48	0.30	0.04
6.25	0.50	0.32	0.04
6.50	0.53	0.35	0.04
6.75	0.56	0.38	0.05
7.00	0.60	0.41	0.05
7.25	0.63	0.44	0.05
7.50	0.67	0.48	0.05
7.75	0.71	0.51	0.06
8.00	0.75	0.55	0.06
8.25	0.80	0.60	0.07
8.50	0.85	0.64	0.07
8.75	0.90	0.70	0.08
9.00	0.96	0.75	0.09
9.25	1.03	0.82	0.10
9.50	1.10	0.88	0.10
9.75	1.17	0.96	0.11
10.00	1.25	1.03	0.12
10.25	1.33	1.12	0.13
10.50	1.43	1.21	0.15
10.75	1.53	1.31	0.16
11.00	1.65	1.43	0.18
11.25	1.79	1.57	0.22
11.50	1.97	1.74	0.28
11.75	2.34	2.12	0.68
12.00	3.30	3.07	**1.73**
12.25	4.26	4.02	**1.05**
12.50	4.63	4.40	0.47
12.75	4.81	4.57	0.26
13.00	4.95	4.71	0.20
13.25	5.07	4.83	0.17
13.50	5.17	4.93	0.16
13.75	5.27	5.03	0.14
14.00	5.35	5.12	0.13
14.25	5.43	5.19	0.12
14.50	5.50	5.27	0.11
14.75	5.57	5.34	0.10
15.00	5.64	5.40	0.10
15.25	5.70	5.46	0.09
15.50	5.75	5.51	0.08
15.75	5.80	5.56	0.08
16.00	5.85	5.61	0.07
16.25	5.89	5.65	0.06
16.50	5.93	5.69	0.06
16.75	5.97	5.73	0.06
17.00	6.00	5.76	0.05
17.25	6.04	5.80	0.05
17.50	6.07	5.83	0.05
17.75	6.10	5.86	0.04
18.00	6.12	5.89	0.04
18.25	6.15	5.91	0.04
18.50	6.18	5.94	0.04
18.75	6.20	5.96	0.04
19.00	6.23	5.99	0.04
19.25	6.25	6.01	0.04
19.50	6.27	6.03	0.04
19.75	6.29	6.06	0.03
20.00	**6.32**	**6.08**	0.03

Subcatchment 50S: Overland runoff to southwest

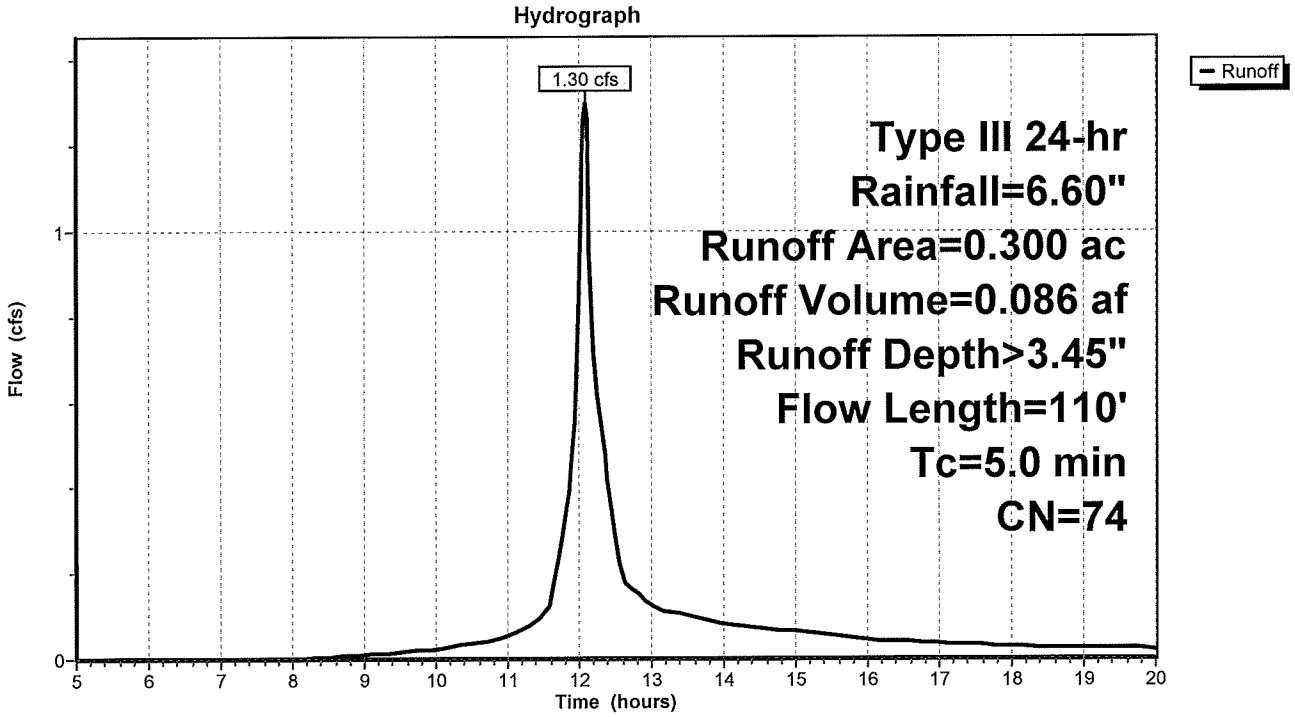
Runoff = 1.30 cfs @ 12.08 hrs, Volume= 0.086 af, Depth> 3.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=6.60"

Area (ac)	CN	Description
0.030	98	Paved parking & roofs
0.070	74	>75% Grass cover, Good, HSG C
0.200	70	Woods, Good, HSG C
0.300	74	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	110		0.4		**Direct Entry, Path 1**

Subcatchment 50S: Overland runoff to southwest



Hydrograph for Subcatchment 50S: Overland runoff to southwest

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
5.00	0.37	0.00	0.00
5.25	0.40	0.00	0.00
5.50	0.42	0.00	0.00
5.75	0.45	0.00	0.00
6.00	0.48	0.00	0.00
6.25	0.50	0.00	0.00
6.50	0.53	0.00	0.00
6.75	0.56	0.00	0.00
7.00	0.60	0.00	0.00
7.25	0.63	0.00	0.00
7.50	0.67	0.00	0.00
7.75	0.71	0.00	0.00
8.00	0.75	0.00	0.00
8.25	0.80	0.00	0.00
8.50	0.85	0.01	0.00
8.75	0.90	0.01	0.01
9.00	0.96	0.02	0.01
9.25	1.03	0.03	0.01
9.50	1.10	0.04	0.02
9.75	1.17	0.05	0.02
10.00	1.25	0.07	0.02
10.25	1.33	0.10	0.03
10.50	1.43	0.12	0.04
10.75	1.53	0.16	0.04
11.00	1.65	0.20	0.05
11.25	1.79	0.26	0.07
11.50	1.97	0.33	0.10
11.75	2.34	0.52	0.28
12.00	3.30	1.10	**0.85**
12.25	4.26	1.79	**0.61**
12.50	4.63	2.08	0.29
12.75	4.81	2.21	0.16
13.00	4.95	2.32	0.13
13.25	5.07	2.42	0.11
13.50	5.17	2.50	0.10
13.75	5.27	2.58	0.09
14.00	5.35	2.65	0.08
14.25	5.43	2.71	0.08
14.50	5.50	2.77	0.07
14.75	5.57	2.83	0.07
15.00	5.64	2.88	0.06
15.25	5.70	2.93	0.06
15.50	5.75	2.98	0.05
15.75	5.80	3.02	0.05
16.00	5.85	3.06	0.04
16.25	5.89	3.09	0.04
16.50	5.93	3.13	0.04
16.75	5.97	3.16	0.04
17.00	6.00	3.19	0.04
17.25	6.04	3.22	0.03
17.50	6.07	3.24	0.03
17.75	6.10	3.27	0.03
18.00	6.12	3.29	0.03
18.25	6.15	3.31	0.03
18.50	6.18	3.33	0.03
18.75	6.20	3.35	0.03
19.00	6.23	3.38	0.02
19.25	6.25	3.40	0.02
19.50	6.27	3.41	0.02
19.75	6.29	3.43	0.02
20.00	**6.32**	**3.45**	0.02

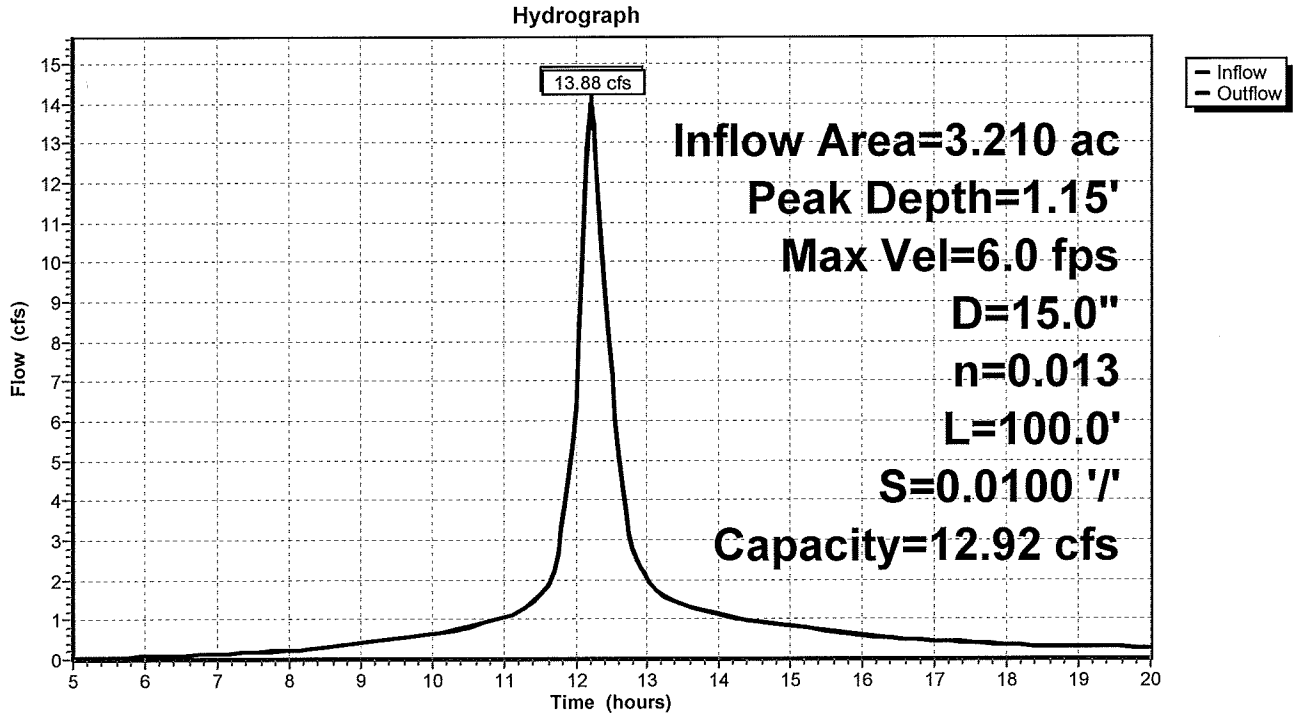
Reach 12R: Driveway Crossing

Inflow Area = 3.210 ac, Inflow Depth > 4.91"
Inflow = 13.98 cfs @ 12.21 hrs, Volume= 1.313 af
Outflow = 13.88 cfs @ 12.22 hrs, Volume= 1.312 af, Atten= 1%, Lag= 0.7 min

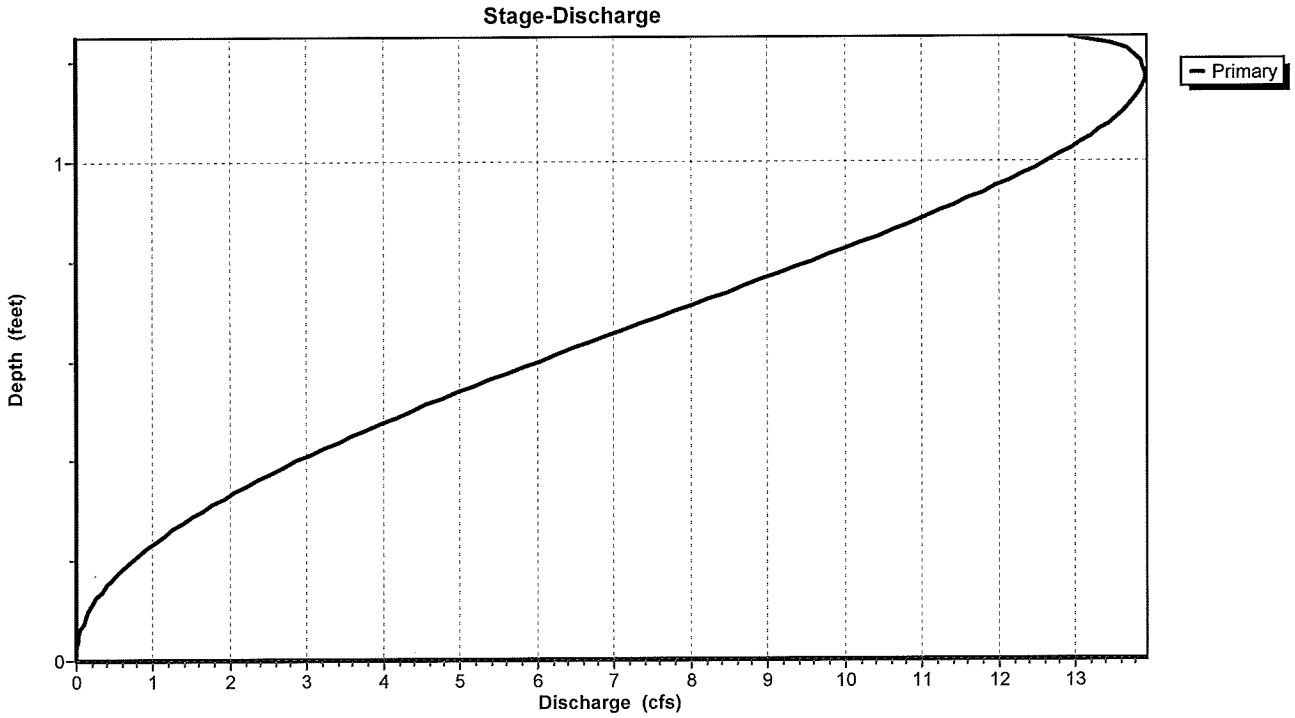
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.0 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.7 fps, Avg. Travel Time= 0.6 min

Peak Depth= 1.15' @ 12.21 hrs
Capacity at bank full= 12.92 cfs
Inlet Invert= 503.00', Outlet Invert= 502.00'
A factor of 2.00 has been applied to the supplied storage and discharge data
15.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 100.0' Slope= 0.0100 '/'

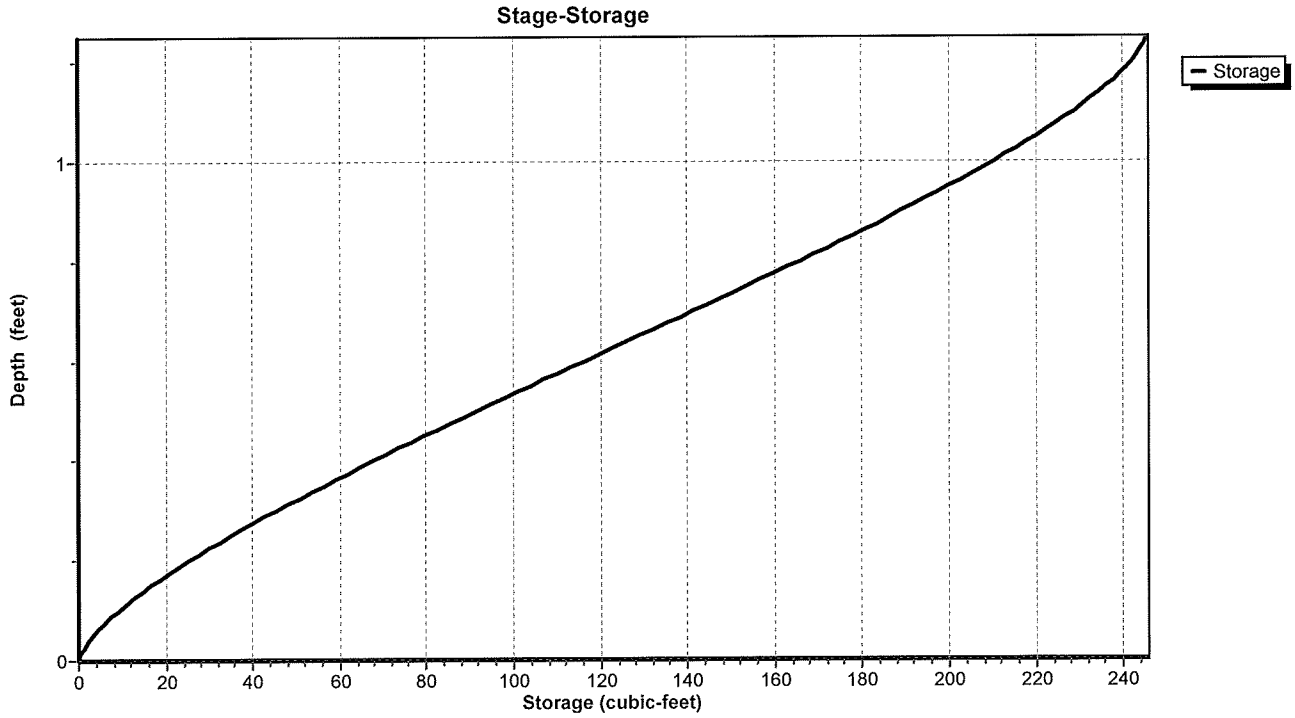
Reach 12R: Driveway Crossing



Reach 12R: Driveway Crossing



Reach 12R: Driveway Crossing



Hydrograph for Reach 12R: Driveway Crossing

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	0.03	0	503.00	0.00
5.50	0.05	4	503.06	0.05
6.00	0.07	5	503.07	0.07
6.50	0.10	6	503.08	0.10
7.00	0.14	8	503.09	0.13
7.50	0.18	10	503.10	0.18
8.00	0.23	11	503.11	0.23
8.50	0.30	14	503.13	0.29
9.00	0.40	17	503.15	0.39
9.50	0.51	20	503.17	0.50
10.00	0.63	23	503.19	0.63
10.50	0.81	27	503.21	0.80
11.00	1.05	33	503.24	1.04
11.50	1.61	45	503.30	1.59
12.00	**6.49**	**122**	**503.62**	**6.31**
12.50	**7.00**	**131**	**503.66**	**7.18**
13.00	1.99	52	503.33	2.01
13.50	1.36	40	503.27	1.37
14.00	1.12	35	503.25	1.12
14.50	0.94	31	503.23	0.94
15.00	0.83	28	503.21	0.83
15.50	0.71	25	503.20	0.71
16.00	0.59	22	503.18	0.59
16.50	0.51	20	503.17	0.51
17.00	0.46	18	503.16	0.46
17.50	0.41	17	503.15	0.41
18.00	0.35	15	503.14	0.36
18.50	0.32	14	503.14	0.32
19.00	0.31	14	503.13	0.31
19.50	0.29	13	503.13	0.29
20.00	0.28	13	503.13	0.28

Stage-Discharge for Reach 12R: Driveway Crossing

Elevation (feet)	Velocity (ft/sec)	Discharge (cfs)
503.00	0.0	0.00
503.01	0.4	0.00
503.02	0.6	0.01
503.03	0.8	0.01
503.04	1.0	0.02
503.05	1.2	0.04
503.06	1.3	0.06
503.07	1.5	0.08
503.08	1.6	0.10
503.09	1.7	0.13
503.10	1.8	0.17
503.11	1.9	0.21
503.12	2.1	0.25
503.13	2.2	0.29
503.14	2.3	0.34
503.15	2.4	0.40
503.16	2.5	0.45
503.17	2.6	0.51
503.18	2.7	0.58
503.19	2.7	0.65
503.20	2.8	0.72
503.21	2.9	0.79
503.22	3.0	0.87
503.23	3.1	0.96
503.24	3.2	1.04
503.25	3.2	1.13
503.26	3.3	1.22
503.27	3.4	1.32
503.28	3.5	1.42
503.29	3.5	1.53
503.30	3.6	1.63
503.31	3.7	1.74
503.32	3.7	1.85
503.33	3.8	1.97
503.34	3.9	2.09
503.35	3.9	2.21
503.36	4.0	2.34
503.37	4.1	2.47
503.38	4.1	2.60
503.39	4.2	2.73
503.40	4.2	2.86
503.41	4.3	3.00
503.42	4.3	3.14
503.43	4.4	3.29
503.44	4.5	3.43
503.45	4.5	3.58
503.46	4.6	3.73
503.47	4.6	3.88
503.48	4.7	4.04
503.49	4.7	4.20
503.50	4.7	4.35
503.51	4.8	4.51
503.52	4.8	4.68
503.53	4.9	4.84
503.54	4.9	5.00
503.55	5.0	5.17
503.56	5.0	5.34
503.57	5.1	5.51
503.58	5.1	5.68
503.59	5.1	5.85
503.60	5.2	6.02
503.61	5.2	6.20
503.62	5.2	6.37
503.63	5.3	6.55
503.64	5.3	6.72
503.65	5.4	6.90
503.66	5.4	7.08
503.67	5.4	7.26
503.68	5.4	7.43
503.69	5.5	7.61
503.70	5.5	7.79
503.71	5.5	7.97
503.72	5.6	8.15
503.73	5.6	8.32
503.74	5.6	8.50
503.75	5.6	8.68
503.76	5.7	8.86
503.77	5.7	9.03
503.78	5.7	9.21
503.79	5.7	9.38
503.80	5.8	9.56
503.81	5.8	9.73
503.82	5.8	9.90
503.83	5.8	10.07
503.84	5.8	10.24
503.85	5.9	10.41
503.86	5.9	10.57
503.87	5.9	10.74
503.88	5.9	10.90
503.89	5.9	11.06
503.90	5.9	11.21
503.91	5.9	11.37
503.92	6.0	11.52
503.93	6.0	11.67
503.94	6.0	11.82
503.95	6.0	11.96
503.96	6.0	12.10
503.97	6.0	12.24
503.98	6.0	12.37
503.99	6.0	12.50
504.00	6.0	12.63
504.01	6.0	12.75
504.02	**6.0**	12.87
504.03	6.0	12.98
504.04	6.0	13.09
504.05	6.0	13.19
504.06	6.0	13.29
504.07	6.0	13.38
504.08	6.0	13.47
504.09	6.0	13.55
504.10	6.0	13.62
504.11	5.9	13.69
504.12	5.9	13.74
504.13	5.9	13.79
504.14	5.9	13.83
504.15	5.9	13.87
504.16	5.8	13.89
504.17	5.8	**13.90**
504.18	5.8	13.89
504.19	5.8	13.88
504.20	5.7	13.84
504.21	5.7	13.79
504.22	5.6	13.71
504.23	5.6	13.59
504.24	5.5	13.41
504.25	5.3	12.92

Stage-Area-Storage for Reach 12R: Driveway Crossing

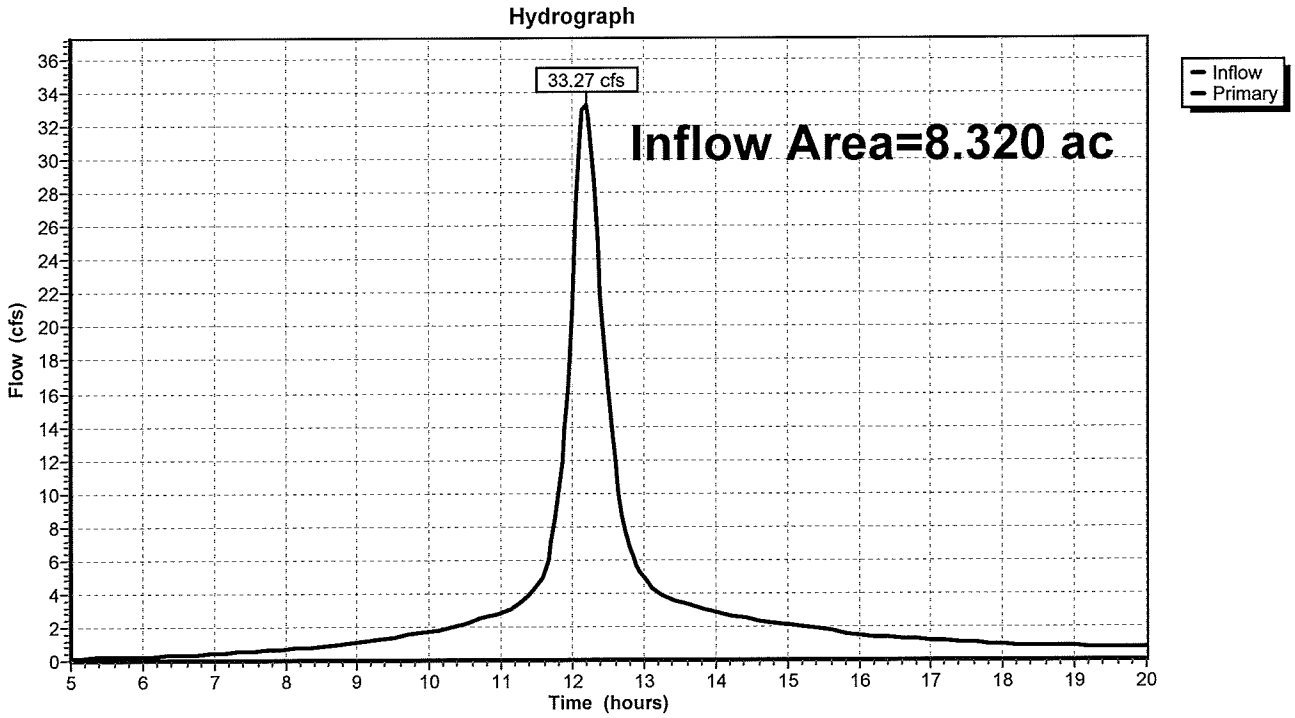
Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)
503.00	0	503.51	94	504.02	214
503.01	0	503.52	97	504.03	216
503.02	1	503.53	99	504.04	218
503.03	2	503.54	102	504.05	220
503.04	2	503.55	104	504.06	222
503.05	3	503.56	106	504.07	224
503.06	4	503.57	109	504.08	225
503.07	5	503.58	111	504.09	227
503.08	7	503.59	114	504.10	229
503.09	8	503.60	116	504.11	230
503.10	9	503.61	119	504.12	232
503.11	11	503.62	121	504.13	233
503.12	12	503.63	124	504.14	235
503.13	14	503.64	126	504.15	236
503.14	15	503.65	129	504.16	238
503.15	17	503.66	131	504.17	239
503.16	18	503.67	134	504.18	240
503.17	20	503.68	136	504.19	241
503.18	22	503.69	139	504.20	242
503.19	24	503.70	141	504.21	243
503.20	25	503.71	144	504.22	244
503.21	27	503.72	146	504.23	245
503.22	29	503.73	149	504.24	245
503.23	31	503.74	151	504.25	**245**
503.24	33	503.75	154		
503.25	35	503.76	156		
503.26	37	503.77	159		
503.27	39	503.78	161		
503.28	41	503.79	163		
503.29	43	503.80	166		
503.30	45	503.81	168		
503.31	47	503.82	171		
503.32	50	503.83	173		
503.33	52	503.84	175		
503.34	54	503.85	178		
503.35	56	503.86	180		
503.36	59	503.87	182		
503.37	61	503.88	185		
503.38	63	503.89	187		
503.39	65	503.90	189		
503.40	68	503.91	191		
503.41	70	503.92	194		
503.42	72	503.93	196		
503.43	75	503.94	198		
503.44	77	503.95	200		
503.45	80	503.96	202		
503.46	82	503.97	204		
503.47	84	503.98	206		
503.48	87	503.99	208		
503.49	89	504.00	210		
503.50	92	504.01	212		

Link DP1: Design Point 1

Inflow Area =	8.320 ac,	Inflow Depth >	4.97"	
Inflow =	33.27 cfs @	12.18 hrs, Volume=	3.448 af	
Primary =	33.27 cfs @	12.18 hrs, Volume=	3.448 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link DP1: Design Point 1



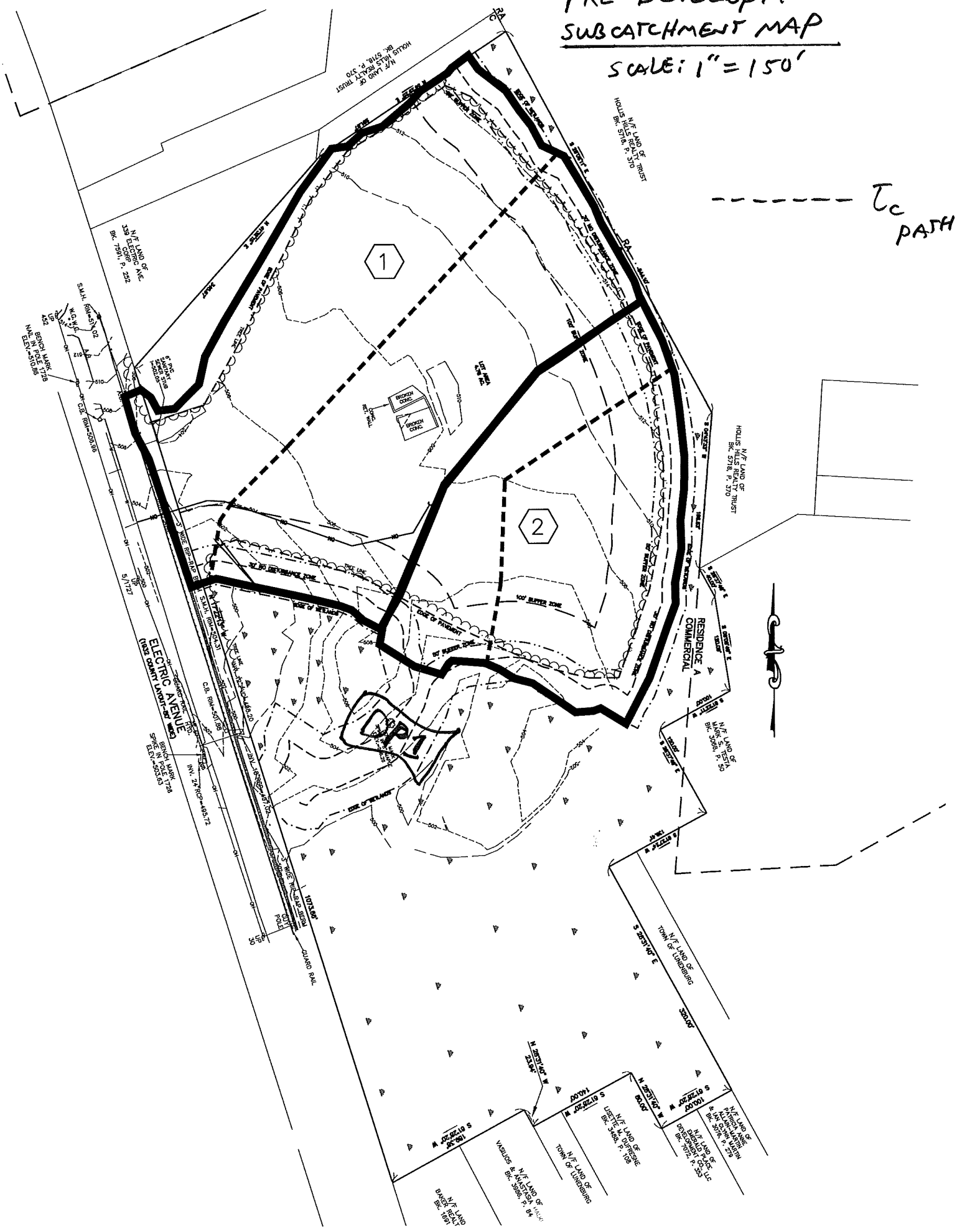
Hydrograph for Link DP1: Design Point 1

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
5.00	0.11	**0.00**	0.11
5.25	0.16	0.00	0.16
5.50	0.19	0.00	0.19
5.75	0.21	0.00	0.21
6.00	0.24	0.00	0.24
6.25	0.27	0.00	0.27
6.50	0.32	0.00	0.32
6.75	0.36	0.00	0.36
7.00	0.41	0.00	0.41
7.25	0.47	0.00	0.47
7.50	0.53	0.00	0.53
7.75	0.59	0.00	0.59
8.00	0.65	0.00	0.65
8.25	0.73	0.00	0.73
8.50	0.85	0.00	0.85
8.75	0.97	0.00	0.97
9.00	1.11	0.00	1.11
9.25	1.25	0.00	1.25
9.50	1.40	0.00	1.40
9.75	1.55	0.00	1.55
10.00	1.72	0.00	1.72
10.25	1.92	0.00	1.92
10.50	2.20	0.00	2.20
10.75	2.51	0.00	2.51
11.00	2.83	0.00	2.83
11.25	3.39	0.00	3.39
11.50	4.41	0.00	4.41
11.75	8.40	0.00	8.40
12.00	**20.99**	0.00	**20.99**
12.25	**31.84**	0.00	**31.84**
12.50	16.35	0.00	16.35
12.75	7.52	0.00	7.52
13.00	4.96	0.00	4.96
13.25	3.92	0.00	3.92
13.50	3.49	0.00	3.49
13.75	3.17	0.00	3.17
14.00	2.86	0.00	2.86
14.25	2.59	0.00	2.59
14.50	2.42	0.00	2.42
14.75	2.27	0.00	2.27
15.00	2.12	0.00	2.12
15.25	1.97	0.00	1.97
15.50	1.82	0.00	1.82
15.75	1.66	0.00	1.66
16.00	1.51	0.00	1.51
16.25	1.39	0.00	1.39
16.50	1.31	0.00	1.31
16.75	1.24	0.00	1.24
17.00	1.18	0.00	1.18
17.25	1.11	0.00	1.11
17.50	1.04	0.00	1.04
17.75	0.98	0.00	0.98
18.00	0.91	0.00	0.91
18.25	0.86	0.00	0.86
18.50	0.83	0.00	0.83
18.75	0.81	0.00	0.81
19.00	0.79	0.00	0.79
19.25	0.77	0.00	0.77
19.50	0.75	0.00	0.75
19.75	0.73	0.00	0.73
20.00	0.71	0.00	0.71

SUBCATCHMENT MAPS

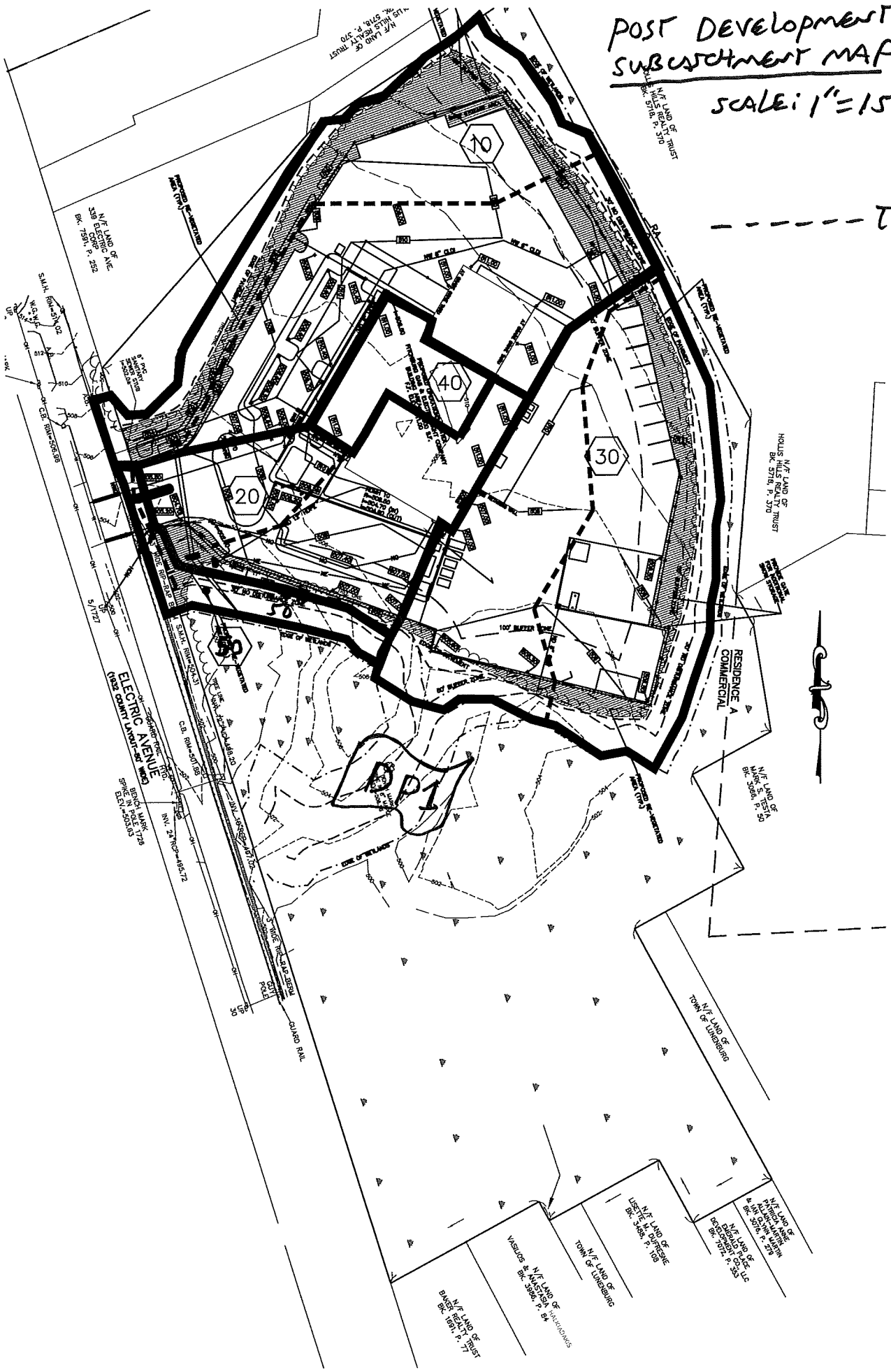
PRE-DEVELOPMENT SUBCATCHMENT MAP

SCALE: 1" = 150'



POST DEVELOPMENT SUBCATCHMENT MAP

SCALE: 1" = 150'



TSS REMOVAL CALCULATIONS

(REDEVELOPMENT - TO THE MAXIMUM EXTENT PRACTICABLE)

TSS Removal Calculation Worksheet

Location: **LUNENBURG, MA**

A BMP	B TSS Removal Rate	C Starting TSS Load *	D Amount Removed (BxC)	E Remaining Load (C-D)
Sweep Parking Area	0.10	1.00	0.100	0.90
Grassed Channel	0.50	0.90	0.450	0.45

Total TSS Removal = 0.550 = ***55.0%***

Project: **357 Electric Avenue**
Prepared By: **MFP**
Date: **11/20/2015**
Note: **Grass channel with stone check dams (forebay)**

* Equals remaining load from previous BMP (E) which enters the BMP

TSS Removal Calculation Worksheet

Location: **LUNENBURG, MA**

A BMP	B TSS Removal Rate	C Starting TSS Load *	D Amount Removed (BxC)	E Remaining Load (C-D)
Sweep Parking Area	0.10	1.00	0.100	0.90
Vegetated Filter Strip	0.50	0.90	0.450	0.45

Total TSS Removal = 0.550 = ***55.0%***

Project: **357 Electric Avenue**
Prepared By: **MFP**
Date: **11/20/2015**
Note: **New vegetation plus natural vegetation greater than 50 feet.**

* Equals remaining load from previous BMP (E) which enters the BMP

RECHARGE VOLUME CALCULATIONS

RECHARGE VOLUME CALCULATION November 20, 2015

Calculate recharge volume lost to existing developed impervious area.

- Urban Land soil (Assume C soil) –

  Total of 6.81 acres of impervious area in C soils group

  Recharge volume =

  (6.81 AC)(0.25"/12"/ft)(43,560 SF/AC) = 6,180 *Cubic Feet (CF)*

TOTAL RECHARGE VOLUME LOST
DUE TO EXISINTING SITE CONDITIONS = 6,180 CF

Calculate recharge volume gained due to re-developed site area.

- Urban Land soil (Assume C soil) –

  Total of 5.26 acres of impervious area in C soils group

  Recharge volume =

  (5.26 AC)(0.25"/12"/ft)(43,560 SF/AC) = 4,774 *Cubic Feet (CF)*

TOTAL RECHARGE VOLUME GAINED
DUE TO PROPOSED SITE CONDITIONS = 6,180 CF – 4,774 CF = 1,406 CF

AERIAL MAP

Google Maps

Imagery ©2015 Google, Map data ©2015 Google 200 ft

CLOSED DRAINAGE SYSTEM

CALCULATIONS

WHITMAN & BINGHAM ASSOCIATES

DESIGN OF STORM SEWERS

PROJECT NAME 357 ELECTRIC AVENUE
PROJECT NO. 13480' SHEET 1 OF 1
CALCULATED BY MFP DATE 11-20-15

A		B		C	D	E	F	G	H	I	J	K	L	M	N	O	P	
FLOW PATH		AREA (Ac)		COEFF. OF RUNOFF (c)	TIME TO INLET (min.)	DESIGN STORM (year)	INTENSITY (i)	DESIGN FLOW (Q) (cfs) (CxFxB)	PIPE SIZE (in.)	PIPE SLOPE (ft./ft.)	ROUGH. COEFF. (n)	FULL CAPACITY (cfs)	FULL VELOCITY (fps)	DESIGN VELOCITY (fps)	LENGTH OF PIPE (ft.)	TIME IN CHANNEL (min.) (N/M)	TIME TO NEXT NODE (min.) (D+O)	REMARKS
FROM	TO	SUB-AREA	TOTAL															
NDMH 10	NFE	—	1.03	0.90	10	25	5	4.64	15	0.005	0.012	5.2	4.4	5.3	230	0.70	10.7	ROOF RUNOFF
15" culverts (2)		—	3.21	0.65	10	50	7	14.61	15	0.010	0.012	7.5	5.8	6.6	120	0.30	10.3	(2) 15" culverts
																		↑ HydroCAD Flow
																		100 year storm = 13.88 cfs

OPERATION AND MAINTENANCE PLAN

WHITMAN & BINGHAM
ASSOCIATES

510 Mechanic Street
Leominster, Massachusetts 01453
(978) 537-5296
FAX (978) 537-1423

STORMWATER MANAGEMENT SYSTEM INSPECTION AND MAINTENANCE PLAN

Proposed Unitil Facility
357 Electric Avenue
Lunenburg, Massachusetts

Prepared for:

Unitil
Fitchburg Gas and Electric Light Company
6 Liberty Lane West
Hampton, NH 03842

Date: November 20, 2015

The proposed Unitil Facility site has been designed to function properly provided that routine maintenance is performed. Maintenance of the parking area, driveways, catch basin, vegetated filter strip, stone check dams and grass channels are required to ensure that sedimentation and pollution is controlled and storm water retention capacity is sustained. To ensure the proper functioning of these facilities the following maintenance practices will be used:

Owner and Party Responsible for Maintenance:

Unitil
Fitchburg Gas and Electric Light Company
6 Liberty Lane West
Hampton, NH 03842
Office: 603-772-0775

The owner shall develop a chart with a list of the following Best Management Practices (BMP's) with the chart listing the maintenance requirement, frequency of maintenance and the date the maintenance was performed.

PART 1 - INSPECTION AND MAINTENANCE (DURING CONSTRUCTION)

A. It shall be the responsibility of the General Contractor to ensure that the inspection, maintenance and protection of the stormwater management system (defined in Section 2a below) is performed during the construction phase of the project and up to final stabilization of the site (refer to attached plan).

B. The on-site stormwater management system shall be protected from the introduction of sediments and debris both during installation and throughout the duration of site construction in order to provide a fully functioning and long lasting system upon completion of construction.

C. The following steps shall be implemented, at a minimum, to protect the stormwater management system during construction:

1. During construction of the grass channels the open excavation shall be protected from on-site sediments from storm runoff and snow melt by providing a line of erosion controls consisting of haybales or silt fence or a combination of both. In the event that the excavation is compromised by sediment, the sediments shall be removed and the bottom of the excavation restored.

2. An inspection of the stormwater management system shall be conducted by the General Contractor weekly as well as during and after all rainstorms until the completion of construction. In case of any noted introduction of sediments into the system, the General Contractor shall immediately remove said sediments and take any necessary steps to limit further introduction of sediments and notify the engineer of any problems involving storm water management systems.

   a) The stormwater management system shall be defined as the catch basin, drain manhole, vegetated filter strip, stone check dams and grass channels.

   b) A rainstorm shall be defined by all or one of the following thresholds:

      i. Any storm in which rain is predicted to last for twelve consecutive hours or more.

      ii. Any storm for which a flash flood watch or warning is issued.

      iii. Any single storm predicted to have a cumulative rainfall of greater than one-half inch.

      iv. Any storm not meeting the previous three thresholds but which would mark a third consecutive day of measurable rainfall.

3. The General Contractor shall also inspect the stormwater management systems at times of significant increase in surface water runoff due to rapid thawing when the risk of sediment migration is significant.

4. All collected/removed sediments shall be removed from the site and disposed of in a legal manner.

PART 2 - INSPECTION AND MAINTENANCE (POST-CONSTRUCTION)

A. It shall be the responsibility of the Owner to ensure that the long-term inspection and maintenance of the stormwater management system on-site is performed. The on-site system shall include the following individual components of the stormwater management system: catch basin, drain manhole, vegetated filter strip, stone check dams and grass channels on the approved plans. The Owner shall obtain the services of a qualified Contractor to perform the required inspections and maintenance of the individual components of the stormwater management system on-site, as listed above. All inspections and maintenance of the components of the stormwater management system.

B. It shall be the responsibility of the Owner to maintain adequate records to demonstrate conformance with this inspection and maintenance plan.

C. The inspection and maintenance plan for the on-site stormwater management system (as listed in Section A above) shall be carried out by the current owner (project applicant) and by any and all future owners of the site in perpetuity.

D. The inspection and maintenance plan shall be carried out as outlined below upon completion and final stabilization of the project site:

E. During the first six months of operation of the facility the stormwater management system shall be inspected a minimum of once per month and after every rainstorm (defined in Part 1 above). A portion of this time period must be in the growing season. As warranted by these inspections maintenance of the system shall be performed including, but not limited to the following:

   1. Visual inspection of the catch basin, vegetated filter strip, stone check dams and grass channels to ensure that the system is not backed up and is emptying properly.

F. After the six month time period above has elapsed, thorough investigations shall be conducted four times a year. Maintenance requirements may be adjusted based upon the results obtained from the first year of operation. As warranted by these inspections maintenance of the system shall be performed including, but not limited to the following:

   1. The vegetated filter strip, stone check dams, grass channel and retention basin requires an annual inspection for necessary maintenance (refer to attached plan). This consists of visually inspecting for the accumulation of sediment; obstructions within the dams, filter strip and grass channels. Remove sediments from the stone check dams (replace stone as necessary), filter strip and grass channels. Sediment, which is removed, shall be legally disposed of. The grass channels shall be monitored at several intervals during and after a small and large rainfall event to ensure they are functional.

MAINTENANCE LOGS

Maintain a log of all operation and maintenance activities including without limitation inspections, repairs, replacement and disposal (for disposal, the log shall indicate the type of material and disposal location). A copy of the yearly maintenance logs shall be made accessible to the following agencies:

Planning Board
Ritter Memorial Building
960 Massachusetts Avenue
Lunenburg, MA 01462

Department of Environmental Protection
Central Regional Office
627 Main Street
Worcester, MA 01608

CATCH BASIN INSPECTION FORM

Unitil
Fitchburg Gas and Electric Light Company
6 Liberty Lane West
Hampton, NH 03842

Owner:_____

Property Manager:_____

Inspected By:_____

Date of Inspection:_____

Catch Basins Inspected (circle):

Acceptable ☐ Needs Work ☐

Add notes below if structures need work:

Date of cleaning:_____ By Whom:_____

Date of repair: _____ By Whom:_____

Below note any further actions that need to be taken as necessary:

DRAIN MANHOLE INSPECTION FORM

Unitil
Fitchburg Gas and Electric Light Company
6 Liberty Lane West
Hampton, NH 03842

Owner:_____

Property Manager:_____

Inspected By:_____

Date of Inspection:_____

Drain Manhole Inspected (circle):

Acceptable ☐ Needs Work ☐

Add notes below if structures need work:

Date of cleaning:_____ By Whom:_____

Date of repair: _____ By Whom:_____

Below note any further actions that need to be taken as necessary:

STONE CHECK DAMS

Unitil
Fitchburg Gas and Electric Light Company
6 Liberty Lane West
Hampton, NH 03842

Owner:_____

Property Manager:_____

Inspected By:_____

Date of Inspection:_____

Stone Check Dams Inspected (Describe location of dam):

Acceptable ☐ Needs Work ☐

Add notes below if structures need work:

Date of cleaning:_____ By Whom:_____

Date of repair: _____ By Whom:_____

Below note any further actions that need to be taken as necessary:

GRASS CHANNEL INSPECTION FORM

Unitil
Fitchburg Gas and Electric Light Company
6 Liberty Lane West
Hampton, NH 03842

Owner:_____

Property Manager:_____

Inspected By:_____

Date of Inspection:_____

Grass Channel Inspected (Describe location of channel):

Acceptable ☐ Needs Work ☐

Add notes below if structures need work:

Date of cleaning:_____ By Whom:_____

Date of repair: _____ By Whom:_____

Below note any further actions that need to be taken as necessary:

VEGETATED FILTER STRIP INSPECTION FORM

Unitil
Fitchburg Gas and Electric Light Company
6 Liberty Lane West
Hampton, NH 03842

Owner:_____

Property Manager:_____

Inspected By:_____

Date of Inspection:_____

Vegetated Filter Strip Inspected (Describe location of filter strip):

Acceptable ☐ Needs Work ☐

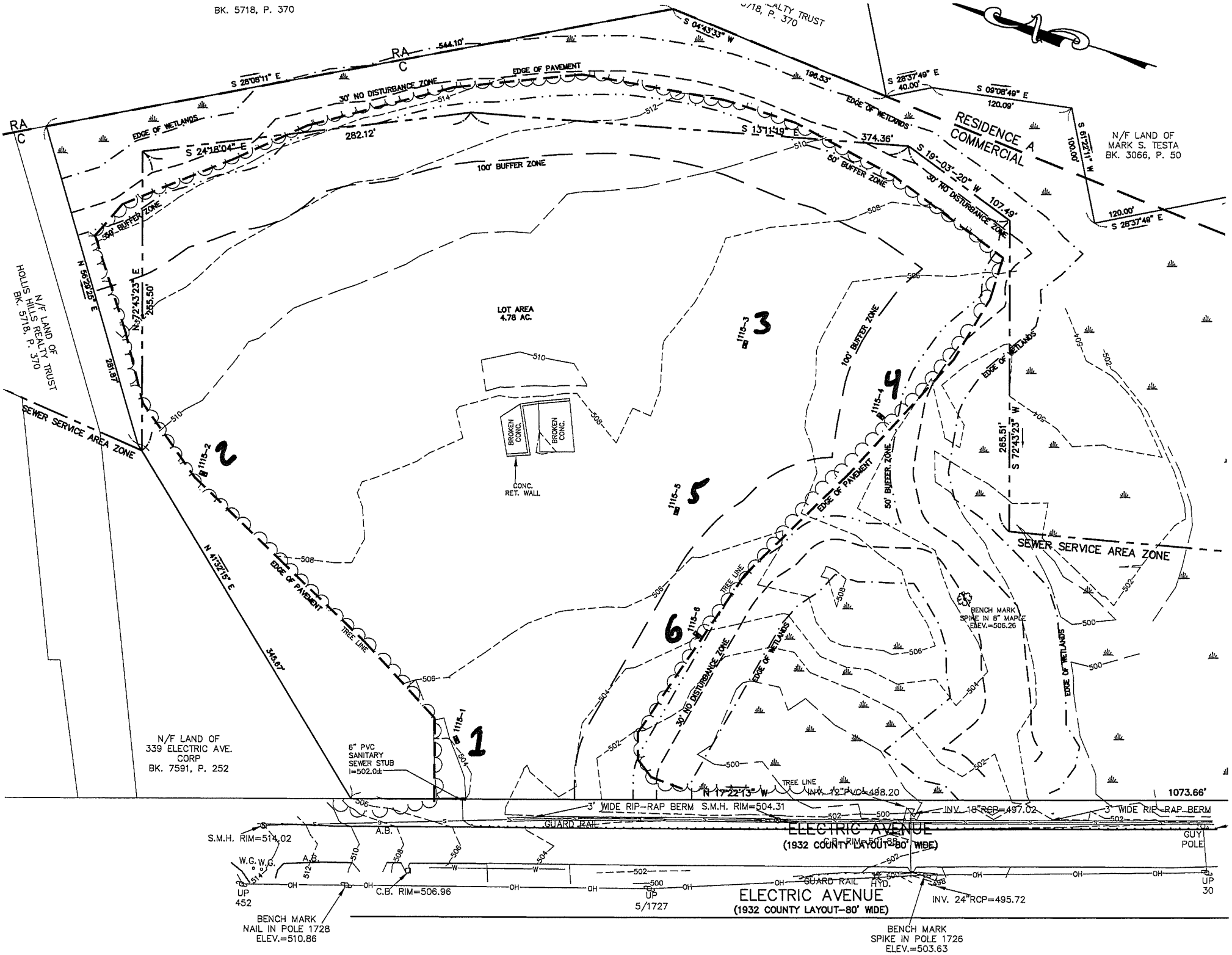
Add notes below if structures need work:

Date of cleaning:_____ By Whom:_____

Date of repair: _____ By Whom:_____

Below note any further actions that need to be taken as necessary:

SOIL TESTING DATA


BK. 5718, P. 370
RA
C
544.10'
S 28°08'11" E
EDGE OF PAVEMENT
30' NO DISTURBANCE ZONE
EDGE OF WETLANDS
S 24°18'04" E
282.12'
100' BUFFER ZONE
S 04°43'33" W
196.53'
S 28°37'49" E
40.00'
S 09°08'49" E
120.09'
S 13°11'19" E
374.36'
S 19°-03'-20" W
107.49'
50' BUFFER ZONE
30' NO DISTURBANCE ZONE
RESIDENCE A
COMMERCIAL
N/F LAND OF
MARK S. TESTA
BK. 3066, P. 50
S 61°22'11" W
100.00'
120.00'
S 28°37'49" E
N/F LAND OF
HOLLIS HILLS REALTY TRUST
BK. 5718, P. 370
N 56°29'25" E
N 72°43'23" E
255.50'
281.87'
LOT AREA
4.78 AC.
BROKEN CONC.
BROKEN CONC.
CONC. RET. WALL
SEWER SERVICE AREA ZONE
N 41°32'15" E
345.67'
EDGE OF PAVEMENT
TREE LINE
1115-1
1115-2
1115-3
1115-4
1115-5
1115-6
1
2
3
4
5
6
265.51'
S 72°43'23" W
50' BUFFER ZONE
BENCH MARK
SPIKE IN 8" MAPLE
ELEV.=506.26
N/F LAND OF
339 ELECTRIC AVE.
CORP
BK. 7591, P. 252
6" PVC
SANITARY
SEWER STUB
I=502.0±
N 17°22'13" W
INV. 12"PVC=498.20
1073.66'
3' WIDE RIP-RAP BERM
S.M.H. RIM=504.31
INV. 18"RCP=497.02
GUARD RAIL
ELECTRIC AVENUE
(1932 COUNTY LAYOUT-80' WIDE)
S.M.H. RIM=514.02
A.B.
W.G.
C.B. RIM=506.96
UP
452
UP
5/1727
HYD.
INV. 24"RCP=495.72
GUY
POLE
UP
30
BENCH MARK
NAIL IN POLE 1728
ELEV.=510.86
BENCH MARK
SPIKE IN POLE 1726
ELEV.=503.63

Whitman & Bingham Associates
Soil Evaluation Report

Whitman & Bingham Associates | 510 Mechanic Street | Leominster, MA 01453
Tel. (978) 537-5296 | Civil/Site Engineers | Fax (978) 537-1426

Performed By: Mark F. Piermarini Date: 11-19-15
Witnessed By: _____

Location Address or Lot #	Applicant's Name and address:
357 Electric Avenue Lunenburg, MA 01462 New Construction ☒ Repair ☐	Unitil 306 Highlander Way Manchester, NH 03103 Telephone # 603-314-5900

On-site Review

Deep Hole Number: 1115-1 Date: 11-19-15 Time: 7:30 am Weather: Cloudy, 50's
Location (identify on site plan) See Plan
Land Use: Drive-In Theatre Slope (%): 4% Surface Stones: none
Vegetation: Pavement
Landform: Outwash Plain
Position on landscape (see attached sketch)
Distances from:

Open Water Body N/A feet
Possible Wet Area >100 feet
Drinking Water Well N/A feet
Drainage way 50 feet
Property Line 50 feet
Other _____

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
0 - 60	**-**	**FILL**			**Pavement, Gravel, Fill**
60 - 96	**C**	**Sandy Loam**	**2.5Y 5/4**	**7.5YR 5/6 @32"**	**SAB, damp, some stones**

Parent Material (geologic): pro-glacial outwash Depth to Bedrock: not encountered

Depth to Groundwater: Standing Water in the Hole: none Weeping from Pit Face: 32"

Estimated Seasonal High Ground Water: 32"

Whitman & Bingham Associates
Soil Evaluation Report

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Tel. (978) 537-5296 | Civil/Site Engineers | Fax (978) 537-1426

Performed By: Mark F. Piermarini Date: 11-19-15
Witnessed By: _____

Location Address or Lot #	Applicant's Name and address:
357 Electric Avenue Lunenburg, MA 01462 New Construction ☒ Repair ☐	Unitil 306 Highlander Way Manchester, NH 03103 Telephone # 603-314-5900

On-site Review

Deep Hole Number: 1115-2 Date: 11-19-15 Time: 7:50 am Weather: Cloudy, 50's
Location (identify on site plan) See Plan
Land Use: Drive-In Theatre Slope (%): 2% Surface Stones: none
Vegetation: Pavement
Landform: Outwash Plain
Position on landscape (see attached sketch)
Distances from:

Open Water Body N/A feet
Possible Wet Area ≥100 feet
Drinking Water Well N/A feet
Drainage way 40 feet
Property Line 40 feet
Other _____

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
0 - 18	**-**	**FILL**			**Pavement, Gravel, Fill**
18 - 60	**C**	**Sandy Loam**	**2.5Y 5/4**	**7.5YR 5/6 @18"**	**SAB, damp, some stones**

Parent Material (geologic): pro-glacial outwash Depth to Bedrock: not encountered

Depth to Groundwater: Standing Water in the Hole: none Weeping from Pit Face: 18"

Estimated Seasonal High Ground Water: 18"

Whitman & Bingham Associates
Soil Evaluation Report

Whitman & Bingham Associates | 510 Mechanic Street | Leominster, MA 01453
Tel. (978) 537-5296 | Civil/Site Engineers | Fax (978) 537-1426

Performed By: Mark F. Piermarini Date: 11-19-15
Witnessed By: _____

Location Address or Lot #	Applicant's Name and address:
357 Electric Avenue Lunenburg, MA 01462 New Construction ☒ Repair ☐	Unitil 306 Highlander Way Manchester, NH 03103 Telephone # 603-314-5900

On-site Review

Deep Hole Number: 1115-3 Date: 11-19-15 Time: 8:10 am Weather: Cloudy, 50's
Location (identify on site plan) See Plan
Land Use: Drive-In Theatre Slope (%): 2% Surface Stones: none
Vegetation: Pavement
Landform: Outwash Plain
Position on landscape (see attached sketch)
Distances from:

Open Water Body N/A feet
Possible Wet Area >100 feet
Drinking Water Well N/A feet
Drainage way N/A feet
Property Line >100 feet
Other _____

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
0 - 12	**-**	**FILL**			**Pavement, Gravel**
12 - 48	**C**	**Sandy Loam**	**2.5Y 5/4**	**7.5YR 5/6 @12"**	**SAB, damp, some stones**

Parent Material (geologic): pro-glacial outwash Depth to Bedrock: 48"

Depth to Groundwater: Standing Water in the Hole: none Weeping from Pit Face: 36"

Estimated Seasonal High Ground Water: 12"

Whitman & Bingham Associates
Soil Evaluation Report

Whitman & Bingham Associates | 510 Mechanic Street | Leominster, MA 01453
Tel. (978) 537-5296 | Civil/Site Engineers | Fax (978) 537-1426

Performed By: Mark F. Piermarini Date: 11-19-15
Witnessed By: _____

Location Address or Lot #	Applicant's Name and address:
357 Electric Avenue Lunenburg, MA 01462 New Construction ☒ Repair ☐	Unitil 306 Highlander Way Manchester, NH 03103 Telephone # 603-314-5900

On-site Review

Deep Hole Number: 1115-4 Date: 11-19-15 Time: 8:30 am Weather: Cloudy, 50's
Location (identify on site plan) See Plan
Land Use: Drive-In Theatre Slope (%): 2% Surface Stones: none
Vegetation: Pavement
Landform: Outwash Plain
Position on landscape (see attached sketch)
Distances from:

Open Water Body N/A feet
Possible Wet Area 60 feet
Drinking Water Well N/A feet
Drainage way N/A feet
Property Line >100 feet
Other _____

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
0 - 40	**-**	**FILL**			**Pavement, Gravel, Fill**
40 - 84	**C**	**Sandy Loam**	**2.5Y 5/4**	**7.5YR 5/6 @36"**	**SAB, damp, some stones**

Parent Material (geologic): pro-glacial outwash Depth to Bedrock: no refusal

Depth to Groundwater: Standing Water in the Hole: none Weeping from Pit Face: 36"

Estimated Seasonal High Ground Water: 36"

Whitman & Bingham Associates
Soil Evaluation Report

Whitman & Bingham Associates | 510 Mechanic Street | Leominster, MA 01453
Tel. (978) 537-5296 | Civil/Site Engineers | Fax (978) 537-1426

Performed By: Mark F. Piermarini Date: 11-19-15
Witnessed By: _____

Location Address or Lot #	Applicant's Name and address:
357 Electric Avenue Lunenburg, MA 01462 New Construction ☒ Repair ☐	Unitil 306 Highlander Way Manchester, NH 03103 Telephone # 603-314-5900

On-site Review

Deep Hole Number: 1115-5 Date: 11-19-15 Time: 8:50 am Weather: Cloudy, 50's
Location (identify on site plan) See Plan
Land Use: Drive-In Theatre Slope (%): 2% Surface Stones: none
Vegetation: Pavement
Landform: Outwash Plain
Position on landscape (see attached sketch)
Distances from:

Open Water Body N/A feet
Possible Wet Area >100 feet
Drinking Water Well N/A feet
Drainage way N/A feet
Property Line >100 feet
Other _____

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
0 - 40	**-**	**FILL**			**Pavement, Gravel**
40 - 54	**C**	**Sandy Loam**	**2.5Y 5/4**	**7.5YR 5/6 @24"**	**SAB, damp, some stones**

Parent Material (geologic): pro-glacial outwash Depth to Bedrock: 54"

Depth to Groundwater: Standing Water in the Hole: 52" Weeping from Pit Face: 40"

Estimated Seasonal High Ground Water: 24"

Whitman & Bingham Associates
Soil Evaluation Report

Whitman & Bingham Associates | 510 Mechanic Street | Leominster, MA 01453
Tel. (978) 537-5296 | Civil/Site Engineers | Fax (978) 537-1426

Performed By: Mark F. Piermarini Date: 11-19-15
Witnessed By: _____

Location Address or Lot #	Applicant's Name and address:
357 Electric Avenue Lunenburg, MA 01462 New Construction ☒ Repair ☐	Unitil 306 Highlander Way Manchester, NH 03103 Telephone # 603-314-5900

On-site Review

Deep Hole Number: 1115-6 Date: 11-19-15 Time: 9:10 am Weather: Cloudy, 50's
Location (identify on site plan) See Plan
Land Use: Drive-In Theatre Slope (%): 2% Surface Stones: none
Vegetation: Pavement
Landform: Outwash Plain
Position on landscape (see attached sketch)
Distances from:

Open Water Body N/A feet
Possible Wet Area 60 feet
Drinking Water Well N/A feet
Drainage way N/A feet
Property Line >100 feet
Other _____

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
0 - 60	**-**	**FILL**			**Pavement, Gravel**
60 - 84	**C**	**Sandy Loam**	**2.5Y 5/4**	**7.5YR 5/6 @60"**	**SAB, damp, some stones**

Parent Material (geologic): pro-glacial outwash Depth to Bedrock: no refusal

Depth to Groundwater: Standing Water in the Hole: none Weeping from Pit Face: none

Estimated Seasonal High Ground Water: 60"

information related to change in retention basin design

Mark Sweeney <marks007@charter.net>

Mon 10/26/2015 8:23 PM

To:Mark Piermarini <mpiermarini@whitmanbingham.com>;

Greetings Mark:

Thanks for taking the time to speak with me today about the invoice I received from the site contractor for the change in the retention basin. I appreciate the quick response on the redesign and am writing because I will need information so I can have a discussion with the original surveyor. As discussed I think it would be helpful if you could print me a copy of the existing conditions plan received and highlight the area for the retention basin and then print a drawing with the actual elevations identified on it.

Also, this is my draft suggestion for a letter that I would appreciate receiving to explain the change:

"Dear Mr. Sweeney:

The following two drawings are being forward to you for your reference to assist in understanding the need for changes to the original retention basin design. The Existing Conditions survey plan received from Todd Chapin of Chappelle Engineering is identified as drawing #1. This drawing was used as the starting point of our site plan submitted to the City of Worcester for approval by the Planning Board, Zoning Board of Appeals and the Conservation Commission.

Once all board approvals were received the plan was recorded at the registry of deeds. The first step in the construction process required by the DPW was to secure the perimeter area and clear the lot. Information was then gathered by our survey crew, the actual conditions evident in the proposed retention basin area are shown on drawing #2. Once construction began the significant changes in elevations were viewed by Ed Kochling, the Department of Public Works representative to the Conservation Commission during a site inspection visit. At his request we had an initial phone conversation to discuss the changes in elevations observed; he then requested a meeting at the site which resulted in the modifications to the perimeter area supporting the retention basin. The changes were conveyed to Glenn Hines Excavation Contractor and the work has been completed.

If you have any questions or need additional information please feel free to contact me at mpiermarini@whitmanbingham.com or by calling 978 537 5296."

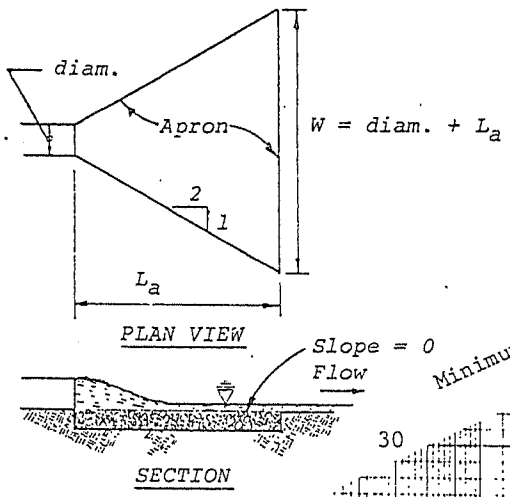
Mark, this is my attempt at providing wording for a letter, feel free to use any or all it. Let me know what you think.

Cheers:

Mark

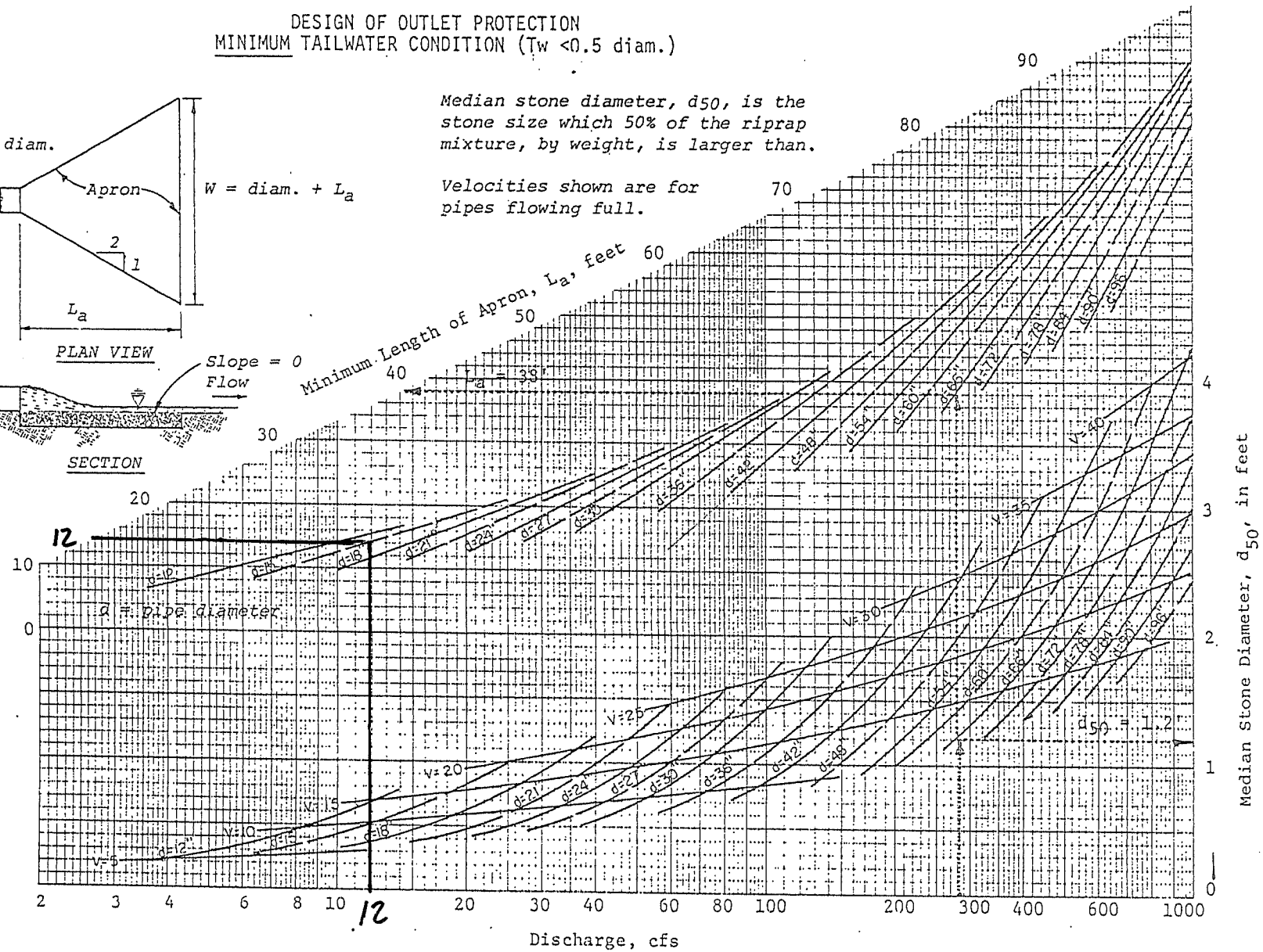
RIPRAP PAD CALCULATIONS

DESIGN OF OUTLET PROTECTION
MINIMUM TAILWATER CONDITION (Tw <0.5 diam.)



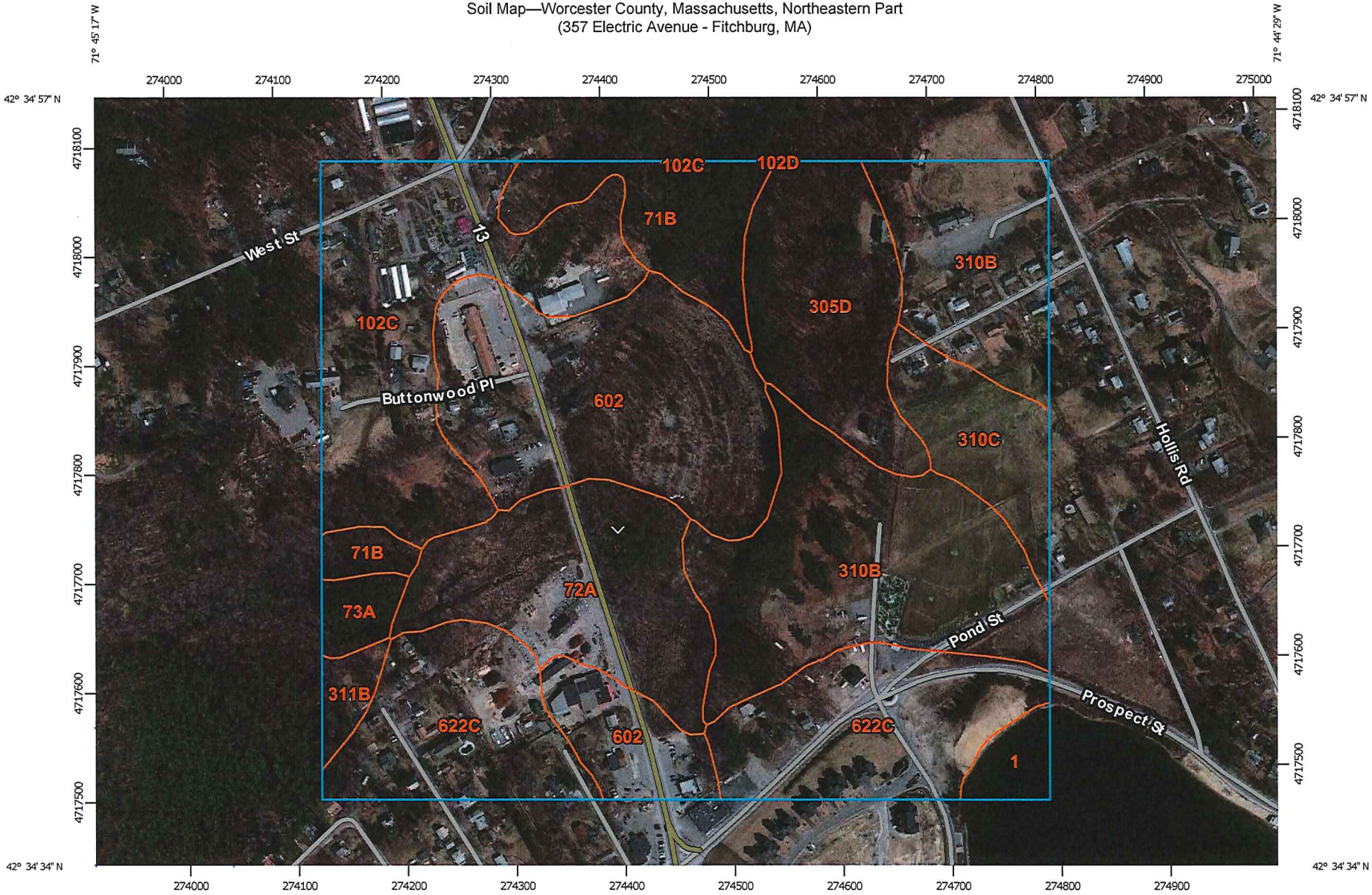
Median stone diameter, d_{50}, is the stone size which 50% of the riprap mixture, by weight, is larger than.

Velocities shown are for pipes flowing full.



NRCS SOIL MAP

Soil Map—Worcester County, Massachusetts, Northeastern Part
(357 Electric Avenue - Fitchburg, MA)



Map Scale: 1:4,960 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Worcester County, Massachusetts, Northeastern Part
Survey Area Data: Version 10, Sep 28, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

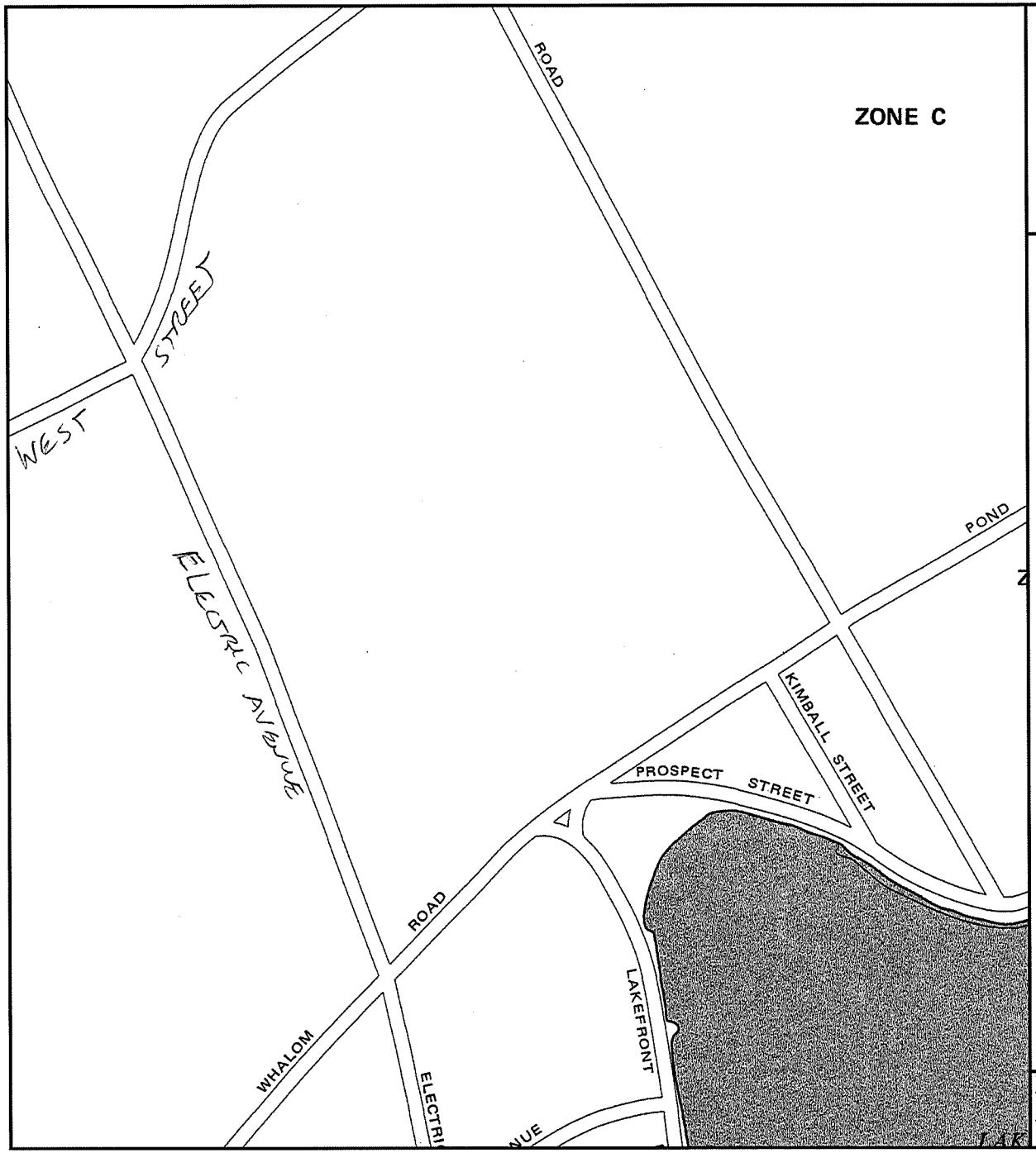
Date(s) aerial images were photographed: Mar 30, 2011—May 1, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Worcester County, Massachusetts, Northeastern Part (MA613)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Water	1.3	1.3%
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	5.5	5.7%
72A	Whitman loam, 0 to 3 percent slopes	9.6	9.9%
73A	Whitman loam, 0 to 3 percent slopes, extremely stony	1.2	1.2%
102C	Chatfield-Hollis-Rock outcrop complex, 3 to 15 percent slopes	14.1	14.6%
102D	Chatfield-Hollis-Rock outcrop complex, 15 to 25 percent slopes	0.0	0.0%
305D	Paxton fine sandy loam, 15 to 25 percent slopes	8.0	8.2%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	19.9	20.5%
310C	Woodbridge fine sandy loam, 8 to 15 percent slopes	4.2	4.3%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	1.0	1.0%
602	Urban land	16.9	17.4%
622C	Paxton-Urban land complex, 8 to 15 percent slopes	15.3	15.8%
Totals for Area of Interest		**97.0**	**100.0%**

FEMA MAP



APPROXIMATE SCALE

500 0 500 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

TOWN OF
LUNENBURG,
MASSACHUSETTS
WORCESTER COUNTY

PANEL 4 OF 6
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
250315 0004 B

EFFECTIVE DATE:
JUNE 15, 1982

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

TABLES AND CHARTS

Table 2-2a.—Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	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 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1]Average runoff condition, and $I_a = 0.2S$.
[2]The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
[3]CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4]Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5]Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

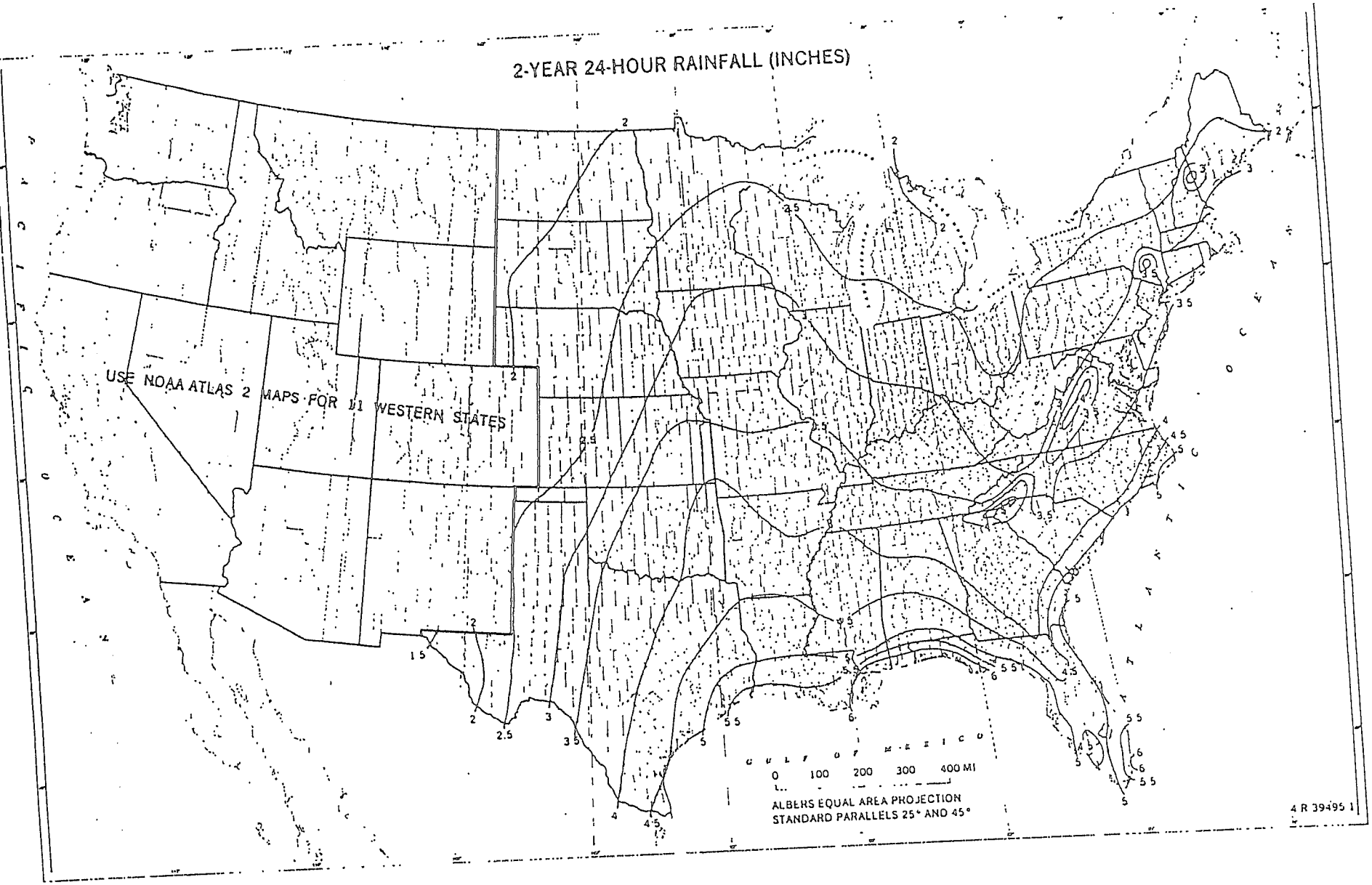


Figure B-3.—Two-year, 24-hour rainfall.

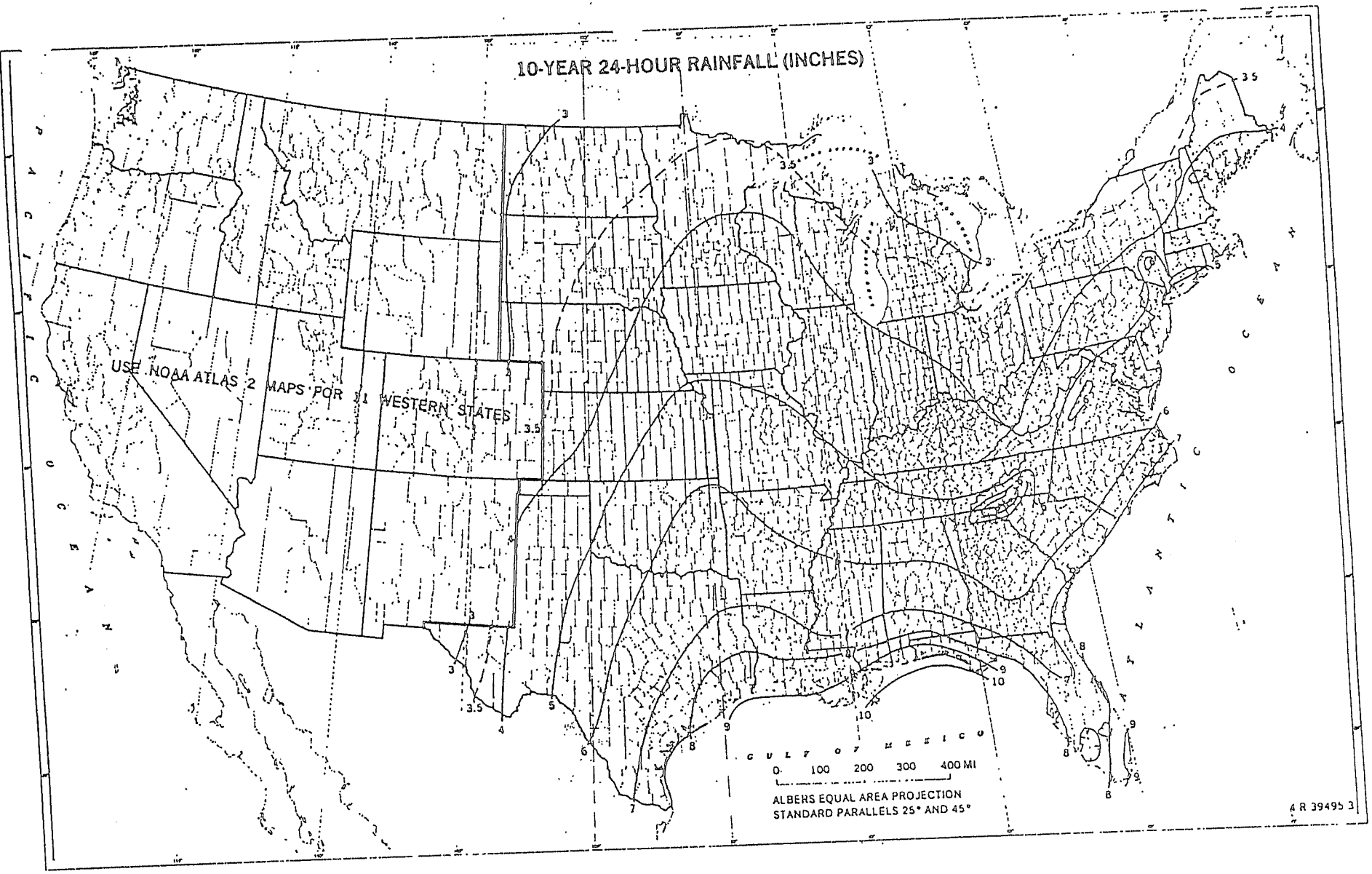


Figure B-5.—Ten-year, 24-hour rainfall.

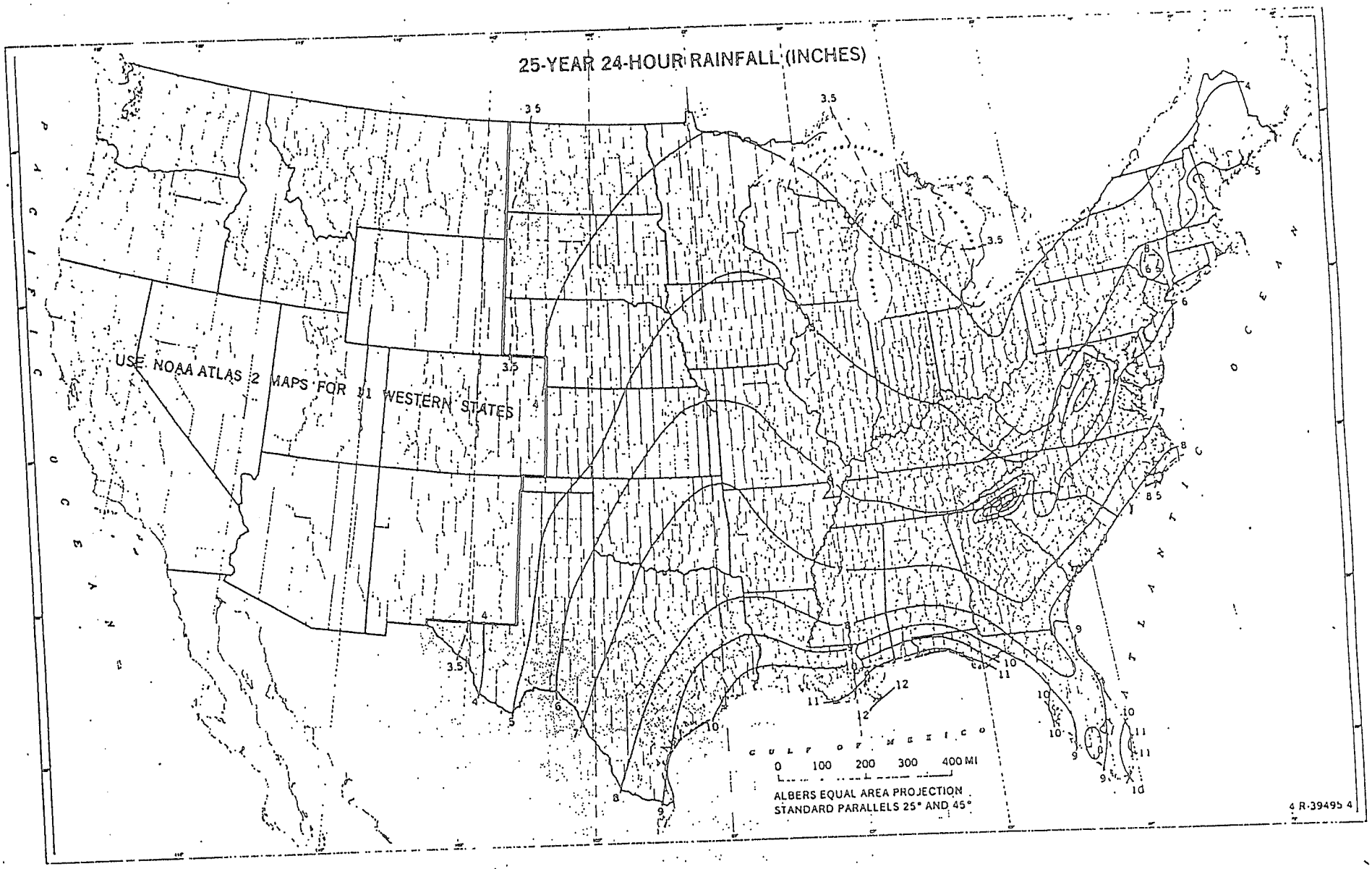


Figure B-6.—Twenty-five-year, 24-hour rainfall.

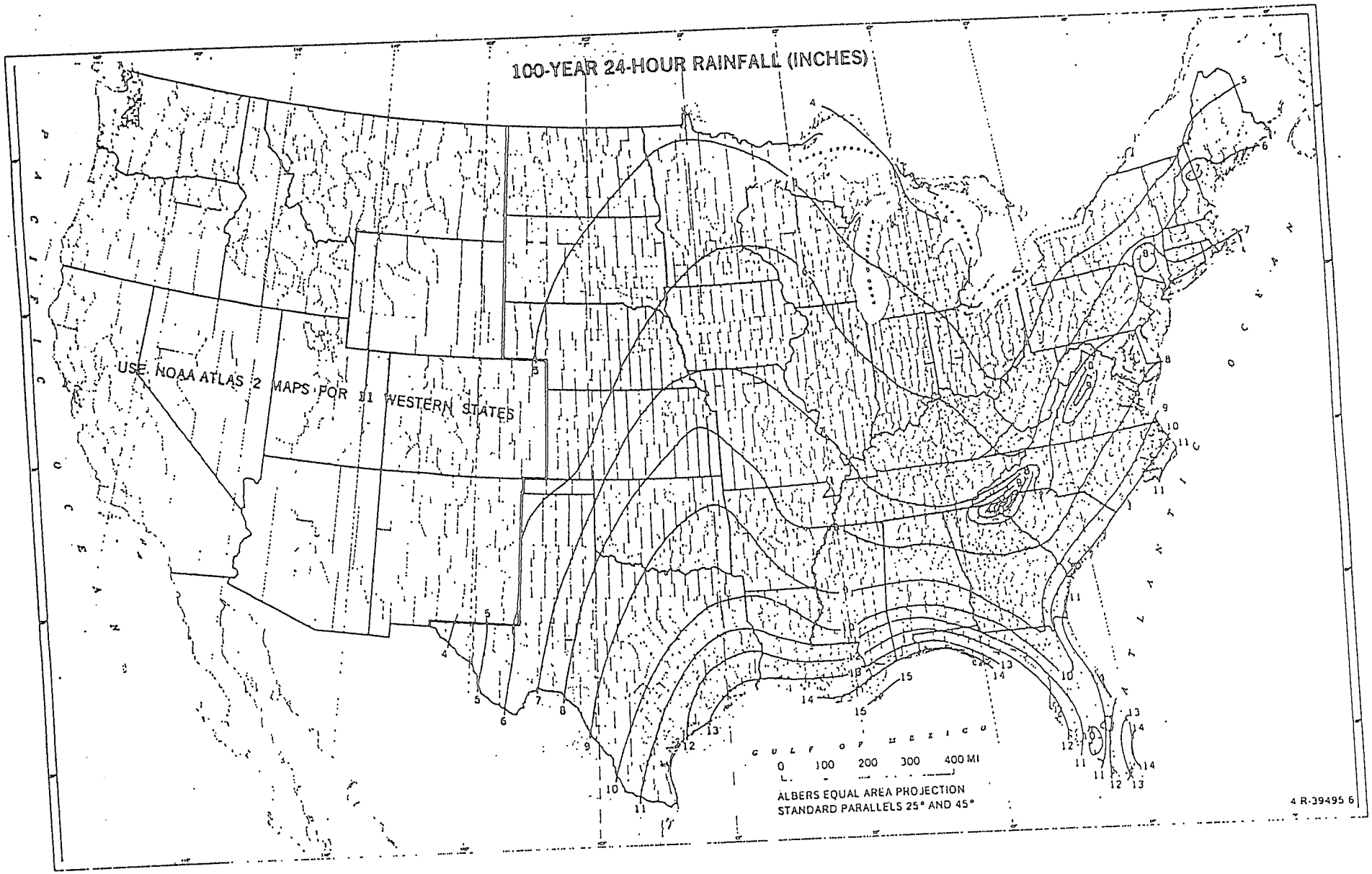


Figure B-8.—One-hundred-year, 24-hour rainfall.

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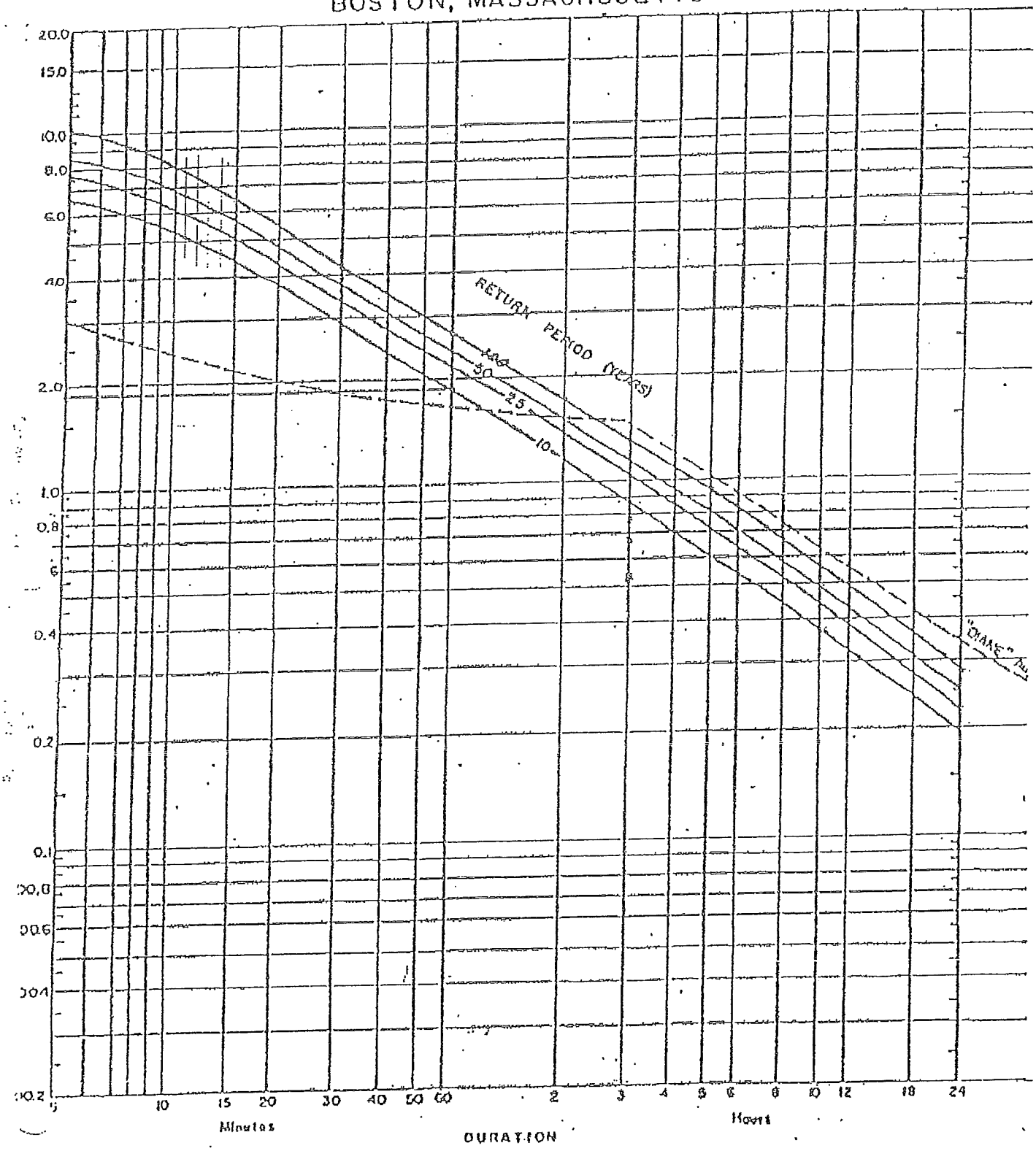


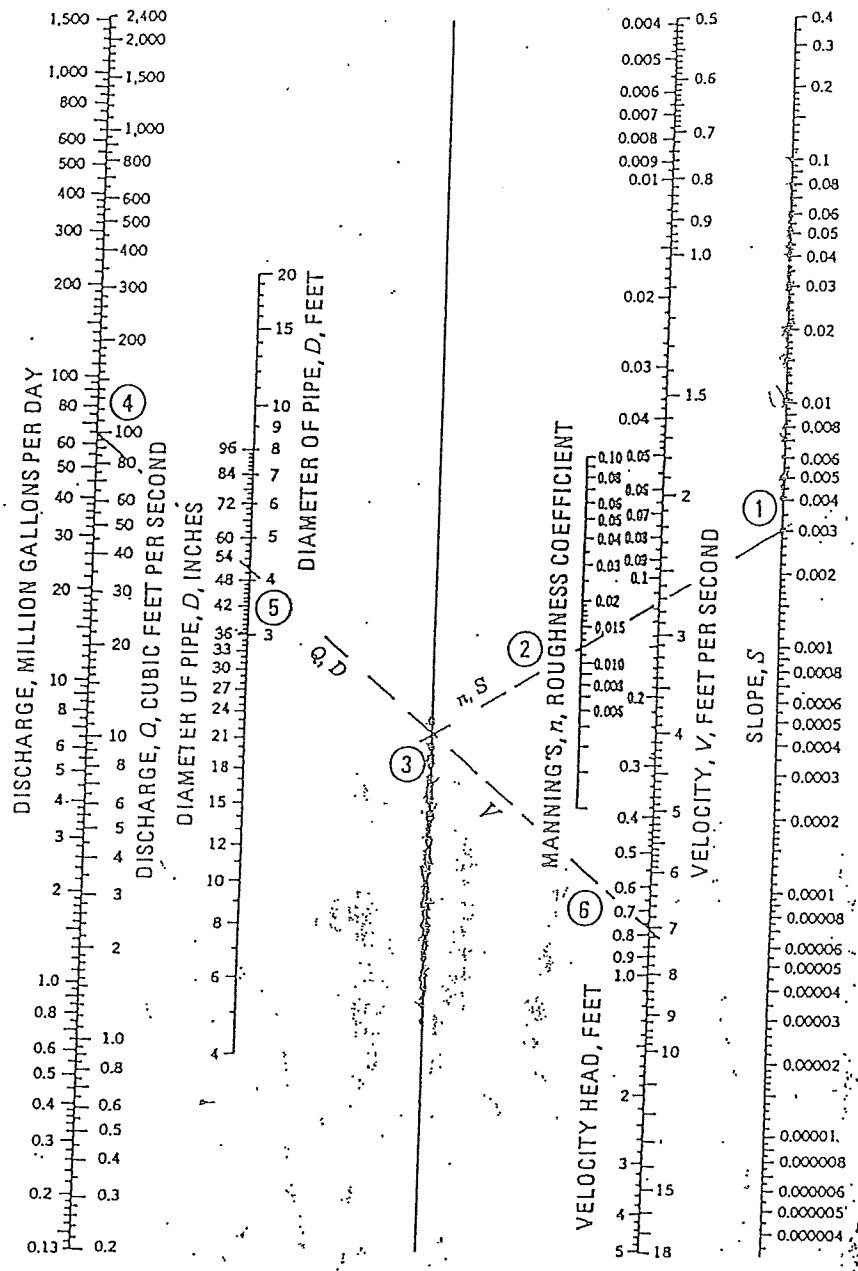
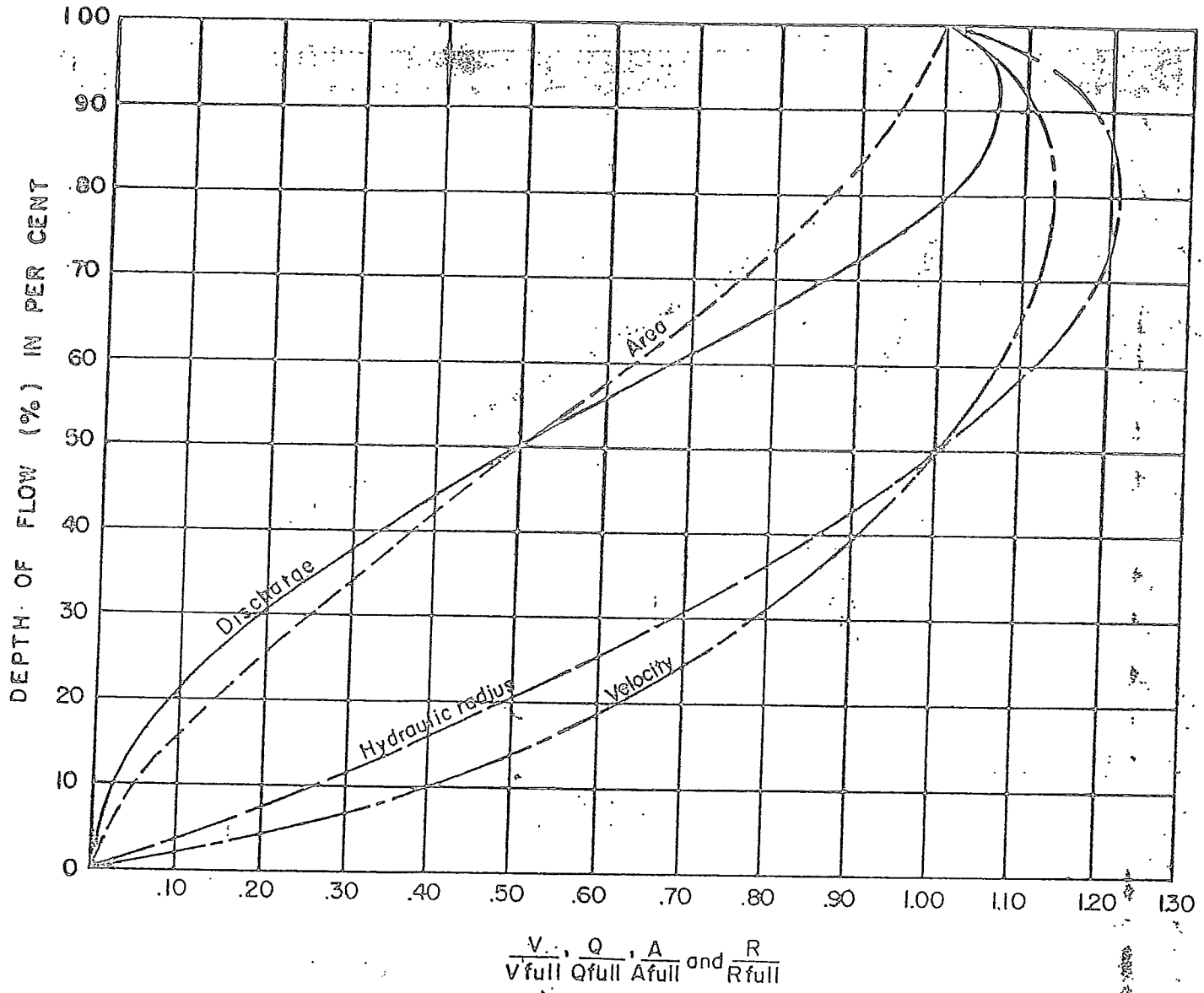


Figure 3.10. Nomograph for Manning's Equation.



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