Section 2 – Supplemental Calculations

Storm Sewer Calculations

Homestead Developers, LLC
Homesteads at Hillview
Eastview Drive and Upper Shelbyville Road
City of Franklin, Indiana

Submitted:
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By:

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Section 1: Pipe Sizing Calculations

Pipe Sizing Summary

The Rational Method and Manning's Equation were used to size the pipes to convey the peak runoff from the 10-year storm. The TR-55 Method was used to calculate the Times of Concentration. The Inlet Basin Map, pipe sizing calculations, and time of concentration worksheets are included within this section.

Homesteads at Hillview - Section 2
Pipe Sizing Calculations

Structure	Pipe Data						Inlet Watershed Data												Contributing Watershed Data						Pipe Analysis	
	Downstream Structure	Length (ft)	Pipe Diameter (in)	Pipe Material	Invert Slope (%)	Mannings Number n	Catchment Area (ac) Impervious	Runoff Coefficient C Impervious	Catchment Area (ac) Grass	Runoff Coefficient C Grass	Catchment Area (ac) Residence	Runoff Coefficient C Residence	Total Area A (ac)	Composite Coefficient C	Tc (min)	Rainfall Intensity (i) in/hr	Manual Input Flow Q (cfs)	Q=CiA (cfs)	Total Area A (ac)	Runoff Coefficient C	Time in Upstream Pipe (min)	Total Time of Concentration Tc (min)	Intensity I (in/hr)	Total Pipe Flow (cfs)	Pipe Capacity Qmax (cfs)	Pipe Velocity (ft/s)
Str. 69	Str. 70	317	12	RCP	0.27	0.012	0.131	0.850	0.156	0.20	0.000	0.45	0.287	0.50	6.74	6.46	--	0.92	0.287	0.497	N/A	6.74	6.46	0.92	2.01	2.55
Str. 70	Str. 71	142	18	RCP	0.17	0.012	0.000	0.850	0.262	0.20	1.439	0.45	1.701	0.41	11.39	5.22	--	3.65	1.988	0.424	N/A	11.39	5.22	4.40	4.55	2.58
Str. 71	Str. 72	26	18	RCP	0.20	0.012	0.062	0.850	0.024	0.20	0.224	0.45	0.310	0.51	12.70	4.98	--	0.79	2.298	0.436	N/A	12.70	4.98	4.98	5.09	2.88
Str. 72	Str. 76	4	18	RCP	0.50	0.012	0.062	0.850	0.024	0.20	0.069	0.45	0.155	0.57	9.58	5.61	--	0.50	2.453	0.444	0.15	12.85	4.95	5.39	8.05	4.55
Str. 73	Str. 74	26	12	RCP	0.30	0.012	0.067	0.850	0.026	0.20	0.208	0.45	0.301	0.52	12.12	5.09	--	0.79	0.301	0.517	N/A	12.12	5.09	0.79	2.11	2.69
Str. 74	Str. 75	4	12	RCP	0.50	0.012	0.074	0.850	0.029	0.20	0.081	0.45	0.184	0.57	10.14	5.45	--	0.57	0.485	0.538	0.16	12.28	5.06	1.32	2.73	3.48
Str. 75	Str. 76	150	12	RCP	0.30	0.012	No Inlet												0.485	0.538	0.02	12.30	5.05	1.32	2.11	2.69
Str. 76	Str. 86	177	18	RCP	0.35	0.012	No Inlet												2.938	0.460	0.93	13.23	4.88	6.59	6.73	3.81
Str. 77	Str. 78	26	12	RCP	0.30	0.012	0.073	0.850	0.028	0.20	0.264	0.45	0.365	0.51	13.59	4.81	--	0.90	0.365	0.511	N/A	13.59	4.81	0.90	2.11	2.69
Str. 78	Str. 86	4	12	RCP	0.50	0.012	0.073	0.850	0.028	0.20	0.082	0.45	0.183	0.57	9.26	5.70	--	0.60	0.548	0.531	0.16	13.75	4.78	1.39	2.73	3.48
Str. 79	Str. 80	26	12	RCP	0.30	0.012	0.089	0.850	0.028	0.20	0.066	0.45	0.183	0.61	9.84	5.53	--	0.61	0.183	0.606	N/A	9.84	5.53	0.61	2.11	2.69
Str. 80	Str. 81	4	12	RCP	0.50	0.012	0.101	0.850	0.042	0.20	0.077	0.45	0.220	0.59	10.15	5.45	--	0.70	0.403	0.595	N/A	10.15	5.45	1.31	2.73	3.48
Str. 81	Str. 85	135	15	RCP	0.20	0.012	No Inlet												0.403	0.595	0.02	10.17	5.45	1.31	3.13	2.55
Str. 82	Str. 83	26	12	RCP	0.30	0.012	0.126	0.850	0.045	0.20	0.277	0.45	0.448	0.54	10.21	5.44	--	1.31	0.448	0.537	N/A	10.21	5.44	1.31	2.11	2.69
Str. 83	Str. 84	81	15	RCP	0.20	0.012	0.183	0.850	0.063	0.20	0.275	0.45	0.521	0.56	13.31	4.86	--	1.42	0.969	0.550	N/A	13.31	4.86	2.59	3.13	2.55
Str. 84	Str. 85	4	15	RCP	0.50	0.012	0.059	0.850	0.022	0.20	0.064	0.45	0.145	0.57	9.69	5.57	--	0.46	1.114	0.553	0.39	13.70	4.79	2.95	4.98	4.03
Str. 85	Str. 86	140	18	RCP	0.16	0.012	No Inlet												1.517	0.564	0.02	13.72	4.79	4.10	4.55	2.58
Str. 86	Outlet	178	24	RCP	0.20	0.012	No Inlet												4.455	0.495	0.90	14.62	4.62	10.19	10.96	3.49
Str. 87	Outlet	252	15	RCP	0.20	0.012	0.341	0.850	0.374	0.20	0.000	0.45	0.688	0.51	10.00	5.48	--	1.92	0.688	0.510	N/A	10.00	5.48	1.92	3.13	2.55
Str. 88	Outlet	92	12	RCP	0.27	0.012	0.193	0.850	0.458	0.20	0.000	0.45	0.651	0.39	10.00	5.48	--	1.40	0.651	0.393	N/A	10.00	5.48	1.40	2.01	2.55
Str. 88A	Outlet	35	12	RCP	1.00	0.012	0.127	0.850	0.596	0.20	0.000	0.45	0.723	0.31	10.00	5.48	--	1.24	0.723	0.314	N/A	10.00	5.48	1.24	3.86	4.91
Str. 88B	Outlet	116	12	RCP	0.75	0.012	0.000	0.850	0.426	0.20	0.519	0.45	0.945	0.34	10.00	5.48	--	1.75	0.945	0.337	N/A	10.00	5.48	1.75	3.34	4.23
Str. 89	Str. 90	181	12	RCP	0.42	0.012	--	--	--	--	--	--	--	--	--	--	1.69	--	0.723	0.314	--	--	--	1.69	2.50	3.18
Str. 90	Str. 91	344	12	RCP	0.42	0.012	--	--	--	--	--	--	--	--	--	--	1.69	--	0.723	0.314	--	--	--	1.69	2.50	3.18
Str. 91	Outlet	182	12	RCP	0.42	0.012	--	--	--	--	--	--	--	--	--	--	1.69	--	0.723	0.314	--	--	--	1.69	2.50	3.18
Str. 92	Str. 95	150	12	RCP	0.27	0.012	0.000	0.850	0.221	0.20	0.000	0.45	0.221	0.20	11.92	5.12	--	0.23	0.221	0.200	N/A	11.92	5.43	0.23	2.01	2.55
Str. 93	Str. 94	56	12	RCP	0.27	0.012	0.062	0.850	0.088	0.20	0.000	0.45	0.150	0.47	6.19	6.63	--	0.47	0.150	0.469	N/A	6.19	6.63	0.47	2.01	2.55
Str. 94	Str. 95	4	12	RCP	0.50	0.012	0.072	0.850	0.109	0.20	0.000	0.45	0.181	0.46	6.37	6.58	--	0.55	0.331	0.463	0.37	6.56	6.52	1.00	2.73	3.48
Str. 95	Str. 96	150	12	RCP	0.27	0.012	No Inlet												0.552	0.358	0.98	12.90	4.94	0.98	2.01	2.55
Str. 96	Str. 97	56	12	RCP	0.27	0.012	0.109	0.850	0.131	0.20	0.000	0.45	0.240	0.50	6.90	6.42	--	0.76	0.240	0.495	N/A	6.90	6.42	0.76	2.11	2.69
Str. 97	Str. 98	4	12	RCP	0.50	0.012	0.109	0.850	0.131	0.20	0.000	0.45	0.240	0.50	6.90	6.42	--	0.76	0.480	0.495	0.37	7.27	6.30	1.50	2.73	3.48
Str. 98	Str. 101	150	12	RCP	0.27	0.012	No Inlet												0.480	0.495	0.02	7.29	6.30	1.50	2.11	2.69
Str. 99	Str. 100	56	12	RCP	0.27	0.012	0.183	0.850	0.265	0.20	0.000	0.45	0.448	0.47	6.72	6.47	--	1.35	0.448	0.466	N/A	6.72	6.47	1.35	2.11	2.69
Str. 100	Str. 101	4	12	RCP	0.50	0.012	0.183	0.850	0.265	0.20	0.000	0.45	0.448	0.47	6.72	6.47	--	1.35	0.896	0.466	0.37	7.09	6.36	2.65	2.73	3.48
Str. 101	Str. 102	53	18	RCP	0.15	0.012	No Inlet												1.928	0.442	0.98	13.88	4.76	4.06	4.41	2.50
Str. 102	Str. 103	390	18	RCP	0.28	0.012	0.000	0.850	0.394	0.20	0.731	0.45	1.125	0.36	13.57	4.82	--	1.97	3.053	0.413	0.35	14.23	4.69	5.91	6.02	3.41
Str. 103	Str. 103A	139	24	RCP	0.28	0.012	--	--	--	--	--	--	2.657	0.60	--	--	--	--	5.710	0.500	1.91	16.14	4.44	12.67	12.97	4.13
Str. 104	Outlet	154	30	RCP	0.35	0.012	--	--	--	SEE ATTACHED EAGLE POINT MODELING			--	--	--	--	26.16	--	--	--	--	--	--	26.16	26.29	5.36
Str. 105	Outlet	182	36	RCP	0.35	0.012	--	--	--	--	--	--	--	--	--	--	15.64	--	--	--	--	--	--	15.64	42.74	6.05

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #69

Sheet Flow

1.	Surface Description	grass		pvmt		pvmt	
2.	Manning's Roughness Coeff., (n)	0.170		0.011		0.011	
3.	Flow Length, (L) **total L<= 300 ft	33.00 ft.		6.00 ft.		0.00 ft.	
4.	Two-yr 24-hr Rainfall, (P2)	2.64 in.		2.64 in.		2.64 in.	
5.	Land Slope, (s)	0.0150 ft./ft.		0.0200 ft./ft.		0.0366 ft./ft.	
6.	Travel Time, (Tt) (Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])	0.092 hr	+	0.002 hr	+	0.000 hr	

Shallow Concentrated Flow

7.	Surface Description (paved or unpaved)	paved		unpaved		unpaved	
8.	Flow Length, (L)	110.00 ft.		0.00 ft.		0.00 ft.	
9.	Watercourse Slope, (s)	0.0068 ft./ft.		0.0202 ft./ft.		0.0060 ft./ft.	
10.	Average Velocity, (V) (Vp = 20.3282(s)^0.5) (Vup = 16.1345(s)^0.5)	1.676 ft./s		2.293 ft./s		1.250 ft./s	
11.	Travel Time, (Tt) (Tt = L/3600V)	0.018 hr	+	0.000 hr	+	0.000 hr	

Watershed or Subarea Tc or Tt =

0.112 hr

or

6.74 min

Channel Flow

12.	Cross Sectional Flow Area, (a)	133.48 ft.^2		132.12 ft.^2		174.24 ft.^2	
13.	Wetted Perimeter, Pw	35.51 ft.		30.71 ft.		43.74 ft.	
14.	Hydraulic Radius, (r) (r = a/Pw)	3.759 ft.		4.302 ft.		3.984 ft.	
15.	Channel Slope, (s)	0.0175 ft./ft.		0.0121 ft./ft.		0.0084 ft./ft.	
16.	Manning's Roughness Coeff., (n)	0.027		0.027		0.027	
17.	Velocity, (V) (V = [1.49*r^0.67*s^0.5]/n)	17.727 ft./s		16.136 ft./s		12.769 ft./s	
18.	Flow Length, (L)	0.00 ft.		0.00 ft.		0.00 ft.	
19.	Travel Time, (Tt) (Tt = L/3600V)	0.000 hr	+	0.000 hr	+	0.000 hr	

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #70

Sheet Flow

1.	**Surface Description**	grass		pvmt		pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170		0.011		0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	65.00	ft.	0.00	ft.	0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.	2.64	in.	2.64	in.
5.	**Land Slope, (s)**	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.141	hr +	0.000	hr +	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description** **(paved or unpaved)**	**paved**		**unpaved**		**unpaved**	
8.	**Flow Length, (L)**	0.00	ft.	285.00	ft.	0.00	ft.
9.	**Watercourse Slope, (s)**	0.0068	ft./ft.	0.0100	ft./ft.	0.0060	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.676	ft./s	1.613	ft./s	1.250	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr +	0.049	hr +	0.000	hr

Watershed or Subarea Tc or Tt = 0.190 hr

or 11.39 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	16.00	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	**Wetted Perimeter, Pw**	16.49	ft.	30.71	ft.	43.74	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	0.970	ft.	4.302	ft.	3.984	ft.
15.	**Channel Slope, (s)**	0.0100	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.027		0.027		0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	5.408	ft./s	16.136	ft./s	12.769	ft./s
18.	**Flow Length, (L)**	0.00	ft.	0.00	ft.	0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #71

Sheet Flow

1.	**Surface Description**	grass		pvmt		pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170		0.011		0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	94.50	ft.	6.00	ft.	0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.	2.64	in.	2.64	in.
5.	**Land Slope, (s)**	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.190	hr +	0.002	hr +	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description** **(paved or unpaved)**	**paved**		**unpaved**		**unpaved**	
8.	**Flow Length, (L)**	100.00	ft.	0.00	ft.	0.00	ft.
9.	**Watercourse Slope, (s)**	0.0050	ft./ft.	0.0200	ft./ft.	0.0060	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.437	ft./s	2.282	ft./s	1.250	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.019	hr +	0.000	hr +	0.000	hr

Watershed or Subarea Tc or Tt = 0.212 hr

or

12.70 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	**Wetted Perimeter, Pw**	35.51	ft.	30.71	ft.	43.74	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759	ft.	4.302	ft.	3.984	ft.
15.	**Channel Slope, (s)**	0.0175	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.027		0.027		0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727	ft./s	16.136	ft./s	12.769	ft./s
18.	**Flow Length, (L)**	0.00	ft.	0.00	ft.	0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #72

Sheet Flow

1.	**Surface Description**	grass		pvmt		pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170		0.011		0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	60.00 ft.		6.00 ft.		0.00 ft.	
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64 in.		2.64 in.		2.64 in.	
5.	**Land Slope, (s)**	0.0200 ft./ft.		0.0200 ft./ft.		0.0366 ft./ft.	
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.132 hr	+	0.002 hr	+	0.000 hr	

Shallow Concentrated Flow

7.	**Surface Description** **(paved or unpaved)**	**paved**		**unpaved**		**unpaved**	
8.	**Flow Length, (L)**	131.00 ft.		0.00 ft.		0.00 ft.	
9.	**Watercourse Slope, (s)**	0.0050 ft./ft.		0.0200 ft./ft.		0.0060 ft./ft.	
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.437 ft./s		2.282 ft./s		1.250 ft./s	
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.025 hr	+	0.000 hr	+	0.000 hr	

Watershed or Subarea Tc or Tt = 0.160 hr

or

9.58 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48 ft.^2		132.12 ft.^2		174.24 ft.^2	
13.	**Wetted Perimeter, Pw**	35.51 ft.		30.71 ft.		43.74 ft.	
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759 ft.		4.302 ft.		3.984 ft.	
15.	**Channel Slope, (s)**	0.0175 ft./ft.		0.0121 ft./ft.		0.0084 ft./ft.	
16.	**Manning's Roughness Coeff., (n)**	0.027		0.027		0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727 ft./s		16.136 ft./s		12.769 ft./s	
18.	**Flow Length, (L)**	0.00 ft.		0.00 ft.		0.00 ft.	
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000 hr	+	0.000 hr	+	0.000 hr	

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str #73

Sheet Flow

1.	**Surface Description**	grass			pvmt			pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170			0.011			0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	94.50	ft.		6.00	ft.		0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.		2.64	in.		2.64	in.
5.	**Land Slope, (s)**	0.0200	ft./ft.		0.0200	ft./ft.		0.0366	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.190	hr	+	0.002	hr	+	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description** **(paved or unpaved)**	**paved**			**unpaved**			**unpaved**	
8.	**Flow Length, (L)**	50.00	ft.		0.00	ft.		0.00	ft.
9.	**Watercourse Slope, (s)**	0.0050	ft./ft.		0.0200	ft./ft.		0.0060	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.437	ft./s		2.282	ft./s		1.250	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.010	hr	+	0.000	hr	+	0.000	hr

Watershed or Subarea Tc or Tt = 0.202 hr

or 12.12 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48	ft.^2		132.12	ft.^2		174.24	ft.^2
13.	**Wetted Perimeter, Pw**	35.51	ft.		30.71	ft.		43.74	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759	ft.		4.302	ft.		3.984	ft.
15.	**Channel Slope, (s)**	0.0175	ft./ft.		0.0121	ft./ft.		0.0084	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.027			0.027			0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727	ft./s		16.136	ft./s		12.769	ft./s
18.	**Flow Length, (L)**	0.00	ft.		0.00	ft.		0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr	+	0.000	hr	+	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str #74

Sheet Flow

1.	Surface Description	grass		pvmt		pvmt	
2.	Manning's Roughness Coeff., (n)	0.170		0.011		0.011	
3.	Flow Length, (L) **total L<= 300 ft	60.00	ft.	6.00	ft.	0.00	ft.
4.	Two-yr 24-hr Rainfall, (P2)	2.64	in.	2.64	in.	2.64	in.
5.	Land Slope, (s)	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	Travel Time, (Tt) (Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])	0.132	hr +	0.002	hr +	0.000	hr

Shallow Concentrated Flow

7.	Surface Description (paved or unpaved)	paved		unpaved		unpaved	
8.	Flow Length, (L)	179.00	ft.	0.00	ft.	0.00	ft.
9.	Watercourse Slope, (s)	0.0050	ft./ft.	0.0200	ft./ft.	0.0060	ft./ft.
10.	Average Velocity, (V) (Vp = 20.3282(s)^0.5) (Vup = 16.1345(s)^0.5)	1.437	ft./s	2.282	ft./s	1.250	ft./s
11.	Travel Time, (Tt) (Tt = L/3600V)	0.035	hr +	0.000	hr +	0.000	hr

Watershed or Subarea Tc or Tt = 0.169 hr

or

10.14 min

Channel Flow

12.	Cross Sectional Flow Area, (a)	133.48	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	Wetted Perimeter, Pw	35.51	ft.	30.71	ft.	43.74	ft.
14.	Hydraulic Radius, (r) (r = a/Pw)	3.759	ft.	4.302	ft.	3.984	ft.
15.	Channel Slope, (s)	0.0175	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	Manning's Roughness Coeff., (n)	0.027		0.027		0.027	
17.	Velocity, (V) (V = [1.49*r^0.67*s^0.5]/n)	17.727	ft./s	16.136	ft./s	12.769	ft./s
18.	Flow Length, (L)	0.00	ft.	0.00	ft.	0.00	ft.
19.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str #77

Sheet Flow

1.	**Surface Description**	grass		pvmt		pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170		0.011		0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	94.50	ft.	6.00	ft.	0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.	2.64	in.	2.64	in.
5.	**Land Slope, (s)**	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.190	hr +	0.002	hr +	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description** **(paved or unpaved)**	paved		unpaved		unpaved	
8.	**Flow Length, (L)**	177.00	ft.	0.00	ft.	0.00	ft.
9.	**Watercourse Slope, (s)**	0.0050	ft./ft.	0.0200	ft./ft.	0.0060	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.437	ft./s	2.282	ft./s	1.250	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.034	hr +	0.000	hr +	0.000	hr

Watershed or Subarea Tc or Tt = 0.226 hr

or

13.59 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	**Wetted Perimeter, Pw**	35.51	ft.	30.71	ft.	43.74	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759	ft.	4.302	ft.	3.984	ft.
15.	**Channel Slope, (s)**	0.0175	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.027		0.027		0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727	ft./s	16.136	ft./s	12.769	ft./s
18.	**Flow Length, (L)**	0.00	ft.	0.00	ft.	0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #78

Sheet Flow

1.	**Surface Description**	grass		pvmt		pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170		0.011		0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	60.00	ft.	6.00	ft.	0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.	2.64	in.	2.64	in.
5.	**Land Slope, (s)**	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.132	hr +	0.002	hr +	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description (paved or unpaved)**	**paved**		**unpaved**		**unpaved**	
8.	**Flow Length, (L)**	103.00	ft.	0.00	ft.	0.00	ft.
9.	**Watercourse Slope, (s)**	0.0050	ft./ft.	0.0200	ft./ft.	0.0060	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.437	ft./s	2.282	ft./s	1.250	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.020	hr +	0.000	hr +	0.000	hr

Watershed or Subarea Tc or Tt = **0.154 hr**

or

9.26 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	**Wetted Perimeter, Pw**	35.51	ft.	30.71	ft.	43.74	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759	ft.	4.302	ft.	3.984	ft.
15.	**Channel Slope, (s)**	0.0175	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.027		0.027		0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727	ft./s	16.136	ft./s	12.769	ft./s
18.	**Flow Length, (L)**	0.00	ft.	0.00	ft.	0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #73

Sheet Flow

1.	**Surface Description**	grass		pvmt		pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170		0.011		0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	60.00	ft.	6.00	ft.	0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.	2.64	in.	2.64	in.
5.	**Land Slope, (s)**	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.132	hr +	0.002	hr +	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description** **(paved or unpaved)**	**paved**		**unpaved**		**unpaved**	
8.	**Flow Length, (L)**	153.00	ft.	0.00	ft.	0.00	ft.
9.	**Watercourse Slope, (s)**	0.0050	ft./ft.	0.0200	ft./ft.	0.0060	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.437	ft./s	2.282	ft./s	1.250	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.030	hr +	0.000	hr +	0.000	hr

Watershed or Subarea Tc or Tt = 0.164 hr

or

9.84 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	**Wetted Perimeter, Pw**	35.51	ft.	30.71	ft.	43.74	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759	ft.	4.302	ft.	3.984	ft.
15.	**Channel Slope, (s)**	0.0175	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.027		0.027		0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727	ft./s	16.136	ft./s	12.769	ft./s
18.	**Flow Length, (L)**	0.00	ft.	0.00	ft.	0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #80

Sheet Flow

1.	**Surface Description**	grass		pvmt		pvmt		
2.	**Manning's Roughness Coeff., (n)**	0.170		0.011		0.011		
3.	**Flow Length, (L) **total L<= 300 ft**	60.00	ft.	6.00	ft.	0.00	ft.	
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.	2.64	in.	2.64	in.	
5.	**Land Slope, (s)**	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.	
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.132	hr +	0.002	hr +	0.000	hr	

Shallow Concentrated Flow

7.	**Surface Description (paved or unpaved)**	**paved**		**unpaved**		**unpaved**		
8.	**Flow Length, (L)**	180.00	ft.	0.00	ft.	0.00	ft.	
9.	**Watercourse Slope, (s)**	0.0050	ft./ft.	0.0200	ft./ft.	0.0060	ft./ft.	
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.437	ft./s	2.282	ft./s	1.250	ft./s	
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.035	hr +	0.000	hr +	0.000	hr	

Watershed or Subarea Tc or Tt = 0.169 hr

or 10.15 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48	ft.^2	132.12	ft.^2	174.24	ft.^2	
13.	**Wetted Perimeter, Pw**	35.51	ft.	30.71	ft.	43.74	ft.	
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759	ft.	4.302	ft.	3.984	ft.	
15.	**Channel Slope, (s)**	0.0175	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.	
16.	**Manning's Roughness Coeff., (n)**	0.027		0.027		0.027		
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727	ft./s	16.136	ft./s	12.769	ft./s	
18.	**Flow Length, (L)**	0.00	ft.	0.00	ft.	0.00	ft.	
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr +	0.000	hr +	0.000	hr	

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #82

Sheet Flow

1.	**Surface Description**	grass		pvmt		pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170		0.011		0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	54.00	ft.	6.00	ft.	0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.	2.64	in.	2.64	in.
5.	**Land Slope, (s)**	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.121	hr +	0.002	hr +	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description** **(paved or unpaved)**	paved		unpaved		unpaved	
8.	**Flow Length, (L)**	240.00	ft.	0.00	ft.	0.00	ft.
9.	**Watercourse Slope, (s)**	0.0050	ft./ft.	0.0202	ft./ft.	0.0060	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.437	ft./s	2.293	ft./s	1.250	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.046	hr +	0.000	hr +	0.000	hr

Watershed or Subarea Tc or Tt =

0.170 hr

or

10.21 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	**Wetted Perimeter, Pw**	35.51	ft.	30.71	ft.	43.74	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759	ft.	4.302	ft.	3.984	ft.
15.	**Channel Slope, (s)**	0.0175	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.027		0.027		0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727	ft./s	16.136	ft./s	12.769	ft./s
18.	**Flow Length, (L)**	0.00	ft.	0.00	ft.	0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #83

Sheet Flow

1.	Surface Description	grass			pvmt			pvmt	
2.	Manning's Roughness Coeff., (n)	0.170			0.011			0.011	
3.	Flow Length, (L) **total L<= 300 ft	94.50	ft.		6.00	ft.		0.00	ft.
4.	Two-yr 24-hr Rainfall, (P2)	2.64	in.		2.64	in.		2.64	in.
5.	Land Slope, (s)	0.0200	ft./ft.		0.0200	ft./ft.		0.0366	ft./ft.
6.	Travel Time, (Tt) (Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])	0.190	hr	+	0.002	hr	+	0.000	hr

Shallow Concentrated Flow

7.	Surface Description (paved or unpaved)	paved			paved			unpaved	
8.	Flow Length, (L)	130.00	ft.		40.00	ft.		0.00	ft.
9.	Watercourse Slope, (s)	0.0050	ft./ft.		0.0150	ft./ft.		0.0060	ft./ft.
10.	Average Velocity, (V) (Vp = 20.3282(s)^0.5) (Vup = 16.1345(s)^0.5)	1.437	ft./s		2.490	ft./s		1.250	ft./s
11.	Travel Time, (Tt) (Tt = L/3600V)	0.025	hr	+	0.004	hr	+	0.000	hr

Watershed or Subarea Tc or Tt = 0.222 hr

or

13.31 min

Channel Flow

12.	Cross Sectional Flow Area, (a)	133.48	ft.^2		132.12	ft.^2		174.24	ft.^2
13.	Wetted Perimeter, Pw	35.51	ft.		30.71	ft.		43.74	ft.
14.	Hydraulic Radius, (r) (r = a/Pw)	3.759	ft.		4.302	ft.		3.984	ft.
15.	Channel Slope, (s)	0.0175	ft./ft.		0.0121	ft./ft.		0.0084	ft./ft.
16.	Manning's Roughness Coeff., (n)	0.027			0.027			0.027	
17.	Velocity, (V) (V = [1.49*r^0.67*s^0.5]/n)	17.727	ft./s		16.136	ft./s		12.769	ft./s
18.	Flow Length, (L)	0.00	ft.		0.00	ft.		0.00	ft.
19.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr	+	0.000	hr	+	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #84

Sheet Flow

1.	Surface Description	grass		pvmt		pvmt		
2.	Manning's Roughness Coeff., (n)	0.170		0.011		0.011		
3.	Flow Length, (L) **total L<= 300 ft	60.00	ft.	6.00	ft.	0.00	ft.	
4.	Two-yr 24-hr Rainfall, (P2)	2.64	in.	2.64	in.	2.64	in.	
5.	Land Slope, (s)	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.	
6.	Travel Time, (Tt) (Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])	0.132	hr +	0.002	hr +	0.000	hr	

Shallow Concentrated Flow

7.	Surface Description (paved or unpaved)	paved		unpaved		unpaved		
8.	Flow Length, (L)	140.00	ft.	0.00	ft.	0.00	ft.	
9.	Watercourse Slope, (s)	0.0050	ft./ft.	0.0200	ft./ft.	0.0060	ft./ft.	
10.	Average Velocity, (V) (Vp = 20.3282(s)^0.5) (Vup = 16.1345(s)^0.5)	1.437	ft./s	2.282	ft./s	1.250	ft./s	
11.	Travel Time, (Tt) (Tt = L/3600V)	0.027	hr +	0.000	hr +	0.000	hr	

Watershed or Subarea Tc or Tt = 0.161 hr

or 9.69 min

Channel Flow

12.	Cross Sectional Flow Area, (a)	133.48	ft.^2	132.12	ft.^2	174.24	ft.^2	
13.	Wetted Perimeter, Pw	35.51	ft.	30.71	ft.	43.74	ft.	
14.	Hydraulic Radius, (r) (r = a/Pw)	3.759	ft.	4.302	ft.	3.984	ft.	
15.	Channel Slope, (s)	0.0175	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.	
16.	Manning's Roughness Coeff., (n)	0.027		0.027		0.027		
17.	Velocity, (V) (V = [1.49*r^0.67*s^0.5]/n)	17.727	ft./s	16.136	ft./s	12.769	ft./s	
18.	Flow Length, (L)	0.00	ft.	0.00	ft.	0.00	ft.	
19.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr +	0.000	hr +	0.000	hr	

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #92

Sheet Flow

1.	Surface Description	grass		pvmt		pvmt	
2.	Manning's Roughness Coeff., (n)	0.170		0.011		0.011	
3.	Flow Length, (L) **total L<= 300 ft	100.00	ft.	0.00	ft.	0.00	ft.
4.	Two-yr 24-hr Rainfall, (P2)	2.64	in.	2.64	in.	2.64	in.
5.	Land Slope, (s)	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	Travel Time, (Tt) (Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])	0.199	hr +	0.000	hr +	0.000	hr

Shallow Concentrated Flow

7.	Surface Description (paved or unpaved)	paved		unpaved		unpaved	
8.	Flow Length, (L)	0.00	ft.	0.00	ft.	0.00	ft.
9.	Watercourse Slope, (s)	0.0068	ft./ft.	0.0100	ft./ft.	0.0060	ft./ft.
10.	Average Velocity, (V) (Vp = 20.3282(s)^0.5) (Vup = 16.1345(s)^0.5)	1.676	ft./s	1.613	ft./s	1.250	ft./s
11.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr +	0.000	hr +	0.000	hr

Watershed or Subarea Tc or Tt = 0.199 hr

or 11.92 min

Channel Flow

12.	Cross Sectional Flow Area, (a)	16.00	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	Wetted Perimeter, Pw	16.49	ft.	30.71	ft.	43.74	ft.
14.	Hydraulic Radius, (r) (r = a/Pw)	0.970	ft.	4.302	ft.	3.984	ft.
15.	Channel Slope, (s)	0.0100	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	Manning's Roughness Coeff., (n)	0.027		0.027		0.027	
17.	Velocity, (V) (V = [1.49*r^0.67*s^0.5]/n)	5.408	ft./s	16.136	ft./s	12.769	ft./s
18.	Flow Length, (L)	0.00	ft.	0.00	ft.	0.00	ft.
19.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #93

Sheet Flow

1.	Surface Description	grass		pvmt		pvmt	
2.	Manning's Roughness Coeff., (n)	0.170		0.011		0.011	
3.	Flow Length, (L) **total L<= 300 ft	34.00	ft.	6.00	ft.	0.00	ft.
4.	Two-yr 24-hr Rainfall, (P2)	2.64	in.	2.64	in.	2.64	in.
5.	Land Slope, (s)	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	Travel Time, (Tt) (Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])	0.084	hr +	0.002	hr +	0.000	hr

Shallow Concentrated Flow

7.	Surface Description (paved or unpaved)	paved		unpaved		unpaved	
8.	Flow Length, (L)	102.00	ft.	0.00	ft.	0.00	ft.
9.	Watercourse Slope, (s)	0.0067	ft./ft.	0.0202	ft./ft.	0.0060	ft./ft.
10.	Average Velocity, (V) (Vp = 20.3282(s)^0.5) (Vup = 16.1345(s)^0.5)	1.664	ft./s	2.293	ft./s	1.250	ft./s
11.	Travel Time, (Tt) (Tt = L/3600V)	0.017	hr +	0.000	hr +	0.000	hr

Watershed or Subarea Tc or Tt = 0.103 hr

or 6.19 min

Channel Flow

12.	Cross Sectional Flow Area, (a)	133.48	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	Wetted Perimeter, Pw	35.51	ft.	30.71	ft.	43.74	ft.
14.	Hydraulic Radius, (r) (r = a/Pw)	3.759	ft.	4.302	ft.	3.984	ft.
15.	Channel Slope, (s)	0.0175	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	Manning's Roughness Coeff., (n)	0.027		0.027		0.027	
17.	Velocity, (V) (V = [1.49*r^0.67*s^0.5]/n)	17.727	ft./s	16.136	ft./s	12.769	ft./s
18.	Flow Length, (L)	0.00	ft.	0.00	ft.	0.00	ft.
19.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #94

Sheet Flow

1.	**Surface Description**	grass			pvmt			pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170			0.011			0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	34.00	ft.		6.00	ft.		0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.		2.64	in.		2.64	in.
5.	**Land Slope, (s)**	0.0200	ft./ft.		0.0200	ft./ft.		0.0366	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.084	hr	+	0.002	hr	+	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description (paved or unpaved)**	**paved**			**unpaved**			**unpaved**	
8.	**Flow Length, (L)**	120.00	ft.		0.00	ft.		0.00	ft.
9.	**Watercourse Slope, (s)**	0.0067	ft./ft.		0.0202	ft./ft.		0.0060	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.664	ft./s		2.293	ft./s		1.250	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.020	hr	+	0.000	hr	+	0.000	hr

Watershed or Subarea Tc or Tt = 0.106 hr

or 6.37 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48	ft.^2		132.12	ft.^2		174.24	ft.^2
13.	**Wetted Perimeter, Pw**	35.51	ft.		30.71	ft.		43.74	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759	ft.		4.302	ft.		3.984	ft.
15.	**Channel Slope, (s)**	0.0175	ft./ft.		0.0121	ft./ft.		0.0084	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.027			0.027			0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727	ft./s		16.136	ft./s		12.769	ft./s
18.	**Flow Length, (L)**	0.00	ft.		0.00	ft.		0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr	+	0.000	hr	+	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #96 and 98

Sheet Flow

1.	**Surface Description**	grass		pvmt		pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170		0.011		0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	34.00	ft.	6.00	ft.	0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.	2.64	in.	2.64	in.
5.	**Land Slope, (s)**	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.084	hr +	0.002	hr +	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description (paved or unpaved)**	paved		unpaved		unpaved	
8.	**Flow Length, (L)**	167.00	ft.	0.00	ft.	0.00	ft.
9.	**Watercourse Slope, (s)**	0.0063	ft./ft.	0.0202	ft./ft.	0.0060	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.614	ft./s	2.293	ft./s	1.250	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.029	hr +	0.000	hr +	0.000	hr

Watershed or Subarea Tc or Tt = 0.115 hr

or 6.90 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	**Wetted Perimeter, Pw**	35.51	ft.	30.71	ft.	43.74	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759	ft.	4.302	ft.	3.984	ft.
15.	**Channel Slope, (s)**	0.0175	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.027		0.027		0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727	ft./s	16.136	ft./s	12.769	ft./s
18.	**Flow Length, (L)**	0.00	ft.	0.00	ft.	0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str. #99 and 100

Sheet Flow

1.	**Surface Description**	grass			pvmt			pvmt	
2.	**Manning's Roughness Coeff., (n)**	0.170			0.011			0.011	
3.	**Flow Length, (L) **total L<= 300 ft**	34.00	ft.		6.00	ft.		0.00	ft.
4.	**Two-yr 24-hr Rainfall, (P2)**	2.64	in.		2.64	in.		2.64	in.
5.	**Land Slope, (s)**	0.0200	ft./ft.		0.0200	ft./ft.		0.0366	ft./ft.
6.	**Travel Time, (Tt)** **(Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])**	0.084	hr	+	0.002	hr	+	0.000	hr

Shallow Concentrated Flow

7.	**Surface Description** **(paved or unpaved)**	**paved**			**unpaved**			**unpaved**	
8.	**Flow Length, (L)**	150.00	ft.		0.00	ft.		0.00	ft.
9.	**Watercourse Slope, (s)**	0.0063	ft./ft.		0.0202	ft./ft.		0.0060	ft./ft.
10.	**Average Velocity, (V)** **(Vp = 20.3282(s)^0.5)** **(Vup = 16.1345(s)^0.5)**	1.614	ft./s		2.293	ft./s		1.250	ft./s
11.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.026	hr	+	0.000	hr	+	0.000	hr

Watershed or Subarea Tc or Tt = 0.112 hr

or 6.72 min

Channel Flow

12.	**Cross Sectional Flow Area, (a)**	133.48	ft.^2		132.12	ft.^2		174.24	ft.^2
13.	**Wetted Perimeter, Pw**	35.51	ft.		30.71	ft.		43.74	ft.
14.	**Hydraulic Radius, (r)** **(r = a/Pw)**	3.759	ft.		4.302	ft.		3.984	ft.
15.	**Channel Slope, (s)**	0.0175	ft./ft.		0.0121	ft./ft.		0.0084	ft./ft.
16.	**Manning's Roughness Coeff., (n)**	0.027			0.027			0.027	
17.	**Velocity, (V)** **(V = [1.49*r^0.67*s^0.5]/n)**	17.727	ft./s		16.136	ft./s		12.769	ft./s
18.	**Flow Length, (L)**	0.00	ft.		0.00	ft.		0.00	ft.
19.	**Travel Time, (Tt)** **(Tt = L/3600V)**	0.000	hr	+	0.000	hr	+	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Hillview - Section 2

Designer: WFH **Date:** 7/9/2014

Scenario/Structure: Str #102

Sheet Flow

1.	Surface Description	grass		pvmt		pvmt	
2.	Manning's Roughness Coeff., (n)	0.170		0.011		0.011	
3.	Flow Length, (L) **total L<= 300 ft	85.00	ft.	0.00	ft.	0.00	ft.
4.	Two-yr 24-hr Rainfall, (P2)	2.64	in.	2.64	in.	2.64	in.
5.	Land Slope, (s)	0.0200	ft./ft.	0.0200	ft./ft.	0.0366	ft./ft.
6.	Travel Time, (Tt) (Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])	0.174	hr +	0.000	hr +	0.000	hr

Shallow Concentrated Flow

7.	Surface Description (paved or unpaved)	paved		unpaved		unpaved	
8.	Flow Length, (L)	0.00	ft.	300.00	ft.	0.00	ft.
9.	Watercourse Slope, (s)	0.0068	ft./ft.	0.0100	ft./ft.	0.0060	ft./ft.
10.	Average Velocity, (V) (Vp = 20.3282(s)^0.5) (Vup = 16.1345(s)^0.5)	1.676	ft./s	1.613	ft./s	1.250	ft./s
11.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr +	0.052	hr +	0.000	hr

Watershed or Subarea Tc or Tt = 0.226 hr

or 13.57 min

Channel Flow

12.	Cross Sectional Flow Area, (a)	16.00	ft.^2	132.12	ft.^2	174.24	ft.^2
13.	Wetted Perimeter, Pw	16.49	ft.	30.71	ft.	43.74	ft.
14.	Hydraulic Radius, (r) (r = a/Pw)	0.970	ft.	4.302	ft.	3.984	ft.
15.	Channel Slope, (s)	0.0100	ft./ft.	0.0121	ft./ft.	0.0084	ft./ft.
16.	Manning's Roughness Coeff., (n)	0.027		0.027		0.027	
17.	Velocity, (V) (V = [1.49*r^0.67*s^0.5]/n)	5.408	ft./s	16.136	ft./s	12.769	ft./s
18.	Flow Length, (L)	0.00	ft.	0.00	ft.	0.00	ft.
19.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr +	0.000	hr +	0.000	hr

TIME OF CONCENTRATION or TRAVEL TIME WORKSHEET

Project: Homesteads at Hillview

Designer: WFH **Date:** 11-Dec-13

Str. No.: STR #104

Sheet Flow

1.	Surface Description	Cultivated Soils			Grass			pavement
2.	Manning's Roughness Coeff., (n)	0.170			0.150			0.011
3.	Flow Length, (L) **total L<= 300 ft	n/a	ft.		100.00	ft.		n/a ft.
4.	Two-yr 24-hr Rainfall, (P2)	2.64	in.		2.64	in.		2.64 in.
5.	Land Slope, (s)	0.0050	ft./ft.		0.0400	ft./ft.		0.0100 ft./ft.
6.	Travel Time, (Tt) (Tt = [0.007(nL)^0.8]/[P2^0.5*s^0.4])	0.000	hr	+	0.136	hr	+	0.000 hr

Shallow Concentrated Flow

7.	Surface Description (paved or unpaved)	paved			unpaved			unpaved
8.	Flow Length, (L)	n/a	ft.		580.00	ft.		1155.00 ft.
9.	Watercourse Slope, (s)	0.0047	ft./ft.		0.0140	ft./ft.		0.0030 ft./ft.
10.	Average Velocity, (V) (Vp = 20.3282(s)^0.5) (Vup = 16.1345(s)^0.5)	0.000	ft./s		1.909	ft./s		0.884 ft./s
11.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr	+	0.084	hr	+	0.363 hr

Watershed or Subarea Tc or Tt =

0.584 hr

or

35.02 min

Channel Flow

12.	Cross Sectional Flow Area, (a)	180.00	ft.^2		50.00	ft.^2		20.20 ft.^2
13.	Wetted Perimeter, Pw	180.05	ft.		30.00	ft.		18.20 ft.
14.	Hydraulic Radius, (r) (r = a/Pw)	1.000	ft.		1.667	ft.		1.110 ft.
15.	Channel Slope, (s)	0.0060	ft./ft.		0.0050	ft./ft.		0.0050 ft./ft.
16.	Manning's Roughness Coeff., (n)	0.170			0.012			0.060
17.	Velocity, (V) (V = [1.49*r^0.67*s^0.5]/n)	0.679	ft./s		12.363	ft./s		1.883 ft./s
18.	Flow Length, (L)	0.00	ft.		n/a	ft.		n/a ft.
19.	Travel Time, (Tt) (Tt = L/3600V)	0.000	hr	+	0.000	hr	+	0.000 hr

UNIT HYDROGRAPH REPORT

==========

Hydrograph Number:1
Name: Str. No. 104 Basin (including R/W)
Type: SCS Curvilinear

[UNIT HYDROGRAPH INFORMATION]

Peak Flow (Qp)	=	56.67 (cfs)
Time to Peak (Tp)	=	23.35 (min)
Time of Base (Tb)	=	116.73 (min)
Volume	=	2.43 (ac-ft)
Shape Factor	=	484.00
Time Step	=	1.00 (min)
Excess Rain	=	1.00 (in)
Storm Duration	=	4.66 (min)
Lag Time	=	21.01 (min)

[BASIN INFORMATION]

[WEIGHTED WATERSHED AREA]

Description	Area	CN
<None>		
Overall Approximation	29.16	68

[TIME CONCENTRATION -- User Defined]
Time of Concentration (Tc) = 35.02 (min)

FLOOD HYDROGRAPH REPORT

Hydrograph Number: 1
Name: 10 yr. - 24 hr.
Type: Computed Flood

[HYDROGRAPH INFORMATION]
- Peak Flow (Qp) = 26.16 (cfs)
- Time to Peak (Tp) = 735.00 (min)
- Time of Base (Tb) = 1551.29 (min)
- Volume = 3.02 (ac-ft)
- Time Step = 1.00 (min)
- Flow Multiplier = 1.00

[UNIT HYDROGRAPH INFORMATION]
- Number = 1
- Type = SCS Curvilinear
- Peak Flow (Qp) = 56.67 (cfs)
- Time to Peak (Tp) = 23.35 (min)
- Time of Base (Tb) = 116.73 (min)
- Volume = 2.43 (ac-ft)
- Shape Factor = 484.00
- Time Step: = 1.00 (min)
- Excess Rain = 1.00 (in)
- Lag Time = 21.01 (min)

[BASIN INFORMATION]

[WEIGHTED WATERSHED AREA]

Description	Area	CN
<None>		
Overall Approximation	29.16	68

[TIME CONCENTRATION -- User Defined]
- Time of Concentration (Tc) = 35.02 (min)

[RAINFALL DESCRIPTION]
- Distribution Type = SCS II
- Total Precipitation = 4.08 (in)
- Return Period = User Defined (yr)
- Storm Duration = 24.00 (hr)

Section 2: Storm Inlet Calculations

Storm inlets were placed throughout the site to ensure that there will be adequate capacity to pass the design 10-year flow with 50% of the sag inlet clogged with the maximum depth of water not exceeding six inches, or maintaining a 10' travel lane in paved areas. The attached charts are a Discharge vs. Depth provided by Neenah Foundry Company. Charts are attached for sag inlets located in grassed areas with 50% of the inlet clogged and for inlets located on grade. The inlets located at sags within the roadway were analyzed using the weir equation. The weir equation is as follows:

$$Q = 3.3P(h)^{1.5}$$

Where: P = perimeter of the grate; h = head above the casting; Q = Capacity

The casting used for all road inlets, located in a sag, is a Neenah R-3501-TB, which has a perimeter of 5.7 feet. This length was reduced by 50% to simulate a clogged inlet. Therefore, the perimeter length used in the weir equation is 2.85 feet. The following table indicates the inlets capacity and corresponding roadway spread at each inlet.

Structure No.	Casting Type	Watershed Runoff	Inlet Capacity	Depth Over Grate	Spread	Bypass
69	R-3501-TB	0.92 cfs	1.00 cfs	0.22'	7.88'	0.00 cfs
70	R-4215-C	3.65 cfs	3.70 cfs	0.38'	--	0.00 cfs
71	R-3501-TL	0.79+0.24 = 1.03 cfs	0.65 cfs	0.166'	5.18'	0.38 cfs
72	R-3501-TR	0.50+0.14 = 0.64 cfs	0.48 cfs	0.139'	3.83'	0.16 cfs
73	R-3501-TL	0.79 cfs	0.55 cfs	0.15'	4.38'	0.24 cfs
74	R-3501-TR	0.57 cfs	0.43 cfs	0.13'	3.38'	0.14 cfs
77	R-3501-TL	0.90+0.38 = 1.28 cfs	0.75 cfs	0.18'	5.88'	0.53 cfs
78	R-3501-TR	0.60+0.16 = 0.76 cfs	0.54 cfs	0.148'	4.28'	0.22 cfs
79	R-3501-TB	0.61 cfs	0.70 cfs	0.17'	5.38'	0.00 cfs
80	R-3501-TB	0.70+0.18 = 0.88 cfs	0.90 cfs	0.21'	7.38'	0.00 cfs
82 & 82a	R-3501-TB	1.31 cfs	1.40 cfs	0.18'	5.88'	0.00 cfs
83 & 83a	R-3501-TB	1.42+0.53 = 1.95 cfs	2.10 cfs	0.23'	8.38'	0.00 cfs
84	R-3501-TR	0.46+0.22 = 0.68 cfs	0.50 cfs	0.142'	3.98'	0.18 cfs
88	R-4215-C	1.38 cfs	1.40 cfs	0.18'	--	0.00 cfs
88a	R-4215-C	0.96 cfs	1.00 cfs	0.14'	--	0.00 cfs
92	R-4215-C	0.23 cfs	0.60 cfs	0.10'	--	0.00 cfs
93	R-3501-TL	0.47 cfs	0.40 cfs	0.124'	3.08'	0.07 cfs
94	R-3501-TR	0.55 cfs	0.44 cfs	0.131'	3.43'	0.11 cfs
96	R-3501-TR	0.76 cfs	0.54 cfs	0.148'	4.28'	0.22 cfs
97	R-3501-TL	0.76 cfs	0.54 cfs	0.148'	4.28'	0.22 cfs
99 & 99a	R-3501-TB	1.35+0.29 = 1.64 cfs	1.70 cfs	0.20'	6.88'	0.00 cfs
100&100a	R-3501-TB	1.35+0.48 = 1.77 cfs	1.80 cfs	0.21'	7.38'	0.00 cfs
102	R-4215-C	1.97 cfs	2.10 cfs	0.23'	--	0.00 cfs

MUNICIPAL PRODUCT SEARCH

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ENGINEERING TOOLS

- Modified Manning Calculators
- Weir and Orifice Calculator
  - Weir Flow
  - Orifice Flow
- Curb Opening Hydraulics Calculator
- R-4999 Vane Trench Grate Hydraulics
- Neenah Grate Information
- Engineering Literature & Videos

WEIR & ORIFICE CALCULATOR

The Weir and Orifice Calculator is used to determine the inlet capacity in sag (ponding) conditions by use of the Weir and Orifice equations. Knowing this information will allow you to select the proper grate type and size for your specific job or project.

Weir Flow Calculations

Weir Equation: $Q = 3.3P(h)^{1.5}$

- **Q** = Capacity in CFS
- **P** = Feet perimeter
- **h** = Head in feet
- Weir Information

Orifice Flow Calculations

Orifice Flow Equation: $Q = 0.6A\sqrt{2gh}$

- **Q** = Capacity in CFS
- **A** = Free open area of grate in sq. ft.
- **g** = 32.2 (feet per sec/sec)
- **h** = Head in feet
- Orifice Information

Instructions:

1. Select a catalog number (will automatically fill in Open Area and Perimeter) or enter your own values
2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-3065-L:L

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
2.85	0.22	1.55

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
1		

For additional information regarding Neenah Inlet Grate Capacities, please contact Steven Akkala P.E., at (920) 729.3653 or email at steve.akkala@neenahenterprises.com.

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ENGINEERING TOOLS

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WEIR & ORIFICE CALCULATOR

The Weir and Orifice Calculator is used to determine the inlet capacity in sag (ponding) conditions by use of the Weir and Orifice equations. Knowing this information will allow you to select the proper grate type and size for your specific job or project.

Weir Flow Calculations

Weir Equation: $Q = 3.3P(h)^{1.5}$

- **Q** = Capacity in CFS
- **P** = Feet perimeter
- **h** = Head in feet
- Weir Information

Orifice Flow Calculations

Orifice Flow Equation: $Q = 0.6A\sqrt{2gh}$

- **Q** = Capacity in CFS
- **A** = Free open area of grate in sq. ft.
- **g** = 32.2 (feet per sec/sec)
- **h** = Head in feet
- Orifice Information

Instructions:

1. Select a catalog number (will automatically fill in Open Area and Perimeter) or enter your own values
2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-4215-C:Beehive

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
5.65	0.38	1.65

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
	3.7	

For additional information regarding Neenah Inlet Grate Capacities, please contact Steven Akkala P.E., at (920) 729.3653 or email at steve.akkala@neenahenterprises.com.

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ENGINEERING TOOLS

- Modified Manning Calculators
  - Program Methodology
  - Inlet Spacing
- Weir and Orifice Calculator
- Curb Opening Hydraulics Calculator
- R-4999 Vane Trench Grate Hydraulics
- Neenah Grate Information
- Engineering Literature & Videos

MANNING EQUATION CALCULATOR

The Modified Manning Equation is used to calculate flow velocities and volume (in cubic feet per second or cfs). This information is vitally important when selecting a grate type and size for a given project.

$$Q = \frac{0.56}{N} Z D^{8/3} S^{1/2}$$

Where...

D = Depth of flow in feet

S = Longitudinal slope

Q = Channel flow in cfs (calculated)

N = Roughness coefficient at constant 0.016 (value for concrete and asphalt)

Z = Reciprocal of transverse slope (1/ST)

INSTRUCTIONS

Step 1

Enter the Longitudinal and Transverse Slopes. Enter one of the remaining variables and then press calculate:

- Depth of Flow (D)
- Total flow in cfs (Q)
- Spread of flow in feet

Step 2

To Calculate flow capture of specific Neenah Grates, select a catalog number and grate style from the K Chart drop-down.

1. Select the catalog number for the appropriate "K" chart and from the chart "Determine the "K" value based on the Longitudinal and Transverse slopes entered in Step 1.
2. Derive the Grate Coefficient by plotting the Transverse Slope (ST) and Longitudinal Slope factors onto the K Chart.
3. Enter the "K" value in the space provided.
4. Press Calculate.

Step 1

	Alternate One	Alternate Two	Alternate Three
Depth of flow in feet (D): [?]	0.166		
Transverse Slope in ft./ft. (ST): [?]	0.02		
Longitudinal Slope in ft./ft. (SL): [?]	0.005		
Roughness coefficient (N): (value for concrete or asphalt)	0.016	0.016	0.016
Total flow in cfs (Q): [?]	1.03		
Spread of flow in feet: [?]	8.300		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

Step 2

Catalog numbers and grate types that have K-charts: [?]	3065-L		
Grate Coefficient from K-chart (K):	13		
Grate capacity in cfs: [?]	0.65		
Bypass flow in cfs:	0.38		
Percent captured:	63.11		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

For additional information regarding Neenah Inlet Grate Capacities, please contact Steven Akkala P.E., at (920) 729.3653 or email at steve.akkala@neenahenterprises.com.

Program Methodology

If your inlet is not capturing enough of the flow, some improvement options include:

Utilizing the improved efficiency of vane style grates Pg 112

Improve spread of flow capture utilizing the Neenah R-3599 Slotted Vane Drain System

Remove significant amounts of water utilizing Neenah's R-4999 Vane Style Transverse Drainage Structure Series

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Where...

D = Depth of flow in feet

Q = Channel flow in cfs (calculated)

Z = Reciprocal of transverse slope (1/ST)

S = Longitudinal slope

N = Roughness coefficient at constant 0.016 (value for concrete and asphalt)

INSTRUCTIONS

Step 1

Enter the Longitudinal and Transverse Slopes. Enter one of the remaining variables and then press calculate:

- Depth of Flow (D)
- Total flow in cfs (Q)
- Spread of flow in feet

Step 2

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2. Derive the Grate Coefficient by plotting the Transverse Slope (ST) and Longitudinal Slope factors onto the K Chart.
3. Enter the "K" value in the space provided.
4. Press Calculate.

Step 1

	Alternate One	Alternate Two	Alternate Three
Depth of flow in feet (D): [?]	0.150		
Transverse Slope in ft./ft. (ST): [?]	0.02		
Longitudinal Slope in ft./ft. (SL): [?]	0.005		
Roughness coefficient (N): (value for concrete or asphalt)	0.016	0.016	0.016
Total flow in cfs (Q): [?]	0.79		
Spread of flow in feet: [?]	7.500		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

Step 2

Catalog numbers and grate types that have K-charts: [?]	3065-L		
Grate Coefficient from K-chart (K):	13		
Grate capacity in cfs: [?]	0.55		
Bypass flow in cfs:	0.24		
Percent captured:	69.62		
	Calculate Reset	Calculate Reset	Calculate Reset

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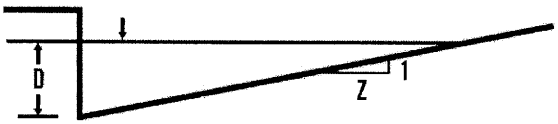

$$Q = \frac{0.56}{N} Z D^{8/3} S^{1/2}$$

Where...

D = Depth of flow in feet

S = Longitudinal slope

Q = Channel flow in cfs (calculated)

N = Roughness coefficient at constant 0.016 (value for concrete and asphalt)

Z = Reciprocal of transverse slope (1/ST)

INSTRUCTIONS

Step 1

Enter the Longitudinal and Transverse Slopes. Enter one of the remaining variables and then press calculate:

- Depth of Flow (D)
- Total flow in cfs (Q)
- Spread of flow in feet

Step 2

To Calculate flow capture of specific Neenah Grates, select a catalog number and grate style from the K Chart drop-down.

1. Select the catalog number for the appropriate "K" chart and from the chart "Determine the "K" value based on the Longitudinal and Transverse slopes entered in Step 1.
2. Derive the Grate Coefficient by plotting the Transverse Slope (ST) and Longitudinal Slope factors onto the K Chart.
3. Enter the "K" value in the space provided.
4. Press Calculate.

Step 1

	Alternate One	Alternate Two	Alternate Three
Depth of flow in feet (D): [?]	0.13		
Transverse Slope in ft./ft. (ST): [?]	0.02		
Longitudinal Slope in ft./ft. (SL): [?]	0.005		
Roughness coefficient (N): (value for concrete or asphalt)	0.016	0.016	0.016
Total flow in cfs (Q): [?]	0.57		
Spread of flow in feet: [?]	6.500		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

Step 2

Catalog numbers and grate types that have K-charts: [?]	3065-L		
Grate Coefficient from K-chart (K):	13		
Grate capacity in cfs: [?]	0.43		
Bypass flow in cfs:	0.14		
Percent captured:	75.44		
	Calculate Reset	Calculate Reset	Calculate Reset

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Program Methodology

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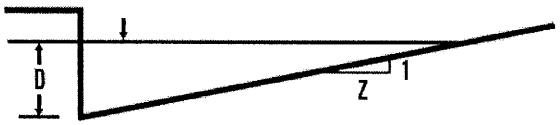
MANNING EQUATION CALCULATOR

The Modified Manning Equation is used to calculate flow velocities and volume (in cubic feet per second or cfs). This information is vitally important when selecting a grate type and size for a given project.



$$Q = \frac{0.56}{N} Z D^{8/3} S^{1/2}$$

Where...

D = Depth of flow in feet

Q = Channel flow in cfs (calculated)

Z = Reciprocal of transverse slope (1/ST)

S = Longitudinal slope

N = Roughness coefficient at constant 0.016 (value for concrete and asphalt)

INSTRUCTIONS

Step 1

Enter the Longitudinal and Transverse Slopes. Enter one of the remaining variables and then press calculate:

- Depth of Flow (D)
- Total flow in cfs (Q)
- Spread of flow in feet

Step 2

To Calculate flow capture of specific Neenah Grates, select a catalog number and grate style from the K Chart drop-down.

1. Select the catalog number for the appropriate "K" chart and from the chart "Determine the "K" value based on the Longitudinal and Transverse slopes entered in Step 1.
2. Derive the Grate Coefficient by plotting the Transverse Slope (ST) and Longitudinal Slope factors onto the K Chart.
3. Enter the "K" value in the space provided.
4. Press Calculate.

Step 1

	Alternate One	Alternate Two	Alternate Three
Depth of flow in feet (D): [?]	0.180		
Transverse Slope in ft./ft. (ST): [?]	0.02		
Longitudinal Slope in ft./ft. (SL): [?]	0.005		
Roughness coefficient (N): (value for concrete or asphalt)	0.016	0.016	0.016
Total flow in cfs (Q): [?]	1.28		
Spread of flow in feet: [?]	9.000		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

Step 2

Catalog numbers and grate types that have K-charts: [?]	3065-L		
Grate Coefficient from K-chart (K):	13		
Grate capacity in cfs: [?]	0.75		
Bypass flow in cfs:	0.53		
Percent captured:	58.59		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

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Program Methodology

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Utilizing the improved efficiency of vane style grates Pg 112

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MANNING EQUATION CALCULATOR

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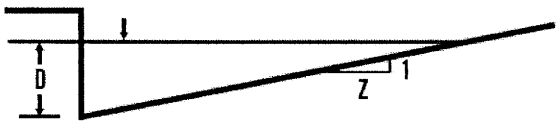

$$Q = \frac{0.56}{N} Z D^{8/3} S^{1/2}$$

Where...

D = Depth of flow in feet

Q = Channel flow in cfs (calculated)

Z = Reciprocal of transverse slope (1/ST)

S = Longitudinal slope

N = Roughness coefficient at constant 0.016 (value for concrete and asphalt)

INSTRUCTIONS

Step 1

Enter the Longitudinal and Transverse Slopes. Enter one of the remaining variables and then press calculate:

- Depth of Flow (D)
- Total flow in cfs (Q)
- Spread of flow in feet

Step 2

To Calculate flow capture of specific Neenah Grates, select a catalog number and grate style from the K Chart drop-down.

1. Select the catalog number for the appropriate "K" chart and from the chart "Determine the "K" value based on the Longitudinal and Transverse slopes entered in Step 1.
2. Derive the Grate Coefficient by plotting the Transverse Slope (ST) and Longitudinal Slope factors onto the K Chart.
3. Enter the "K" value in the space provided.
4. Press Calculate.

Step 1

	Alternate One	Alternate Two	Alternate Three
Depth of flow in feet (D): [?]	0.148		
Transverse Slope in ft./ft. (ST): [?]	0.02		
Longitudinal Slope in ft./ft. (SL): [?]	0.005		
Roughness coefficient (N): (value for concrete or asphalt)	0.016	0.016	0.016
Total flow in cfs (Q): [?]	0.76		
Spread of flow in feet: [?]	7.400		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

Step 2

Catalog numbers and grate types that have K-charts: [?]	3065-L		
Grate Coefficient from K-chart (K):	13		
Grate capacity in cfs: [?]	0.54		
Bypass flow in cfs:	0.22		
Percent captured:	71.05		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

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Program Methodology

If your inlet is not capturing enough of the flow, some improvement options include:

Utilizing the improved efficiency of vane style grates Pg 112

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- Engineering Literature & Videos

WEIR & ORIFICE CALCULATOR

The Weir and Orifice Calculator is used to determine the inlet capacity in sag (ponding) conditions by use of the Weir and Orifice equations. Knowing this information will allow you to select the proper grate type and size for your specific job or project.

Weir Flow Calculations

Weir Equation: $Q = 3.3P(h)^{1.5}$

- **Q** = Capacity in CFS
- **P** = Feet perimeter
- **h** = Head in feet
- Weir Information

Orifice Flow Calculations

Orifice Flow Equation: $Q = 0.6A\sqrt{2gh}$

- **Q** = Capacity in CFS
- **A** = Free open area of grate in sq. ft.
- **g** = 32.2 (feet per sec/sec)
- **h** = Head in feet
- Orifice Information

Instructions:

1. Select a catalog number (will automatically fill in Open Area and Perimeter) or enter your own values
2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-3065-L:L

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
2.85	0.17	1.55

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
0.7		

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- **h** = Head in feet
- Weir Information

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Orifice Flow Equation: $Q = 0.6A\sqrt{2gh}$

- **Q** = Capacity in CFS
- **A** = Free open area of grate in sq. ft.
- **g** = 32.2 (feet per sec/sec)
- **h** = Head in feet
- Orifice Information

Instructions:

1. Select a catalog number (will automatically fill in Open Area and Perimeter) or enter your own values
2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-3065-L:L

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
2.85	0.21	1.55

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
0.9		

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- **h** = Head in feet
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Orifice Flow Equation: $Q = 0.6A\sqrt{2gh}$

- **Q** = Capacity in CFS
- **A** = Free open area of grate in sq. ft.
- **g** = 32.2 (feet per sec/sec)
- **h** = Head in feet
- Orifice Information

Instructions:

1. Select a catalog number (will automatically fill in Open Area and Perimeter) or enter your own values
2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-3065-L:L

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
5.7	0.18	3.10

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
1.4		

Based on weir flow, the following grates match the criteria you entered.

Catalog Number	Grate Type
R-1878-B1G	A
R-1879-B1G	A
R-1881-E	P
R-2474	A
R-2474	G

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Weir Equation: $Q = 3.3P(h)^{1.5}$

- **Q** = Capacity in CFS
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- **h** = Head in feet
- Weir Information

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Orifice Flow Equation: $Q = 0.6A\sqrt{2gh}$

- **Q** = Capacity in CFS
- **A** = Free open area of grate in sq. ft.
- **g** = 32.2 (feet per sec/sec)
- **h** = Head in feet
- Orifice Information

Instructions:

1. Select a catalog number (will automatically fill in Open Area and Perimeter) or enter your own values
2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-3065-L:L

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
5.7	0.23	3.10

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
2.1		

Based on weir flow, the following grates match the criteria you entered.

Catalog Number	Grate Type
R-1878-B1G	A
R-1879-B1G	A
R-1881-E	P
R-2474	A
R-2474	G

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$$Q = \frac{0.56}{N} Z D^{8/3} S^{1/2}$$

Where...

D = Depth of flow in feet

Q = Channel flow in cfs (calculated)

Z = Reciprocal of transverse slope (1/ST)

S = Longitudinal slope

N = Roughness coefficient at constant 0.016 (value for concrete and asphalt)

INSTRUCTIONS

Step 1

Enter the Longitudinal and Transverse Slopes. Enter one of the remaining variables and then press calculate:

- Depth of Flow (D)
- Total flow in cfs (Q)
- Spread of flow in feet

Step 2

To Calculate flow capture of specific Neenah Grates, select a catalog number and grate style from the K Chart drop-down.

1. Select the catalog number for the appropriate "K" chart and from the chart "Determine the "K" value based on the Longitudinal and Transverse slopes entered in Step 1.
2. Derive the Grate Coefficient by plotting the Transverse Slope (ST) and Longitudinal Slope factors onto the K Chart.
3. Enter the "K" value in the space provided.
4. Press Calculate.

Step 1

	Alternate One	Alternate Two	Alternate Three
Depth of flow in feet (D): [?]	0.142		
Transverse Slope in ft./ft. (ST): [?]	0.02		
Longitudinal Slope in ft./ft. (SL): [?]	0.005		
Roughness coefficient (N): (value for concrete or asphalt)	0.016	0.016	0.016
Total flow in cfs (Q): [?]	0.68		
Spread of flow in feet: [?]	7.100		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

Step 2

Catalog numbers and grate types that have K-charts: [?]	3065-L		
Grate Coefficient from K-chart (K):	13		
Grate capacity in cfs: [?]	0.50		
Bypass flow in cfs:	0.18		
Percent captured:	73.53		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

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ENGINEERING TOOLS

- Modified Manning Calculators
- Weir and Orifice Calculator
  - Weir Flow
  - Orifice Flow
- Curb Opening Hydraulics Calculator
- R-4999 Vane Trench Grate Hydraulics
- Neenah Grate Information
- Engineering Literature & Videos

WEIR & ORIFICE CALCULATOR

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Weir Flow Calculations

Weir Equation: $Q = 3.3P(h)^{1.5}$

- **Q** = Capacity in CFS
- **P** = Feet perimeter
- **h** = Head in feet
- Weir Information

Orifice Flow Calculations

Orifice Flow Equation: $Q = 0.6A\sqrt{2gh}$

- **Q** = Capacity in CFS
- **A** = Free open area of grate in sq. ft.
- **g** = 32.2 (feet per sec/sec)
- **h** = Head in feet
- Orifice Information

Instructions:

1. Select a catalog number (will automatically fill in Open Area and Perimeter) or enter your own values
2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-4215-C:Beehive

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
5.65	0.18	1.65

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
1.4		

For additional information regarding Neenah Inlet Grate Capacities, please contact Steven Akkala P.E., at (920) 729.3653 or email at steve.akkala@neenahenterprises.com.

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2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-4215-C:Beehive

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
5.65	0.14	1.65

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
1		

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- **h** = Head in feet
- Orifice Information

Instructions:

1. Select a catalog number (will automatically fill in Open Area and Perimeter) or enter your own values
2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-4215-C:Beehive

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
5.65	0.10	1.65

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
0.6		

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MANNING EQUATION CALCULATOR

The Modified Manning Equation is used to calculate flow velocities and volume (in cubic feet per second or cfs). This information is vitally important when selecting a grate type and size for a given project.

$$Q = \frac{0.56}{N} Z D^{8/3} S^{1/2}$$

Where...

D = Depth of flow in feet

S = Longitudinal slope

Q = Channel flow in cfs (calculated)

N = Roughness coefficient at constant 0.016 (value for concrete and asphalt)

Z = Reciprocal of transverse slope (1/ST)

INSTRUCTIONS

Step 1

Enter the Longitudinal and Transverse Slopes. Enter one of the remaining variables and then press calculate:

- Depth of Flow (D)
- Total flow in cfs (Q)
- Spread of flow in feet

Step 2

To Calculate flow capture of specific Neenah Grates, select a catalog number and grate style from the K Chart drop-down.

1. Select the catalog number for the appropriate "K" chart and from the chart "Determine the "K" value based on the Longitudinal and Transverse slopes entered in Step 1.
2. Derive the Grate Coefficient by plotting the Transverse Slope (ST) and Longitudinal Slope factors onto the K Chart.
3. Enter the "K" value in the space provided.
4. Press Calculate.

Step 1

	Alternate One	Alternate Two	Alternate Three
Depth of flow in feet (D): [?]	0.124		
Transverse Slope in ft./ft. (ST): [?]	0.02		
Longitudinal Slope in ft./ft. (SL): [?]	0.005		
Roughness coefficient (N): (value for concrete or asphalt)	0.016	0.016	0.016
Total flow in cfs (Q): [?]	0.47		
Spread of flow in feet: [?]	6.200		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

Step 2

Catalog numbers and grate types that have K-charts: [?]	3065-L		
Grate Coefficient from K-chart (K):	13		
Grate capacity in cfs: [?]	0.40		
Bypass flow in cfs:	0.07		
Percent captured:	85.11		
	Calculate Reset	Calculate Reset	Calculate Reset

For additional information regarding Neenah Inlet Grate Capacities, please contact Steven Akkala P.E., at (920) 729.3653 or email at steve.akkala@neenahenterprises.com.

Program Methodology

If your inlet is not capturing enough of the flow, some improvement options include:

Utilizing the improved efficiency of vane style grates Pg 112

Improve spread of flow capture utilizing the Neenah R-3599 Slotted Vane Drain System

Remove significant amounts of water utilizing Neenah's R-4999 Vane Style Transverse Drainage Structure Series

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$$Q = \frac{0.56}{N} Z D^{8/3} S^{1/2}$$

Where...

D = Depth of flow in feet

Q = Channel flow in cfs (calculated)

Z = Reciprocal of transverse slope (1/ST)

S = Longitudinal slope

N = Roughness coefficient at constant 0.016 (value for concrete and asphalt)

INSTRUCTIONS

Step 1

Enter the Longitudinal and Transverse Slopes. Enter one of the remaining variables and then press calculate:

- Depth of Flow (D)
- Total flow in cfs (Q)
- Spread of flow in feet

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2. Derive the Grate Coefficient by plotting the Transverse Slope (ST) and Longitudinal Slope factors onto the K Chart.
3. Enter the "K" value in the space provided.
4. Press Calculate.

Step 1

	Alternate One	Alternate Two	Alternate Three
Depth of flow in feet (D): [?]	0.131		
Transverse Slope in ft./ft. (ST): [?]	0.02		
Longitudinal Slope in ft./ft. (SL): [?]	0.005		
Roughness coefficient (N): (value for concrete or asphalt)	0.016	0.016	0.016
Total flow in cfs (Q): [?]	0.55		
Spread of flow in feet: [?]	6.550		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

Step 2

Catalog numbers and grate types that have K-charts: [?]	3065-L		
Grate Coefficient from K-chart (K):	13		
Grate capacity in cfs: [?]	0.44		
Bypass flow in cfs:	0.11		
Percent captured:	80.00		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

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Where...

D = Depth of flow in feet

S = Longitudinal slope

Q = Channel flow in cfs (calculated)

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INSTRUCTIONS

Step 1

Enter the Longitudinal and Transverse Slopes. Enter one of the remaining variables and then press calculate:

- Depth of Flow (D)
- Total flow in cfs (Q)
- Spread of flow in feet

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2. Derive the Grate Coefficient by plotting the Transverse Slope (ST) and Longitudinal Slope factors onto the K Chart.
3. Enter the "K" value in the space provided.
4. Press Calculate.

Step 1

	Alternate One	Alternate Two	Alternate Three
Depth of flow in feet (D): [?]	0.148		
Transverse Slope in ft./ft. (ST): [?]	0.02		
Longitudinal Slope in ft./ft. (SL): [?]	0.005		
Roughness coefficient (N): (value for concrete or asphalt)	0.016	0.016	0.016
Total flow in cfs (Q): [?]	0.76		
Spread of flow in feet: [?]	7.400		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

Step 2

Catalog numbers and grate types that have K-charts: [?]	3065-L		
Grate Coefficient from K-chart (K):	13		
Grate capacity in cfs: [?]	0.54		
Bypass flow in cfs:	0.22		
Percent captured:	71.05		
	Calculate	Calculate	Calculate
	Reset	Reset	Reset

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Orifice Flow Equation: $Q = 0.6A\sqrt{2gh}$

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- **A** = Free open area of grate in sq. ft.
- **g** = 32.2 (feet per sec/sec)
- **h** = Head in feet
- Orifice Information

Instructions:

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2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-3065-L:L

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
5.7	0.20	3.10

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
1.7		

Based on weir flow, the following grates match the criteria you entered.

Catalog Number	Grate Type
R-1878-B1G	A
R-1879-B1G	A
R-1881-E	P
R-2474	A
R-2474	G

Catalog Number	Grate Type
R-2481	A
R-3252-A	V
R-4409-A	C
R-4409-C	B
R-4409-E	A
R-4409-G	B
R-6673-A	A

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Catalog Number and Grate Type:

R-3065-L:L

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
5.7	0.21	3.10

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
1.8		

Based on weir flow, the following grates match the criteria you entered.

Catalog Number	Grate Type
R-1878-B1G	A
R-1879-B1G	A
R-1881-E	P
R-2474	A
R-2474	G

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2. Enter head value
3. Click "calculate"

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, Neenah grates which fall within the parameters chosen will appear below the calculator.

Catalog Number and Grate Type:

R-4215-C:Beehive

Feet perimeter (P):	Head in feet (h):	Free open area in sq. ft. (A):
5.65	0.23	1.65

Calculate

Weir capacity in cfs:	Transitional flow in cfs:	Orifice capacity in cfs:
2.1		

For additional information regarding Neenah Inlet Grate Capacities, please contact Steven Akkala P.E., at (920) 729.3653 or email at steve.akkala@neenahenterprises.com.

Section 3: Emergency Scenario Calculations (Pond #3)

Due to the location and required elevations of Pond #3 to accommodate existing off-site areas to the east, a traditional emergency overflow spillway weir is unable to be provided for Pond #3. Instead, it is proposed that an emergency spillway facility shall be provided above the peak 100-year elevation resulting from a blocked primary outlet orifice modeling scenario. The design of the spillway weir and outlet pipe shall be sufficient to pass back to back peak 100 yr. – 24 hr. storm event through the emergency spillway (outlet structure) while providing adequate freeboard from the proposed top of bank elevations.

The first step of designing the emergency spillway was to route the post-developed 100 yr. - 24 hr. storm through the detention system with the primary outlet orifices blocked, and setting the crest elevation of the emergency spillway weir (top of proposed outlet structure) at the resulting elevation, **737.42 ft**. A second post-developed 100 yr. – 24 hr. storm was then routed through the detention system again, above the peak elevation of 737.42 ft., through the proposed outlet structure by only employing the top of structure weir and outlet pipe to convey the peak 100 yr. storm. The emergency flood event will then drain via the 12" RCP at 0.42% to the proposed Pond #2 west of Section 2. The resulting peak emergency flood elevation within the pond has been determined to be **739.04 ft**. In comparison, the minimum top of bank elevation of the pond is **740.00 ft**. Therefore, the provided minimum freeboard depths are as follows:

- Freeboard from Peak 100-yr. Elevation (Per Ordinance) → 740.00 – 737.27 = **2.73 ft.**
- Freeboard from Peak 100-yr. Elevation (Blocked Outlet) → 740.00 – 737.42 = **2.58 ft.**
- Freeboard from Emergency Flood Elevation → 740.00 – 739.04 = **0.96 ft.**

FLOOD HYDROGRAPH REPORT

Hydrograph Number: 78
Name: POND #3 - BLOCKED
Type: Reservoir: Storage Indication

[HYDROGRAPH INFORMATION]
- Peak Flow (Qp) = 1.95 (cfs)
- Time to Peak (Tp) = 1138.00 (min)
- Time of Base (Tb) = 2880.00 (min)
- Volume = 1.59 (ac-ft)
- Time Step = 2.00 (min)
- Peak Elevation = 737.41 (ft)
- Detention Time = NA

[RESERVOIR STRUCTURE INFORMATION]
- Number = 5
- Name = Pond #3 Blocked
- Storage Type = User-Defined Volume
- Maximum Storage = 578059.70 (cu ft)
- Maximum Discharge = 3.72 (cfs)

[INFLOW HYDROGRAPH INFORMATION]
- Number = 39
- Name = Post 100 yr. - 24 hr. - Pond 3
- Peak Flow (Qp) = 110.38 (cfs)
- Time to Peak (Tp) = 722.00 (min)
- Time of Base (Tb) = 1487.63 (min)
- Volume = 7.10 (ac-ft)
- Flow Multiplier = 1.00

FLOOD HYDROGRAPH REPORT

==========

Hydrograph Number: 76
Name: POND #3 - EMERGENCY SCENARIO
Type: Reservoir: Storage Indication

[HYDROGRAPH INFORMATION]

Peak Flow (Qp)	= 3.45 (cfs)
Time to Peak (Tp)	= 922.00 (min)
Time of Base (Tb)	= 2880.00 (min)
Volume	= 7.09 (ac-ft)
Time Step	= 2.00 (min)
Peak Elevation	= 739.04 (ft)
Detention Time	= NA

[RESERVOIR STRUCTURE INFORMATION]

Number	= 4
Name	= POND #3 EMERGENCY SCENARIO
Storage Type	= User-Defined Volume
Maximum Storage	= 318684.69 (cu ft)
Maximum Discharge	= 3.72 (cfs)

[INFLOW HYDROGRAPH INFORMATION]

Number	= 39
Name	= Post 100 yr. - 24 hr. - Pond 3
Peak Flow (Qp)	= 110.38 (cfs)
Time to Peak (Tp)	= 722.00 (min)
Time of Base (Tb)	= 1487.63 (min)
Volume	= 7.10 (ac-ft)
Flow Multiplier	= 1.00

RESERVOIR REPORT

Reservoir Number: 5
Name: Pond #3 Blocked

[RATING CURVE LIMIT]
Minimum Elevation = 735.00 (ft)
Maximum Elevation = 740.00 (ft)
Elevation Increment = 0.25 (ft)

[STAGE STORAGE INFORMATION]
Storage Method: User-Defined Storage

Input Method: Volume

Number	Elevation (ft)	Area (sq ft)	Ave Area (sq ft)	Volume (cu ft)	Cumulative Volume (cu ft)
1	735.00	99696.76	0.00	0.00	0.00
2	735.25	101251.52	100474.14	25118.43	25118.43
3	735.50	102811.22	102031.37	25507.74	50626.17
4	735.75	104375.87	103593.55	25898.28	76524.45
5	736.00	109214.88	106795.38	26290.07	102814.52
6	736.25	107525.41	108370.15	26683.76	129498.28
7	736.50	109110.28	108317.85	27079.36	156577.64
8	736.75	110700.09	109905.19	27476.19	184053.83
9	737.00	116081.17	113390.63	27874.27	211928.10
10	737.25	113899.89	114990.53	28274.23	240202.33
11	737.50	115509.88	114704.89	28676.12	268878.45
12	737.75	117124.81	116317.35	29079.23	297957.68
13	738.00	123567.02	120345.92	29483.59	327441.27
14	738.25	120374.65	121970.84	29889.81	357331.08
15	738.50	122009.45	121192.05	30297.91	387628.99
16	738.75	123649.11	122829.28	30707.22	418336.21
17	739.00	129198.60	126423.85	31117.74	449453.95
18	739.25	126946.71	128072.65	31529.96	480983.91
19	739.50	128603.38	127775.04	31943.69	512927.60
20	739.75	130263.60	129433.49	32358.30	545285.90
21	740.00	131927.38	131095.49	32773.80	578059.70

[DISCHARGE INFORMATION]
Structure Number: 1
Type:
Name: Outlet #3 - Blocked

RESERVOIR REPORT

Reservoir Number: 4
Name: POND #3 EMERGENCY SCENARIO

[RATING CURVE LIMIT]
Minimum Elevation = 735.00 (ft)
Maximum Elevation = 740.00 (ft)
Elevation Increment = 0.25 (ft)

[STAGE STORAGE INFORMATION]
Storage Method: User-Defined Storage

Input Method: Volume

Number	Elevation (ft)	Area (sq ft)	Ave Area (sq ft)	Volume (cu ft)	Cumulative Volume (cu ft)
1	737.42	115958.90	0.00	0.00	0.00
2	737.75	117544.48	116751.69	38530.09	38530.09
3	738.00	123134.21	120339.35	29536.16	68066.25
4	738.25	120374.65	121754.43	29889.81	97956.07
5	738.50	122009.45	121192.05	30297.91	128253.98
6	738.75	123649.11	122829.28	30707.22	158961.20
7	739.00	128663.68	126156.39	31117.74	190078.94
8	739.25	126946.71	127805.20	31529.96	221608.90
9	739.50	128603.38	127775.04	31943.69	253552.59
10	739.75	130263.60	129433.49	32358.30	285910.89
11	740.00	131927.38	131095.49	32773.80	318684.69

[DISCHARGE INFORMATION]
Structure Number: 1
Type:
Name: Outlet #3 - Emergency Scenario

OUTLET STRUCTURE REPORT

Structure Number : 5
Type : Stand Pipe
Name : Outlet #3 - Blocked

[RATING CURVE LIMIT]
Minimum Elevation = 735.00 (ft)
Maximum Elevation = 740.00 (ft)
Elevation Increment = 0.25 (ft)

[STAND PIPE INFORMATION]

[ORIFICE INFORMATION]
Height = 2.50 (ft)
Width = 2.50 (ft)
Crest Length = 10.00 (ft)
Effective Crest Length = 10.00 (ft)
Orifice Coefficient = 0.60
Fractional Open Area = 1.00

[ORIFICE EQUATION]
Q = Co*A((2gh)/k)^0.5

[DEFINITIONS]
Co = Orifice Coefficient
A = Wetted Area, (sq ft)

[WEIR INFORMATION]
Crest Elevation = 737.30 (ft)
Weir Coefficient = 3.33
Exponential = 1.50

[WEIR EQUATION]
Q = Cw * L * H^exp

[DEFINITIONS]
Cw = Weir Coefficient
H = Headwater depth above inlet control section invert ft
L = Crest lenght ft

[CULVERT INFORMATION]
Type : Circular Concrete - Square Edge with Headwall

[OUTLET STRUCTURE INFORMATION]
Diameter = 12.00 (in)
Invert Elevation = 735.00 (ft)

OUTLET STRUCTURE REPORT

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Pipe Length = 700.00 (ft)
Slope = 0.00
Manning's n Value = 0.01
Orifice Coefficient = 0.60
Tailwater Elevation = 732.00 (ft)
Number of Barrels = 1

[UNSUBMERGED EQUATION]
H/Diam = Hc/Diam+K*(Q/(A*Diam^0.5))^M-0.5*S
Coefficient K = 0.01
Coefficient M = 2.00
Q Maximum = 2.75

[SUBMERGED EQUATION]
H/Diam = c*(Q/(A*Diam^0.5))^2+Y-0.5*S
Coefficient c = 0.04
Coefficient Y = 0.67
Q Minimum = 3.14

[DEFINITIONS]
H = Headwater depth above inlet control section invert, (ft)
Diam = Interior height of culvert barrel, (ft)
Hc = Specific head at critical depth (dc+Vc^2/2g), (ft)
Q = Discharge, (cfs)
A = Full cross sectional area of culvert barrel, (sq ft)
S = Culvert barrel slope, (ft/ft)

OUTLET STRUCTURE REPORT

Structure Number : 4
Type : Stand Pipe
Name : Outlet #3 - Emergency Scenario

[RATING CURVE LIMIT]
Minimum Elevation = 735.00 (ft)
Maximum Elevation = 740.00 (ft)
Elevation Increment = 0.25 (ft)

[STAND PIPE INFORMATION]

[ORIFICE INFORMATION]
Height = 2.50 (ft)
Width = 2.50 (ft)
Crest Length = 10.00 (ft)
Effective Crest Length = 10.00 (ft)
Orifice Coefficient = 0.60
Fractional Open Area = 1.00

[ORIFICE EQUATION]
Q = Co*A((2gh)/k)^0.5

[DEFINITIONS]
Co = Orifice Coefficient
A = Wetted Area, (sq ft)

[WEIR INFORMATION]
Crest Elevation = 737.42 (ft)
Weir Coefficient = 3.33
Exponential = 1.50

[WEIR EQUATION]
Q = Cw * L * H^exp

[DEFINITIONS]
Cw = Weir Coefficient
H = Headwater depth above inlet control section invert ft
L = Crest lenght ft

[CULVERT INFORMATION]
Type : Circular Concrete - Square Edge with Headwall

[OUTLET STRUCTURE INFORMATION]
Diameter = 12.00 (in)
Invert Elevation = 735.00 (ft)

OUTLET STRUCTURE REPORT

Pipe Length	=	700.00	(ft)
Slope	=	0.00	
Manning's n Value	=	0.01	
Orifice Coefficient	=	0.60	
Tailwater Elevation	=	732.00	(ft)
Number of Barrels	=	1	

[UNSUBMERGED EQUATION]
H/Diam = Hc/Diam+K*(Q/(A*Diam^0.5))^M-0.5*S

Coefficient K	=	0.01
Coefficient M	=	2.00
Q Maximum	=	2.75

[SUBMERGED EQUATION]
H/Diam = c*(Q/(A*Diam^0.5))^2+Y-0.5*S

Coefficient c	=	0.04
Coefficient Y	=	0.67
Q Minimum	=	3.14

[DEFINITIONS]
- H = Headwater depth above inlet control section invert, (ft)
- Diam = Interior height of culvert barrel, (ft)
- Hc = Specific head at critical depth (dc+Vc^2/2g), (ft)
- Q = Discharge, (cfs)
- A = Full cross sectional area of culvert barrel, (sq ft)
- S = Culvert barrel slope, (ft/ft)