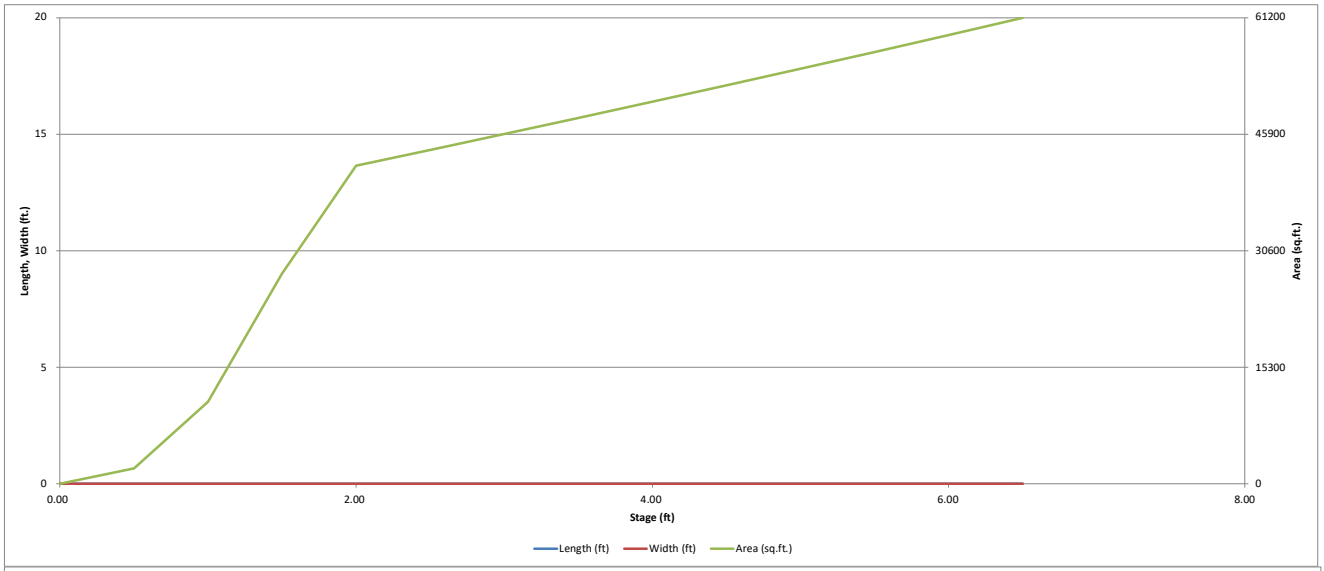
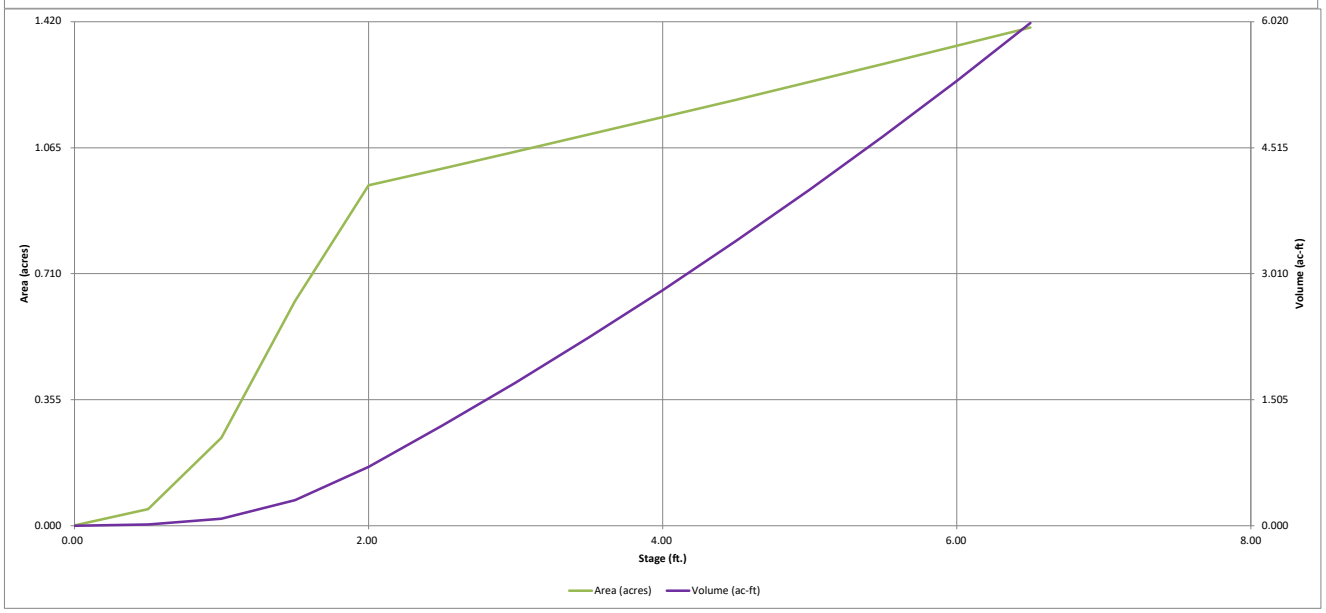

20
15
10
5
0
Length, Width (ft.)
61200
45900
30600
15300
0
Area (sq.ft.)
0.00
2.00
4.00
6.00
8.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

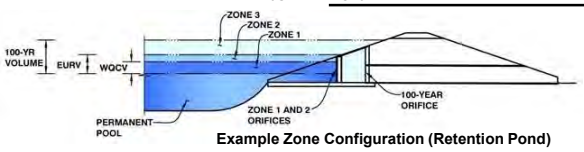

1.420
1.065
0.710
0.355
0.000
Area (acres)
6.020
4.515
3.010
1.505
0.000
Volume (ac-ft)
0.00
2.00
4.00
6.00
8.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview**

Basin ID: **Pond A**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.06	0.756	Orifice Plate
Zone 2 (EURV)	4.06	2.115	Rectangular Orifice
Zone 3 (100-year)	5.22	1.418	Weir&Pipe (Restrict)
Total (all zones)		4.290	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.083E-02	ft^2
Depth at top of Zone using Orifice Plate =	2.06	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	8.20	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	3.00	sq. inches (diameter = 1-15/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.70	1.40					
Orifice Area (sq. inches)	3.00	3.00	3.00					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	2.10	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	4.06	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.00	N/A	inches
Vertical Orifice Width =	7.00		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	0.10	N/A	ft^2
Vertical Orifice Centroid =	0.08	N/A	feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.10	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.85	N/A	feet
Overflow Weir Slope Length =	3.09	N/A	feet
Grate Open Area / 100-yr Orifice Area =	7.31	N/A	
Overflow Grate Open Area w/o Debris =	6.46	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.23	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	9.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.88	N/A	ft^2
Outlet Orifice Centroid =	0.43	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.57	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.60	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.57	feet
Spillway Crest Length =	60.00	feet	Stage at Top of Freeboard =	7.17	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.40	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	6.00	acre-ft

Calculated Parameters for Spillway

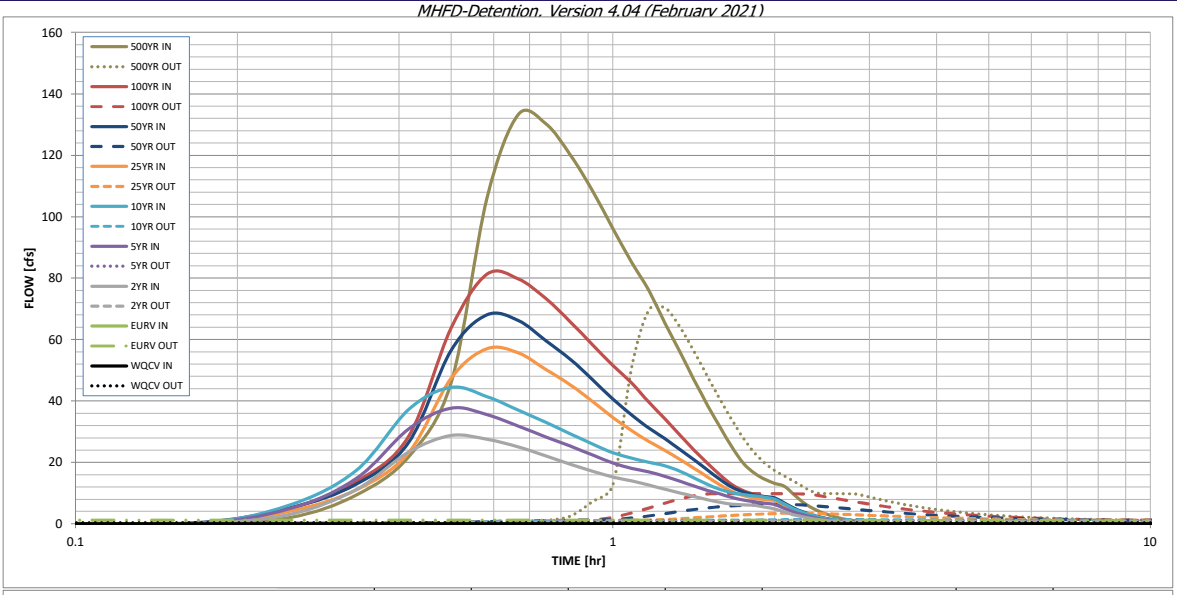
Routed Hydrograph Results

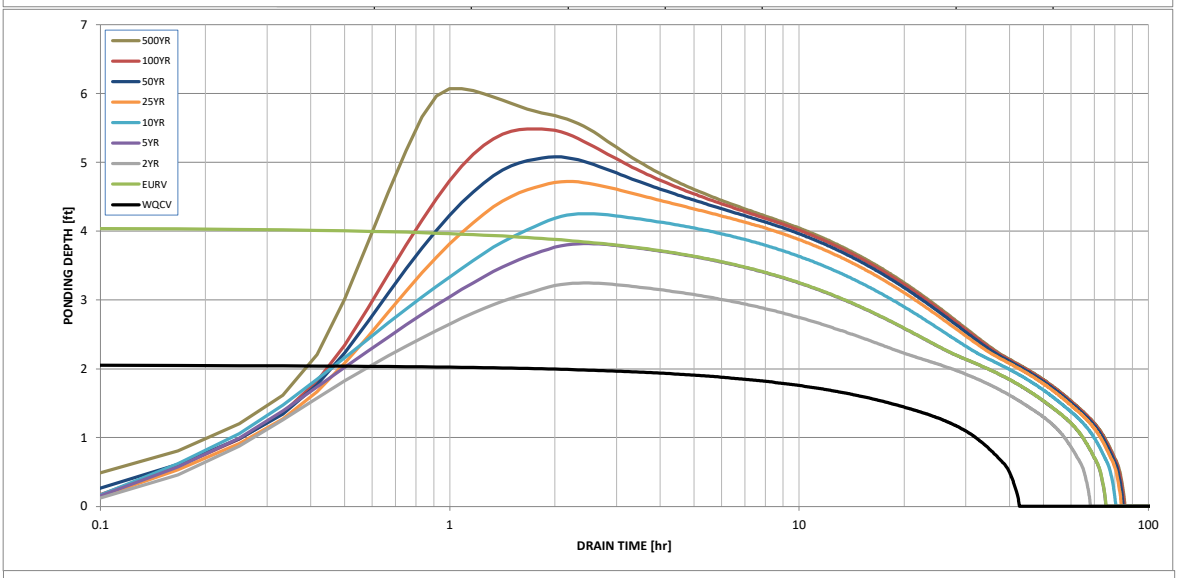
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

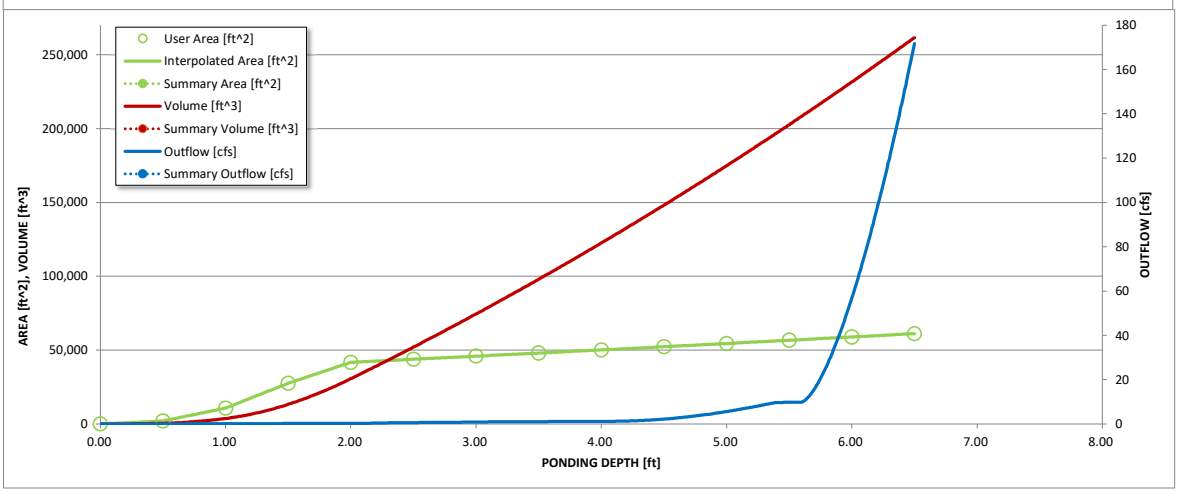
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.756	2.872	2.125	2.788	3.319	4.018	4.705	5.540	9.026
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.125	2.788	3.319	4.018	4.705	5.540	9.026
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.4	0.6	5.0	10.1	16.9	44.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.14	0.28	0.47	1.22
Peak Inflow Q (cfs) =	N/A	N/A	28.7	37.7	44.4	57.0	68.0	81.3	133.3
Peak Outflow Q (cfs) =	0.3	1.2	1.0	1.1	1.4	3.4	6.4	9.8	70.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.8	2.6	0.7	0.6	0.6	1.6
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.3	0.8	1.3	1.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	65	59	65	69	70	70	69	63
Time to Drain 99% of Inflow Volume (hours) =	**41**	70	64	70	75	77	77	77	75
Maximum Ponding Depth (ft) =	2.06	4.06	3.25	3.82	4.25	4.72	5.08	5.49	6.07
Area at Maximum Ponding Depth (acres) =	0.96	1.16	1.08	1.13	1.18	1.22	1.26	1.30	1.36
Maximum Volume Stored (acre-ft) =	0.761	2.882	1.966	2.596	3.104	3.668	4.114	4.626	5.410

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.03	2.02
	0:15:00	0.00	0.00	3.00	4.88	6.06	4.07	5.14	4.98	9.37
	0:20:00	0.00	0.00	11.17	14.80	17.46	11.06	12.95	13.80	21.83
	0:25:00	0.00	0.00	23.37	30.89	37.17	23.12	26.44	28.44	45.91
	0:30:00	0.00	0.00	28.73	37.68	44.43	47.38	56.52	63.76	106.09
	0:35:00	0.00	0.00	27.51	35.49	41.42	57.02	68.02	81.26	133.30
	0:40:00	0.00	0.00	25.06	31.80	37.01	55.62	66.23	79.74	130.23
	0:45:00	0.00	0.00	22.09	28.29	33.04	50.24	59.65	73.33	120.11
	0:50:00	0.00	0.00	19.43	25.32	29.30	45.28	53.56	65.81	108.39
	0:55:00	0.00	0.00	17.14	22.37	25.94	39.80	46.90	58.26	96.14
	1:00:00	0.00	0.00	15.25	19.80	23.14	34.65	40.63	51.57	85.17
	1:05:00	0.00	0.00	13.98	18.08	21.34	30.38	35.43	45.88	75.95
	1:10:00	0.00	0.00	12.57	16.86	20.05	26.79	31.15	39.58	65.30
	1:15:00	0.00	0.00	11.24	15.45	18.85	23.90	27.69	34.19	55.97
	1:20:00	0.00	0.00	10.04	13.84	17.12	20.93	24.17	28.86	46.85
	1:25:00	0.00	0.00	8.90	12.27	14.88	18.09	20.81	23.97	38.57
	1:30:00	0.00	0.00	7.83	10.85	12.81	15.24	17.47	19.68	31.36
	1:35:00	0.00	0.00	6.96	9.70	11.15	12.64	14.40	15.87	24.93
	1:40:00	0.00	0.00	6.42	8.54	10.11	10.51	11.88	12.70	19.61
	1:45:00	0.00	0.00	6.15	7.71	9.50	9.16	10.33	10.73	16.45
	1:50:00	0.00	0.00	6.01	7.15	9.09	8.36	9.41	9.55	14.50
	1:55:00	0.00	0.00	5.41	6.72	8.65	7.84	8.82	8.79	13.19
	2:00:00	0.00	0.00	4.82	6.27	7.99	7.48	8.41	8.24	12.25
	2:05:00	0.00	0.00	3.86	5.05	6.43	6.05	6.80	6.56	9.68
	2:10:00	0.00	0.00	2.98	3.88	4.95	4.63	5.19	4.93	7.22
	2:15:00	0.00	0.00	2.30	2.99	3.80	3.54	3.97	3.72	5.41
	2:20:00	0.00	0.00	1.76	2.28	2.88	2.69	3.02	2.82	4.10
	2:25:00	0.00	0.00	1.33	1.73	2.17	2.03	2.28	2.14	3.10
	2:30:00	0.00	0.00	1.01	1.28	1.61	1.51	1.69	1.60	2.31
	2:35:00	0.00	0.00	0.74	0.93	1.20	1.11	1.24	1.19	1.71
	2:40:00	0.00	0.00	0.54	0.68	0.89	0.83	0.93	0.89	1.28
	2:45:00	0.00	0.00	0.38	0.48	0.63	0.61	0.68	0.64	0.92
	2:50:00	0.00	0.00	0.24	0.33	0.42	0.41	0.46	0.44	0.62
	2:55:00	0.00	0.00	0.14	0.20	0.26	0.26	0.28	0.27	0.38
	3:00:00	0.00	0.00	0.07	0.11	0.13	0.14	0.15	0.14	0.20
	3:05:00	0.00	0.00	0.03	0.04	0.05	0.06	0.06	0.05	0.07
	3:10:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

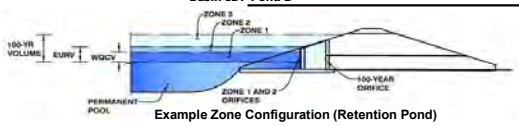
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview**

Basin ID: **Pond B**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	28.99	acres
Watershed Length =	1,700	ft
Watershed Length to Centroid =	850	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	61.90%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

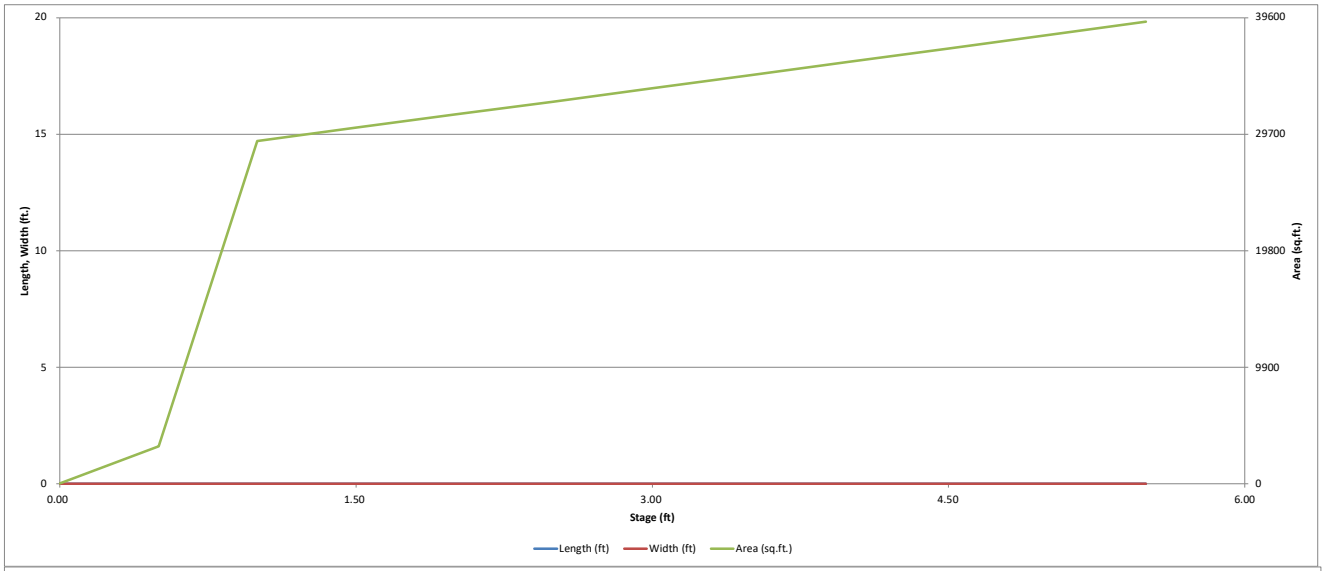
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.586	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	2.197	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.628	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.140	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.552	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	3.104	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.648	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	4.314	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	7.093	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	1.426	acre-feet		
Approximate 5-yr Detention Volume =	1.867	acre-feet		
Approximate 10-yr Detention Volume =	2.255	acre-feet		
Approximate 25-yr Detention Volume =	2.722	acre-feet		
Approximate 50-yr Detention Volume =	3.006	acre-feet		
Approximate 100-yr Detention Volume =	3.310	acre-feet		

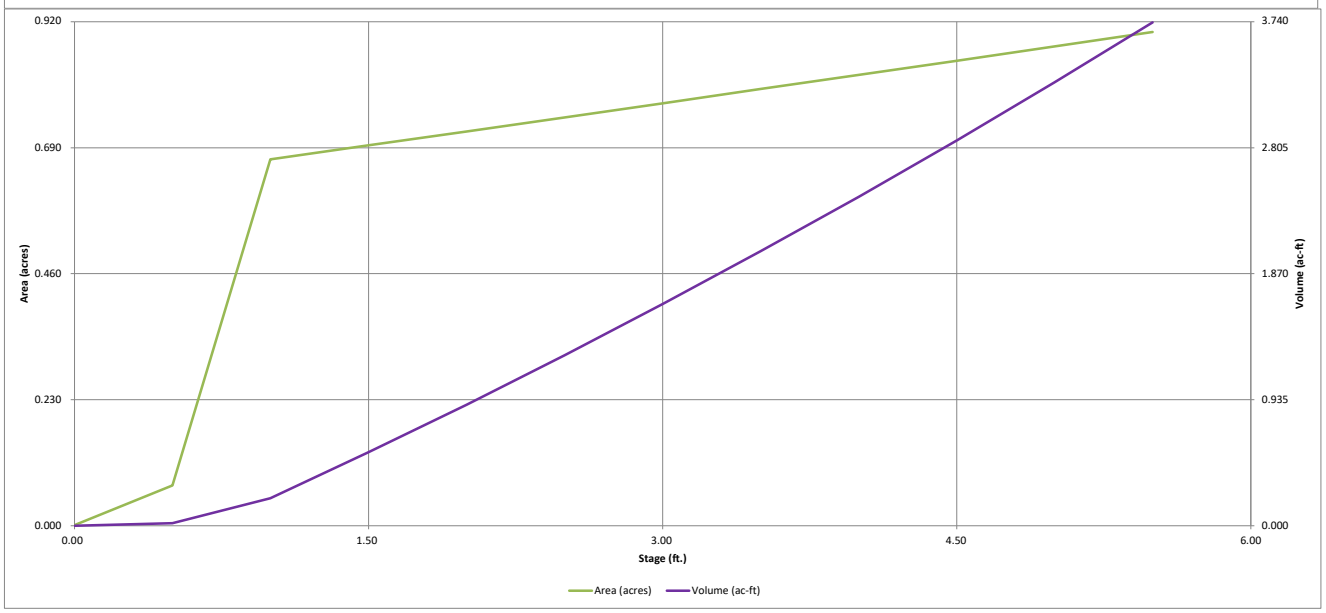
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.586	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.610	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.114	acre-feet
Total Detention Basin Volume =	3.310	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	35	0.001		
	--	0.50	--	--	--	3,203	0.074	809	0.019
6964	--	1.00	--	--	--	29,135	0.669	8,894	0.204
	--	1.50	--	--	--	30,250	0.694	23,740	0.545
6965	--	2.00	--	--	--	31,366	0.720	39,144	0.899
	--	2.50	--	--	--	32,485	0.746	55,107	1.265
6966	--	3.00	--	--	--	33,606	0.771	71,629	1.644
	--	3.50	--	--	--	34,729	0.797	88,713	2.037
6967	--	4.00	--	--	--	35,856	0.823	106,360	2.442
	--	4.50	--	--	--	36,987	0.849	124,570	2.860
6968	--	5.00	--	--	--	38,126	0.875	143,348	3.291
6968.5	--	5.50	--	--	--	39,275	0.902	162,698	3.735


20
15
10
5
0
Length, Width (ft.)
39600
29700
19800
9900
0
Area (sq.ft.)
0.00
1.50
3.00
4.50
6.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

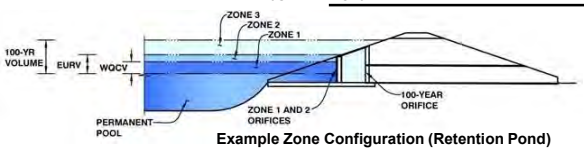

0.920
0.690
0.460
0.230
0.000
Area (acres)
3.740
2.805
1.870
0.935
0.000
Volume (ac-ft)
0.00
1.50
3.00
4.50
6.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview**

Basin ID: **Pond B**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.56	0.586	Orifice Plate
Zone 2 (EURV)	3.70	1.610	Rectangular Orifice
Zone 3 (100-year)	5.03	1.114	Weir&Pipe (Restrict)
Total (all zones)		3.310	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.875E-02	ft^2
Depth at top of Zone using Orifice Plate =	1.57	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	6.30	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	2.70	sq. inches (diameter = 1-13/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.52	1.05					
Orifice Area (sq. inches)	2.70	2.70	2.70					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	1.60	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.76	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	1.50	N/A	inches
Vertical Orifice Width =	6.00		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	0.06	N/A	ft^2
Vertical Orifice Centroid =	0.06	N/A	feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.80	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.55	N/A	feet
Overflow Weir Slope Length =	3.09	N/A	feet
Grate Open Area / 100-yr Orifice Area =	8.04	N/A	
Overflow Grate Open Area w/o Debris =	8.61	N/A	ft^2
Overflow Grate Open Area w/ Debris =	4.30	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	10.50		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.07	N/A	ft^2
Outlet Orifice Centroid =	0.50	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.74	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.25	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.49	feet
Spillway Crest Length =	68.00	feet	Stage at Top of Freeboard =	6.74	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.90	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	3.74	acre-ft

Calculated Parameters for Spillway

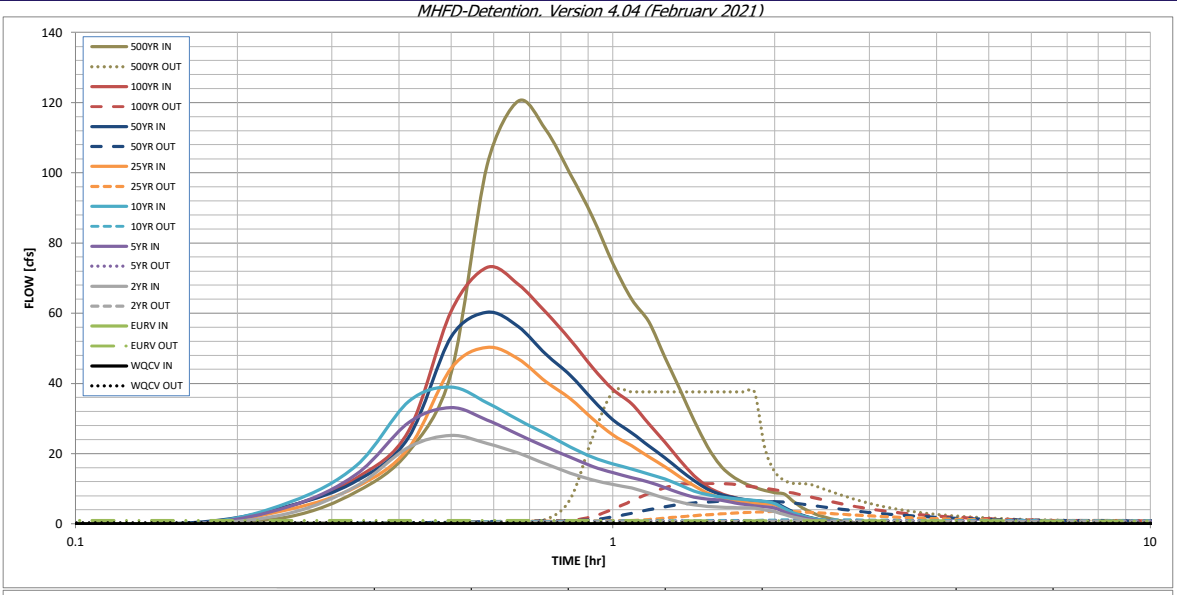
Routed Hydrograph Results

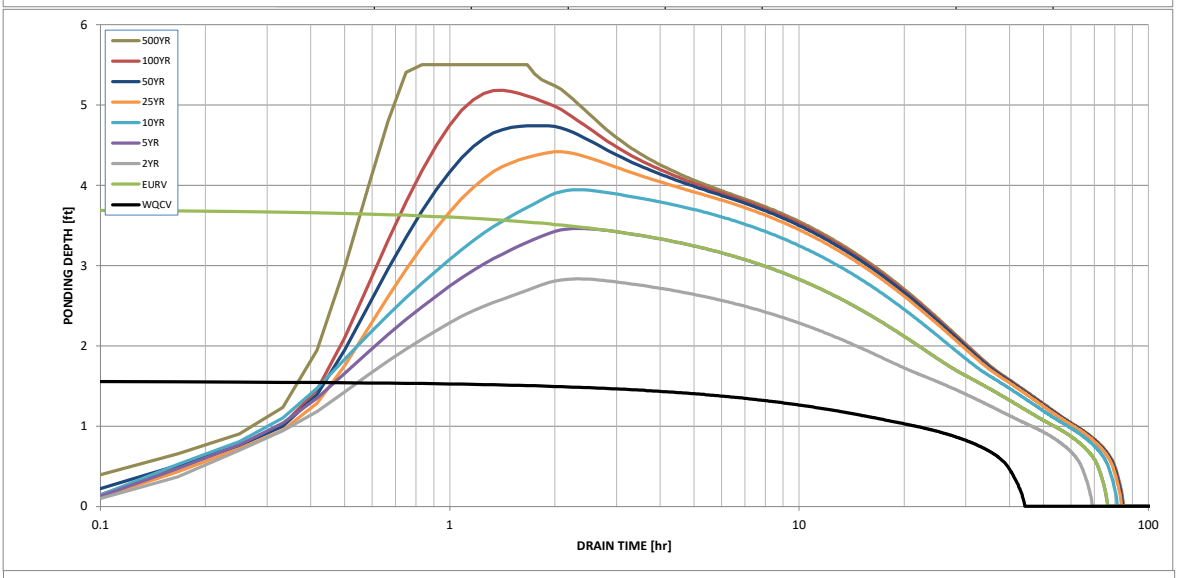
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

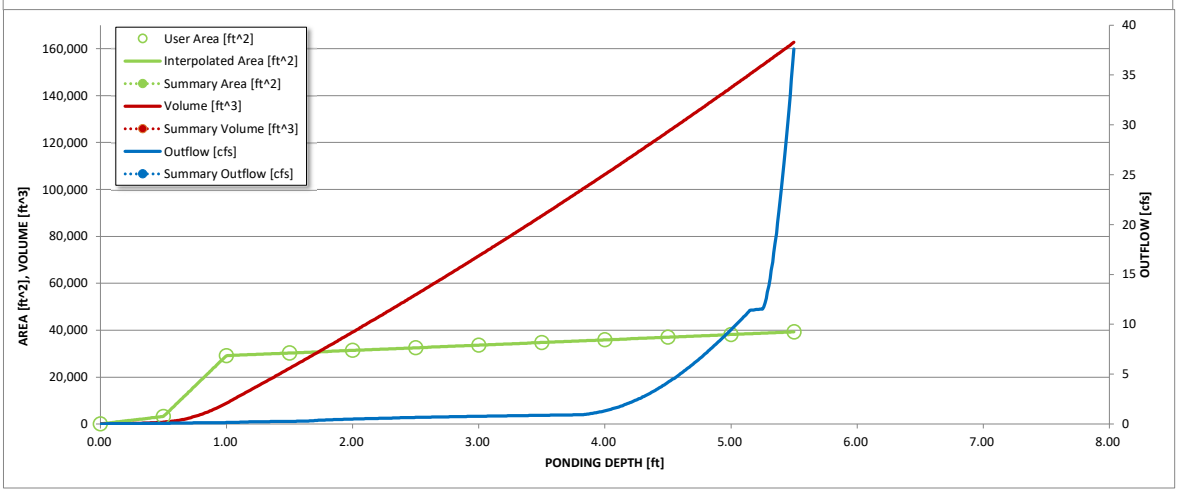
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.586	2.197	1.628	2.140	2.552	3.104	3.648	4.314	7.093
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.628	2.140	2.552	3.104	3.648	4.314	7.093
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.4	0.5	5.0	9.9	16.2	42.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.17	0.34	0.56	1.45
Peak Inflow Q (cfs) =	N/A	N/A	25.2	33.1	38.9	50.3	60.3	73.0	120.5
Peak Outflow Q (cfs) =	0.3	0.9	0.7	0.9	1.2	3.5	6.5	11.4	37.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.2	2.1	0.7	0.7	0.7	0.9
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.3	0.6	1.2	1.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	66	60	66	70	71	70	68	62
Time to Drain 99% of Inflow Volume (hours) =	**42**	71	65	71	76	77	77	77	74
Maximum Ponding Depth (ft) =	1.56	3.70	2.84	3.46	3.94	4.42	4.74	5.18	5.50
Area at Maximum Ponding Depth (acres) =	0.70	0.81	0.76	0.80	0.82	0.84	0.86	0.88	0.90
Maximum Volume Stored (acre-ft) =	0.587	2.197	1.514	2.005	2.392	2.784	3.065	3.449	3.735

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.03	2.04
	0:15:00	0.00	0.00	3.02	4.91	6.09	4.10	5.12	5.00	9.11
	0:20:00	0.00	0.00	10.77	14.11	16.60	10.48	12.21	13.09	20.49
	0:25:00	0.00	0.00	21.79	28.81	34.81	21.55	24.59	26.44	42.94
	0:30:00	0.00	0.00	25.16	33.07	38.94	44.29	53.29	60.57	102.02
	0:35:00	0.00	0.00	22.90	29.59	34.51	50.29	60.28	73.00	120.48
	0:40:00	0.00	0.00	20.14	25.48	29.62	46.96	56.21	68.24	112.28
	0:45:00	0.00	0.00	17.06	21.91	25.61	40.51	48.31	60.24	99.69
	0:50:00	0.00	0.00	14.44	18.97	21.87	35.63	42.32	52.43	87.38
	0:55:00	0.00	0.00	12.47	16.33	18.94	29.94	35.34	44.54	74.23
	1:00:00	0.00	0.00	11.19	14.55	17.09	25.32	29.67	38.26	63.98
	1:05:00	0.00	0.00	10.18	13.18	15.62	22.22	25.93	34.19	57.50
	1:10:00	0.00	0.00	8.72	11.88	14.16	19.09	22.17	28.45	47.40
	1:15:00	0.00	0.00	7.35	10.29	12.75	16.28	18.81	23.27	38.32
	1:20:00	0.00	0.00	6.19	8.73	11.02	13.32	15.30	18.09	29.42
	1:25:00	0.00	0.00	5.40	7.62	9.32	10.84	12.35	13.72	21.96
	1:30:00	0.00	0.00	4.97	7.05	8.31	8.74	9.89	10.55	16.67
	1:35:00	0.00	0.00	4.76	6.73	7.68	7.47	8.43	8.72	13.60
	1:40:00	0.00	0.00	4.63	6.08	7.23	6.70	7.54	7.63	11.71
	1:45:00	0.00	0.00	4.55	5.54	6.90	6.19	6.96	6.89	10.41
	1:50:00	0.00	0.00	4.49	5.15	6.68	5.84	6.56	6.38	9.52
	1:55:00	0.00	0.00	3.94	4.86	6.36	5.60	6.30	6.02	8.89
	2:00:00	0.00	0.00	3.46	4.51	5.79	5.43	6.11	5.78	8.46
	2:05:00	0.00	0.00	2.61	3.41	4.35	4.12	4.63	4.36	6.36
	2:10:00	0.00	0.00	1.91	2.48	3.15	2.98	3.35	3.16	4.59
	2:15:00	0.00	0.00	1.39	1.80	2.28	2.17	2.43	2.30	3.34
	2:20:00	0.00	0.00	1.00	1.29	1.65	1.57	1.76	1.67	2.43
	2:25:00	0.00	0.00	0.71	0.90	1.16	1.10	1.24	1.18	1.71
	2:30:00	0.00	0.00	0.48	0.61	0.81	0.77	0.86	0.82	1.19
	2:35:00	0.00	0.00	0.32	0.42	0.56	0.54	0.60	0.57	0.83
	2:40:00	0.00	0.00	0.19	0.27	0.35	0.35	0.39	0.37	0.53
	2:45:00	0.00	0.00	0.10	0.16	0.19	0.20	0.22	0.21	0.30
	2:50:00	0.00	0.00	0.04	0.07	0.08	0.09	0.10	0.10	0.13
	2:55:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.03
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

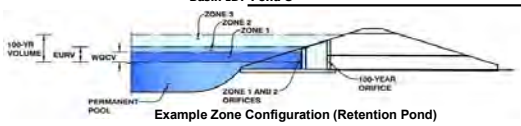
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview**

Basin ID: **Pond C**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	41.47	acres
Watershed Length =	1,890	ft
Watershed Length to Centroid =	1,050	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	61.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

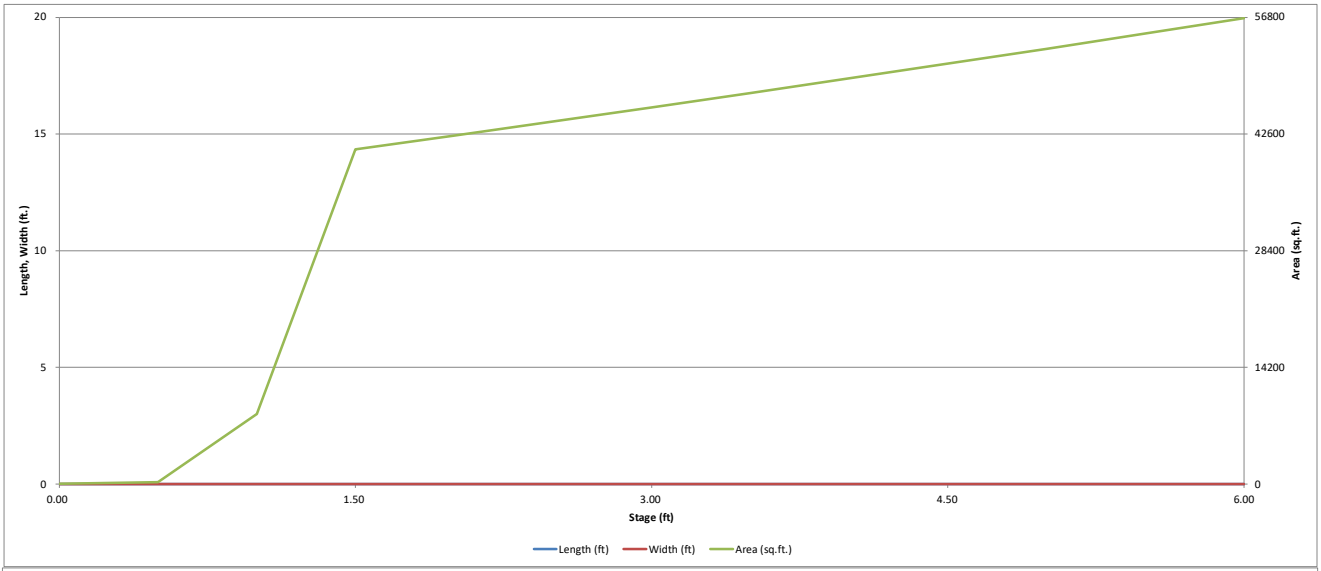
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.828	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	3.084	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	2.295	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	3.020	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.602	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	4.390	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	5.166	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	6.119	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	10.099	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	2.001	acre-feet		
Approximate 5-yr Detention Volume =	2.620	acre-feet		
Approximate 10-yr Detention Volume =	3.167	acre-feet		
Approximate 25-yr Detention Volume =	3.827	acre-feet		
Approximate 50-yr Detention Volume =	4.228	acre-feet		
Approximate 100-yr Detention Volume =	4.663	acre-feet		

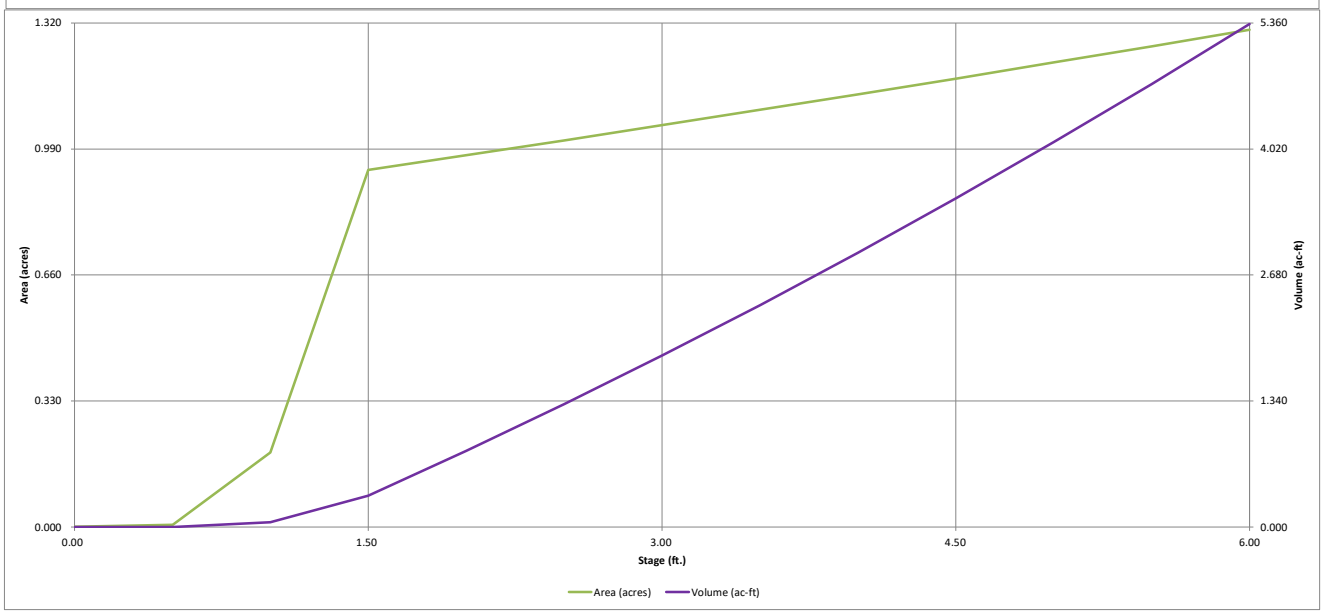
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.828	acre-feet
Zone 2 Volume (EURV - Zone 1) =	2.256	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.579	acre-feet
Total Detention Basin Volume =	4.663	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	35	0.001		
6927	--	0.50	--	--	--	246	0.006	70	0.002
	--	1.00	--	--	--	8,508	0.195	2,258	0.052
6928	--	1.50	--	--	--	40,729	0.935	14,567	0.334
	--	2.00	--	--	--	42,406	0.974	35,351	0.812
6929	--	2.50	--	--	--	44,107	1.013	56,979	1.308
	--	3.00	--	--	--	45,833	1.052	79,464	1.824
6930	--	3.50	--	--	--	47,584	1.092	102,818	2.360
	--	4.00	--	--	--	49,360	1.133	127,054	2.917
6931	--	4.50	--	--	--	51,160	1.174	152,184	3.494
	--	5.00	--	--	--	52,986	1.216	178,221	4.091
6932	--	5.50	--	--	--	54,836	1.259	205,176	4.710
6932.5	--	6.00	--	--	--	56,711	1.302	233,063	5.350


20
15
10
5
0
Length, Width (ft.)
56800
42600
28400
14200
0
Area (sq.ft.)
0.00
1.50
3.00
4.50
6.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

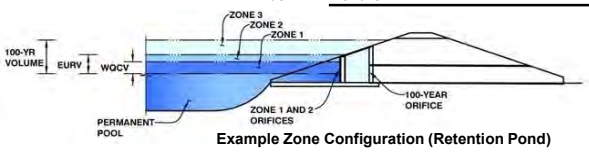

1.320
0.990
0.660
0.330
0.000
Area (acres)
5.360
4.020
2.680
1.340
0.000
Volume (ac-ft)
0.00
1.50
3.00
4.50
6.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview**

Basin ID: **Pond C**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.02	0.828	Orifice Plate
Zone 2 (EURV)	4.15	2.256	Rectangular Orifice
Zone 3 (100-year)	5.47	1.579	Weir&Pipe (Restrict)
Total (all zones)		4.663	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.083E-02	ft^2
Depth at top of Zone using Orifice Plate =	2.02	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	8.30	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	3.00	sq. inches (diameter = 1-15/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.67	1.35					
Orifice Area (sq. inches)	3.00	3.00	3.00					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	2.02	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	4.15	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.50	N/A	inches
Vertical Orifice Width =	6.00		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	0.10	N/A	ft^2
Vertical Orifice Centroid =	0.10	N/A	feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.20	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.95	N/A	feet
Overflow Weir Slope Length =	3.09	N/A	feet
Grate Open Area / 100-yr Orifice Area =	6.00	N/A	
Overflow Grate Open Area w/o Debris =	6.46	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.23	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	9.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.08	N/A	ft^2
Outlet Orifice Centroid =	0.44	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.32	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.67	feet
Spillway Crest Length =	60.00	feet	Stage at Top of Freeboard =	7.67	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.30	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	5.35	acre-ft

Calculated Parameters for Spillway

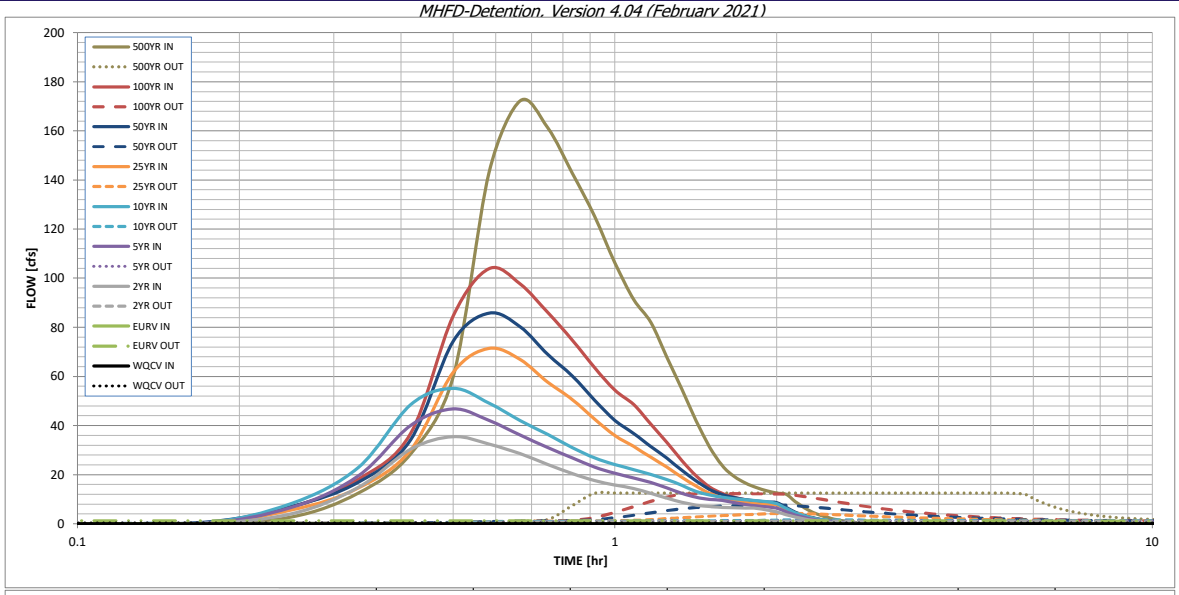
Routed Hydrograph Results

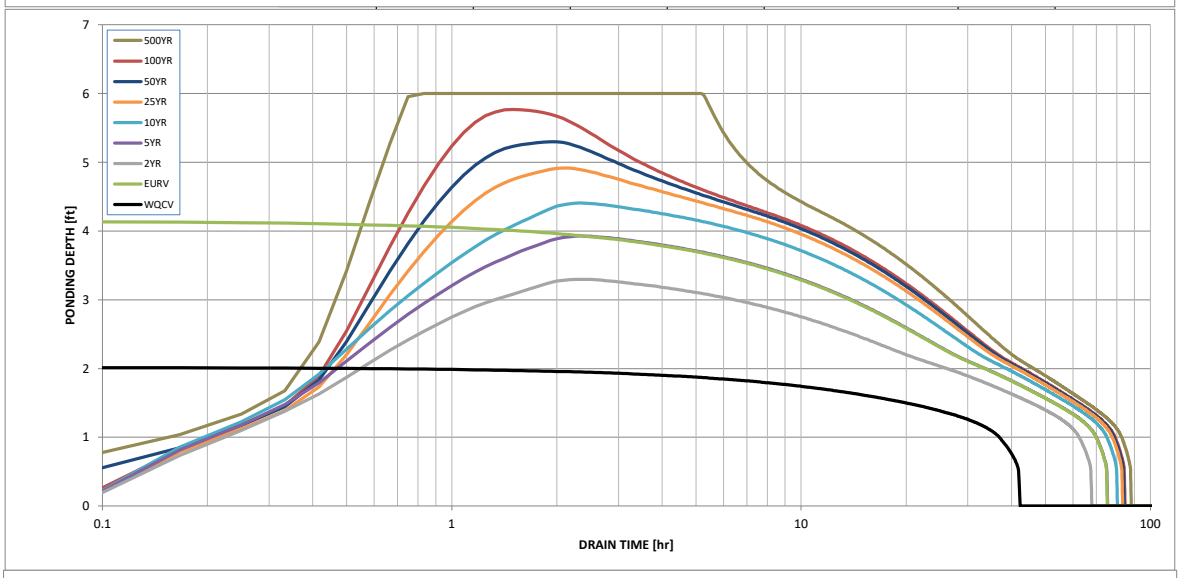
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

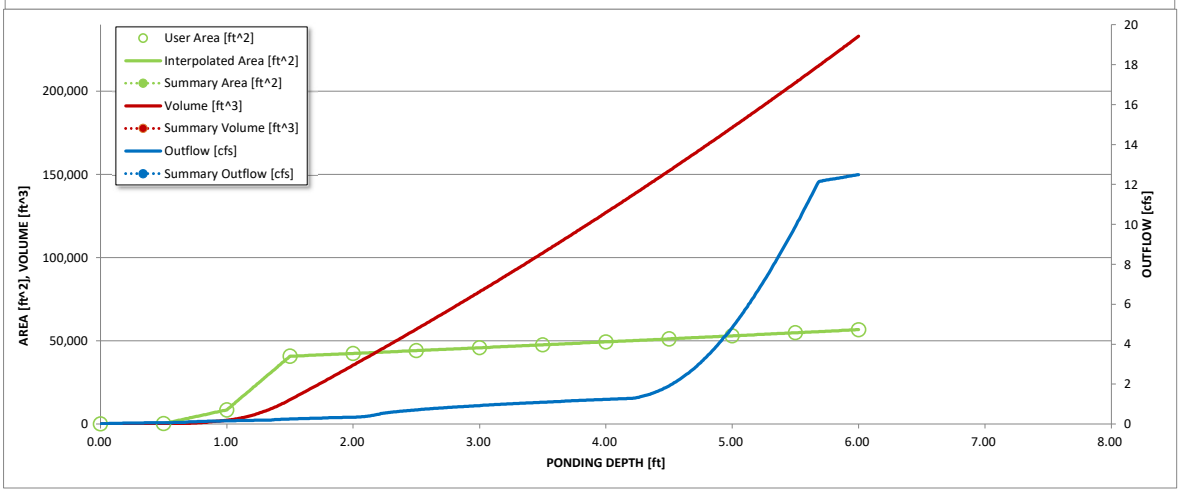
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.828	3.084	2.295	3.020	3.602	4.390	5.166	6.119	10.099
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.295	3.020	3.602	4.390	5.166	6.119	10.099
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	0.6	0.8	7.2	14.3	23.5	61.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.17	0.34	0.57	1.47
Peak Inflow Q (cfs) =	N/A	N/A	35.5	46.7	55.2	71.4	85.8	103.9	172.3
Peak Outflow Q (cfs) =	0.3	1.3	1.0	1.2	1.6	4.2	7.6	12.2	12.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.2	2.1	0.6	0.5	0.5	0.2
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.4	1.0	1.6	1.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	67	61	67	71	72	72	70	67
Time to Drain 99% of Inflow Volume (hours) =	**41**	72	65	72	76	78	79	79	79
Maximum Ponding Depth (ft) =	2.02	4.15	3.30	3.93	4.40	4.92	5.30	5.77	6.00
Area at Maximum Ponding Depth (acres) =	0.98	1.15	1.08	1.13	1.17	1.21	1.24	1.28	1.30
Maximum Volume Stored (acre-ft) =	0.831	3.088	2.133	2.826	3.377	3.982	4.448	5.040	5.350

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.05	2.77
	0:15:00	0.00	0.00	4.11	6.67	8.28	5.57	6.99	6.81	12.53
	0:20:00	0.00	0.00	14.84	19.53	23.00	14.54	16.96	18.16	28.48
	0:25:00	0.00	0.00	30.31	40.06	48.42	29.97	34.20	36.77	59.81
	0:30:00	0.00	0.00	35.49	46.73	55.15	61.71	74.34	84.53	142.93
	0:35:00	0.00	0.00	32.45	42.04	49.08	71.41	85.81	103.91	172.29
	0:40:00	0.00	0.00	28.50	36.14	42.03	66.86	80.18	97.61	161.15
	0:45:00	0.00	0.00	24.17	31.05	36.32	57.67	68.91	86.01	142.85
	0:50:00	0.00	0.00	20.44	26.87	31.02	50.61	60.24	74.82	125.19
	0:55:00	0.00	0.00	17.63	23.10	26.80	42.59	50.37	63.54	106.35
	1:00:00	0.00	0.00	15.80	20.57	24.16	35.91	42.16	54.43	91.39
	1:05:00	0.00	0.00	14.38	18.63	22.07	31.48	36.78	48.56	82.03
	1:10:00	0.00	0.00	12.34	16.79	20.01	27.07	31.47	40.52	67.82
	1:15:00	0.00	0.00	10.39	14.56	18.01	23.07	26.68	33.08	54.71
	1:20:00	0.00	0.00	8.76	12.35	15.60	18.89	21.72	25.74	42.02
	1:25:00	0.00	0.00	7.62	10.77	13.20	15.35	17.50	19.50	31.32
	1:30:00	0.00	0.00	7.02	9.95	11.74	12.37	14.01	14.96	23.71
	1:35:00	0.00	0.00	6.71	9.50	10.85	10.57	11.92	12.34	19.28
	1:40:00	0.00	0.00	6.54	8.59	10.21	9.47	10.66	10.78	16.58
	1:45:00	0.00	0.00	6.42	7.83	9.74	8.74	9.83	9.73	14.72
	1:50:00	0.00	0.00	6.33	7.27	9.42	8.24	9.27	9.02	13.46
	1:55:00	0.00	0.00	5.58	6.86	8.98	7.90	8.89	8.50	12.55
	2:00:00	0.00	0.00	4.89	6.37	8.19	7.66	8.62	8.16	11.95
	2:05:00	0.00	0.00	3.72	4.86	6.20	5.87	6.60	6.21	9.07
	2:10:00	0.00	0.00	2.72	3.52	4.48	4.24	4.76	4.49	6.53
	2:15:00	0.00	0.00	1.97	2.56	3.24	3.07	3.45	3.27	4.74
	2:20:00	0.00	0.00	1.42	1.84	2.34	2.22	2.49	2.38	3.44
	2:25:00	0.00	0.00	1.01	1.28	1.65	1.57	1.75	1.68	2.42
	2:30:00	0.00	0.00	0.69	0.87	1.15	1.09	1.22	1.17	1.69
	2:35:00	0.00	0.00	0.46	0.60	0.79	0.76	0.85	0.81	1.17
	2:40:00	0.00	0.00	0.28	0.39	0.50	0.49	0.55	0.52	0.75
	2:45:00	0.00	0.00	0.14	0.22	0.27	0.28	0.31	0.30	0.42
	2:50:00	0.00	0.00	0.06	0.10	0.12	0.13	0.14	0.14	0.19
	2:55:00	0.00	0.00	0.02	0.03	0.03	0.04	0.04	0.04	0.05
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

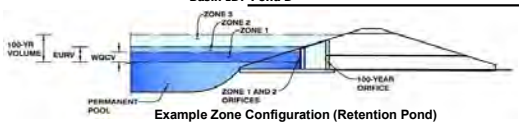
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview**

Basin ID: **Pond D**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	12.15	acres
Watershed Length =	1,200	ft
Watershed Length to Centroid =	600	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	61.30%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

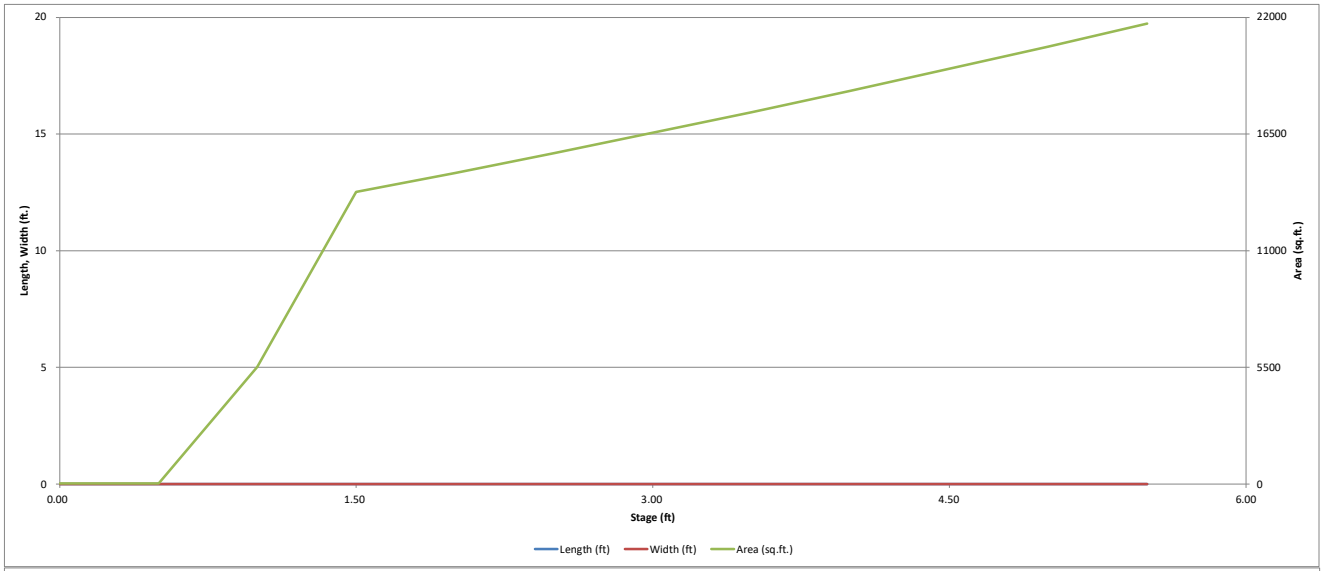
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.244	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.909	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.666	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.876	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.045	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.272	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.496	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.770	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	2.916	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.590	acre-feet		
Approximate 5-yr Detention Volume =	0.772	acre-feet		
Approximate 10-yr Detention Volume =	0.934	acre-feet		
Approximate 25-yr Detention Volume =	1.128	acre-feet		
Approximate 50-yr Detention Volume =	1.246	acre-feet		
Approximate 100-yr Detention Volume =	1.373	acre-feet		

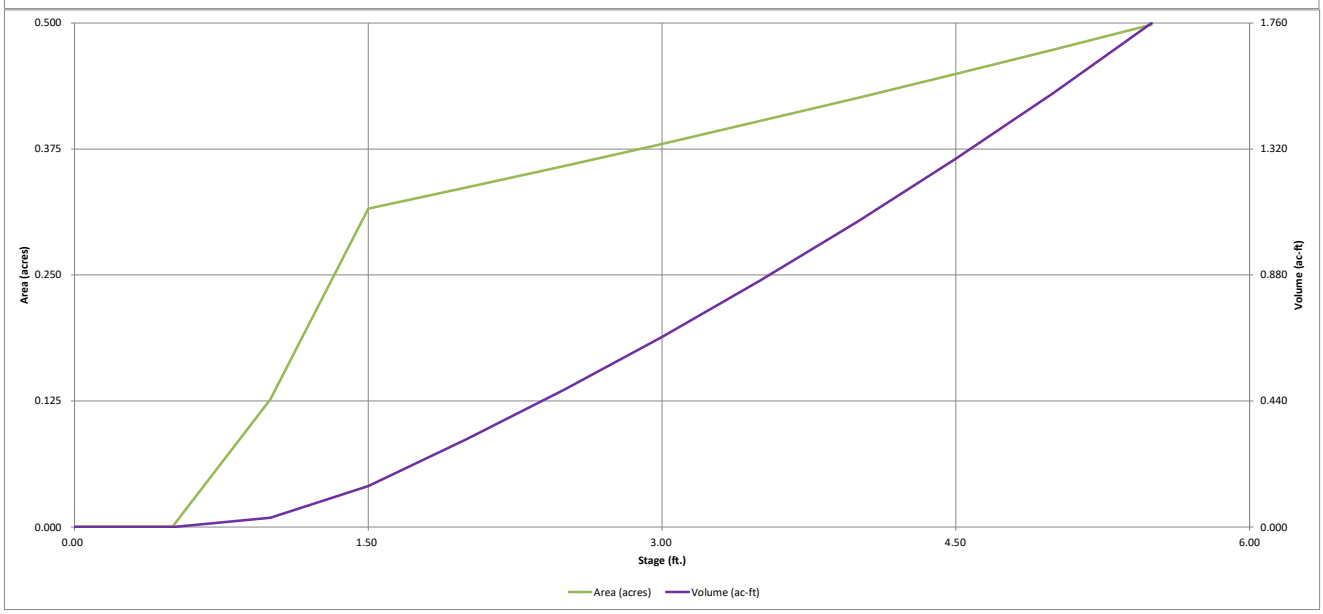
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.244	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.666	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.464	acre-feet
Total Detention Basin Volume =	1.373	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft^2)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	35	0.001		
6969	--	0.50	--	--	--	35	0.001	18	0.000
	--	1.00	--	--	--	5,514	0.127	1,404	0.032
6970	--	1.50	--	--	--	13,763	0.316	6,223	0.143
	--	2.00	--	--	--	14,669	0.337	13,331	0.306
6971	--	2.50	--	--	--	15,600	0.358	20,899	0.480
	--	3.00	--	--	--	16,556	0.380	28,938	0.664
6972	--	3.50	--	--	--	17,537	0.403	37,461	0.860
	--	4.00	--	--	--	18,542	0.426	46,481	1.067
6973	--	4.50	--	--	--	19,573	0.449	56,009	1.286
	--	5.00	--	--	--	20,628	0.474	66,059	1.517
6974	--	5.50	--	--	--	21,708	0.498	76,643	1.759


20
15
10
5
0
22000
16500
11000
5500
0
Length, Width (ft.)
Area (sq.ft.)
0.00
1.50
3.00
4.50
6.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

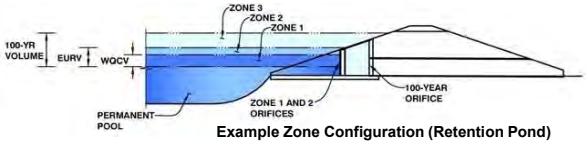

0.500
0.375
0.250
0.125
0.000
1.760
1.320
0.880
0.440
0.000
Area (acres)
Volume (ac-ft)
0.00
1.50
3.00
4.50
6.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview**

Basin ID: **Pond D**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.82	0.244	Orifice Plate
Zone 2 (EURV)	3.63	0.666	Circular Orifice
Zone 3 (100-year)	4.70	0.464	Weir&Pipe (Restrict)
Total (all zones)		1.373	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.597E-03	ft^2
Depth at top of Zone using Orifice Plate =	1.82	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	7.10	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.95	sq. inches (diameter = 1-1/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.61	1.21					
Orifice Area (sq. inches)	0.95	0.95	0.95					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	1.90	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.63	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	2.50	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.03	N/A	ft^2
Vertical Orifice Centroid =	0.10	N/A	feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.67	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.42	N/A	feet
Overflow Weir Slope Length =	3.09	N/A	feet
Grate Open Area / 100-yr Orifice Area =	9.78	N/A	
Overflow Grate Open Area w/o Debris =	6.46	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.23	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	7.20		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.66	N/A	ft^2
Outlet Orifice Centroid =	0.35	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.37	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.75	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.32	feet
Spillway Crest Length =	50.00	feet	Stage at Top of Freeboard =	6.07	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.50	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.76	acre-ft

Calculated Parameters for Spillway

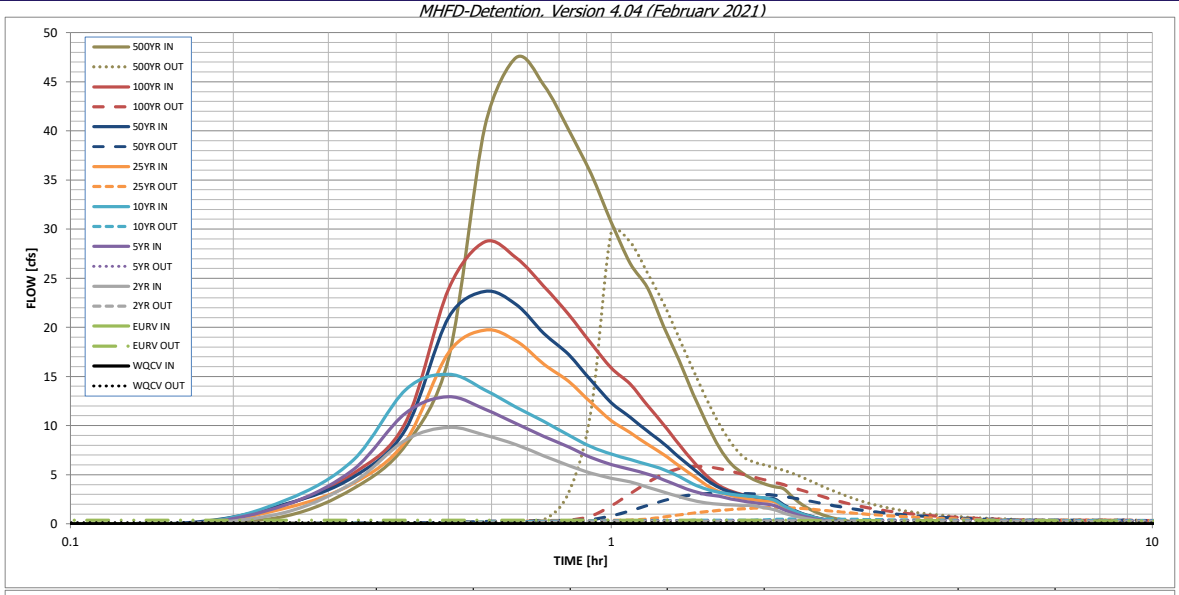
Routed Hydrograph Results

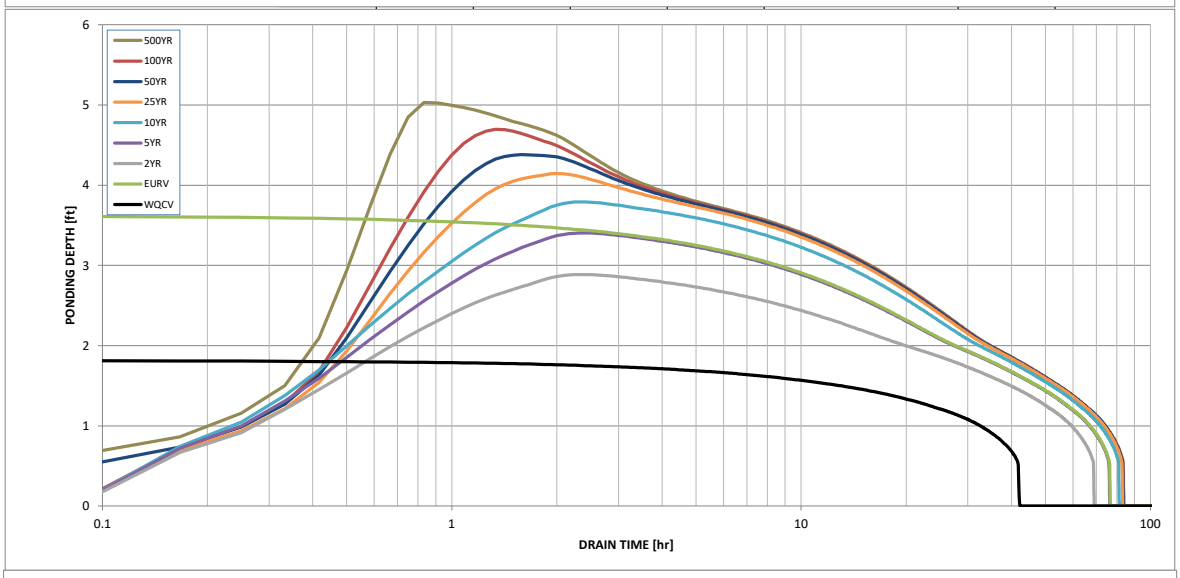
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

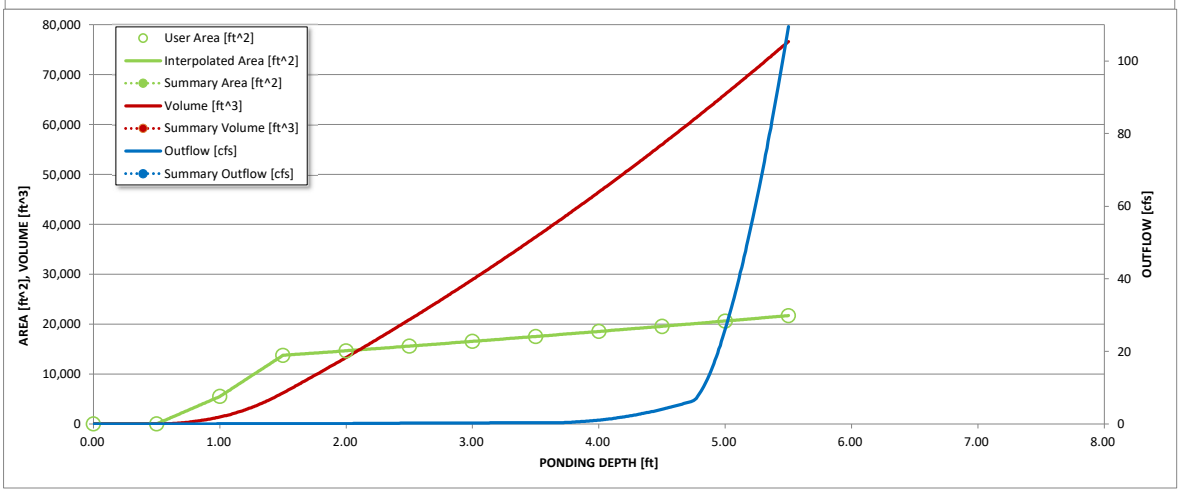
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.244	0.909	0.666	0.876	1.045	1.272	1.496	1.770	2.916
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.666	0.876	1.045	1.272	1.496	1.770	2.916
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.2	0.2	2.0	4.0	6.5	16.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.16	0.33	0.53	1.38
Peak Inflow Q (cfs) =	N/A	N/A	9.8	12.9	15.2	19.7	23.7	28.7	47.5
Peak Outflow Q (cfs) =	0.1	0.4	0.3	0.4	0.5	1.7	3.1	5.8	29.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.3	2.4	0.9	0.8	0.9	1.8
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.2	0.4	0.8	1.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	68	62	68	72	72	71	70	63
Time to Drain 99% of Inflow Volume (hours) =	**41**	73	66	73	78	79	78	78	75
Maximum Ponding Depth (ft) =	1.82	3.63	2.89	3.40	3.79	4.14	4.38	4.69	5.03
Area at Maximum Ponding Depth (acres) =	0.33	0.41	0.37	0.40	0.42	0.43	0.44	0.46	0.48
Maximum Volume Stored (acre-ft) =	0.246	0.913	0.619	0.820	0.979	1.127	1.228	1.372	1.531

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.01	0.80
	0:15:00	0.00	0.00	1.19	1.94	2.41	1.62	2.02	1.98	3.58
	0:20:00	0.00	0.00	4.23	5.53	6.50	4.10	4.78	5.12	8.02
	0:25:00	0.00	0.00	8.53	11.29	13.66	8.45	9.65	10.36	16.88
	0:30:00	0.00	0.00	9.83	12.93	15.22	17.43	21.01	23.91	40.39
	0:35:00	0.00	0.00	9.02	11.68	13.64	19.73	23.67	28.70	47.46
	0:40:00	0.00	0.00	8.05	10.21	11.88	18.62	22.32	27.08	44.68
	0:45:00	0.00	0.00	6.92	8.91	10.43	16.25	19.40	24.18	40.12
	0:50:00	0.00	0.00	5.95	7.82	9.03	14.49	17.24	21.32	35.63
	0:55:00	0.00	0.00	5.17	6.77	7.85	12.35	14.60	18.38	30.71
	1:00:00	0.00	0.00	4.65	6.05	7.10	10.51	12.33	15.86	26.53
	1:05:00	0.00	0.00	4.27	5.53	6.55	9.28	10.85	14.23	23.97
	1:10:00	0.00	0.00	3.73	5.07	6.04	8.09	9.41	12.03	20.09
	1:15:00	0.00	0.00	3.23	4.49	5.53	7.04	8.16	10.09	16.66
	1:20:00	0.00	0.00	2.76	3.86	4.82	5.90	6.80	8.09	13.22
	1:25:00	0.00	0.00	2.38	3.33	4.05	4.90	5.61	6.35	10.25
	1:30:00	0.00	0.00	2.12	2.99	3.51	3.93	4.47	4.89	7.75
	1:35:00	0.00	0.00	1.99	2.81	3.21	3.26	3.68	3.89	6.09
	1:40:00	0.00	0.00	1.92	2.53	3.01	2.86	3.23	3.32	5.14
	1:45:00	0.00	0.00	1.88	2.31	2.87	2.62	2.94	2.96	4.51
	1:50:00	0.00	0.00	1.85	2.15	2.77	2.45	2.76	2.72	4.09
	1:55:00	0.00	0.00	1.63	2.03	2.64	2.34	2.63	2.55	3.78
	2:00:00	0.00	0.00	1.44	1.88	2.41	2.26	2.54	2.43	3.57
	2:05:00	0.00	0.00	1.10	1.44	1.84	1.73	1.94	1.83	2.67
	2:10:00	0.00	0.00	0.83	1.07	1.36	1.28	1.44	1.35	1.96
	2:15:00	0.00	0.00	0.62	0.80	1.01	0.95	1.07	1.00	1.45
	2:20:00	0.00	0.00	0.46	0.59	0.74	0.70	0.79	0.75	1.08
	2:25:00	0.00	0.00	0.33	0.42	0.54	0.51	0.57	0.54	0.78
	2:30:00	0.00	0.00	0.24	0.30	0.39	0.36	0.41	0.39	0.56
	2:35:00	0.00	0.00	0.17	0.21	0.28	0.26	0.30	0.28	0.41
	2:40:00	0.00	0.00	0.11	0.14	0.19	0.18	0.20	0.19	0.28
	2:45:00	0.00	0.00	0.06	0.09	0.12	0.12	0.13	0.12	0.17
	2:50:00	0.00	0.00	0.03	0.05	0.06	0.07	0.07	0.07	0.10
	2:55:00	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.04
	3:00:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

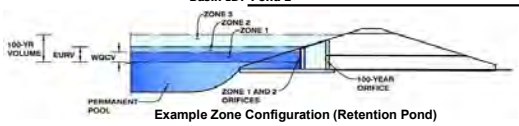
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview**

Basin ID: **Pond E**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	21.36	acres
Watershed Length =	1,800	ft
Watershed Length to Centroid =	900	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	61.70%	percent
Percentage Hydrologic Soil Group A =	90.0%	percent
Percentage Hydrologic Soil Group B =	10.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

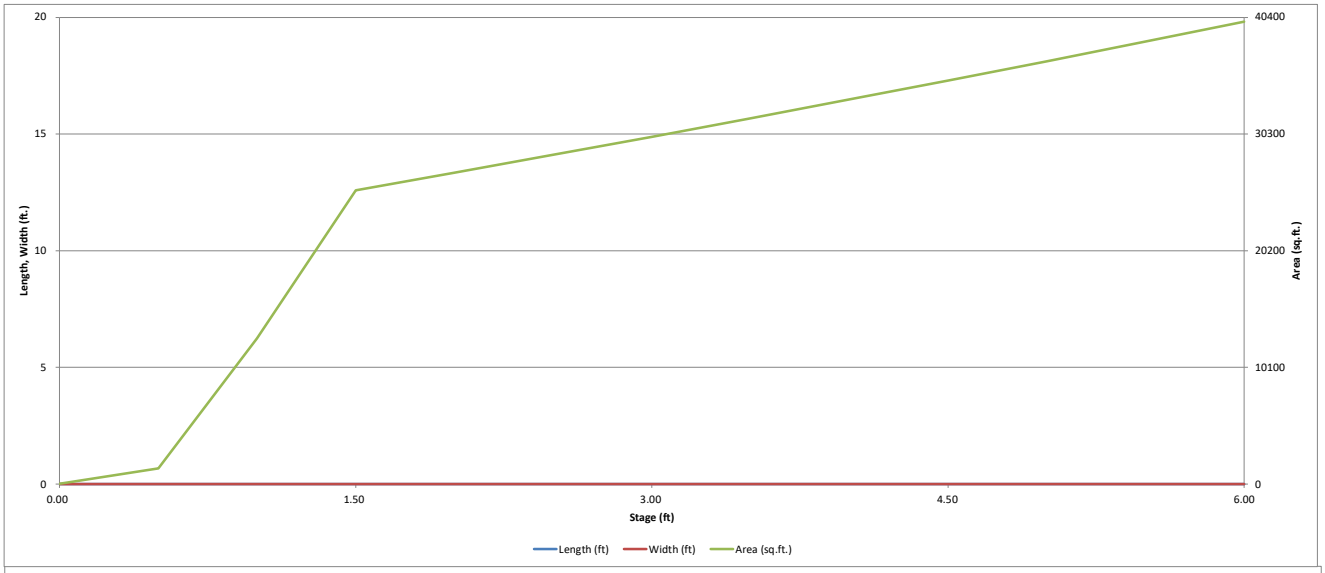
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.431	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.594	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.208	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.585	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.887	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	2.347	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.751	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.260	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	5.338	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	1.052	acre-feet		
Approximate 5-yr Detention Volume =	1.381	acre-feet		
Approximate 10-yr Detention Volume =	1.680	acre-feet		
Approximate 25-yr Detention Volume =	2.004	acre-feet		
Approximate 50-yr Detention Volume =	2.201	acre-feet		
Approximate 100-yr Detention Volume =	2.421	acre-feet		

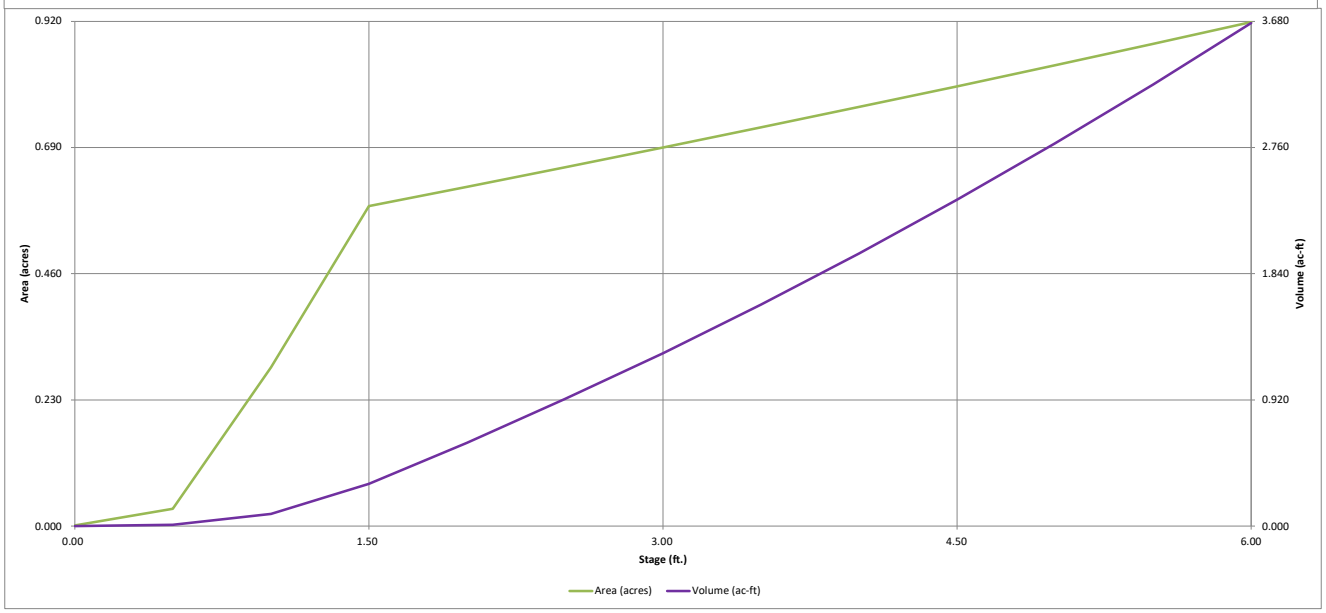
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.431	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.163	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.828	acre-feet
Total Detention Basin Volume =	2.421	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft^2)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	35	0.001		
	--	0.50	--	--	--	1,362	0.031	349	0.008
6947	--	1.00	--	--	--	12,615	0.290	3,843	0.088
	--	1.50	--	--	--	25,422	0.584	13,352	0.307
6948	--	2.00	--	--	--	26,944	0.619	26,443	0.607
	--	2.50	--	--	--	28,490	0.654	40,302	0.925
6949	--	3.00	--	--	--	30,062	0.690	54,940	1.261
	--	3.50	--	--	--	31,660	0.727	70,370	1.615
6950	--	4.00	--	--	--	33,282	0.764	86,606	1.988
	--	4.50	--	--	--	34,931	0.802	103,659	2.380
6951	--	5.00	--	--	--	36,604	0.840	121,543	2.790
	--	5.50	--	--	--	38,303	0.879	140,270	3.220
6952	--	6.00	--	--	--	40,027	0.919	159,852	3.670


20
15
10
5
0
Length, Width (ft.)
40400
30300
20200
10100
0
Area (sq.ft.)
0.00
1.50
3.00
4.50
6.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

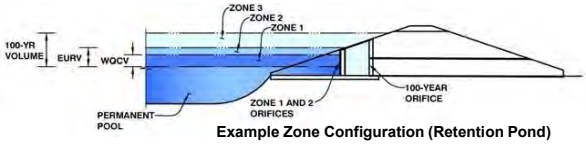

0.920
0.690
0.460
0.230
0.000
Area (acres)
3.680
2.760
1.840
0.920
0.000
Volume (ac-ft)
0.00
1.50
3.00
4.50
6.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview**

Basin ID: **Pond E**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.72	0.431	Orifice Plate
Zone 2 (EURV)	3.48	1.163	Rectangular Orifice
Zone 3 (100-year)	4.56	0.828	Weir&Pipe (Restrict)
Total (all zones)		2.421	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.250E-02	ft^2
Depth at top of Zone using Orifice Plate =	1.72	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	6.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.80	sq. inches (diameter = 1-1/2 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.57	1.15					
Orifice Area (sq. inches)	1.80	1.80	1.80					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	1.75	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.48	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	1.50	N/A	inches
Vertical Orifice Width =	6.00		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	0.06	N/A	ft^2
Vertical Orifice Centroid =	0.06	N/A	feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.50	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.25	N/A	feet
Overflow Weir Slope Length =	3.09	N/A	feet
Grate Open Area / 100-yr Orifice Area =	6.40	N/A	
Overflow Grate Open Area w/o Debris =	6.46	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.23	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	10.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.01	N/A	ft^2
Outlet Orifice Centroid =	0.48	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.68	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.80	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.40	feet
Spillway Crest Length =	60.00	feet	Stage at Top of Freeboard =	6.20	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.92	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	3.67	acre-ft

Calculated Parameters for Spillway

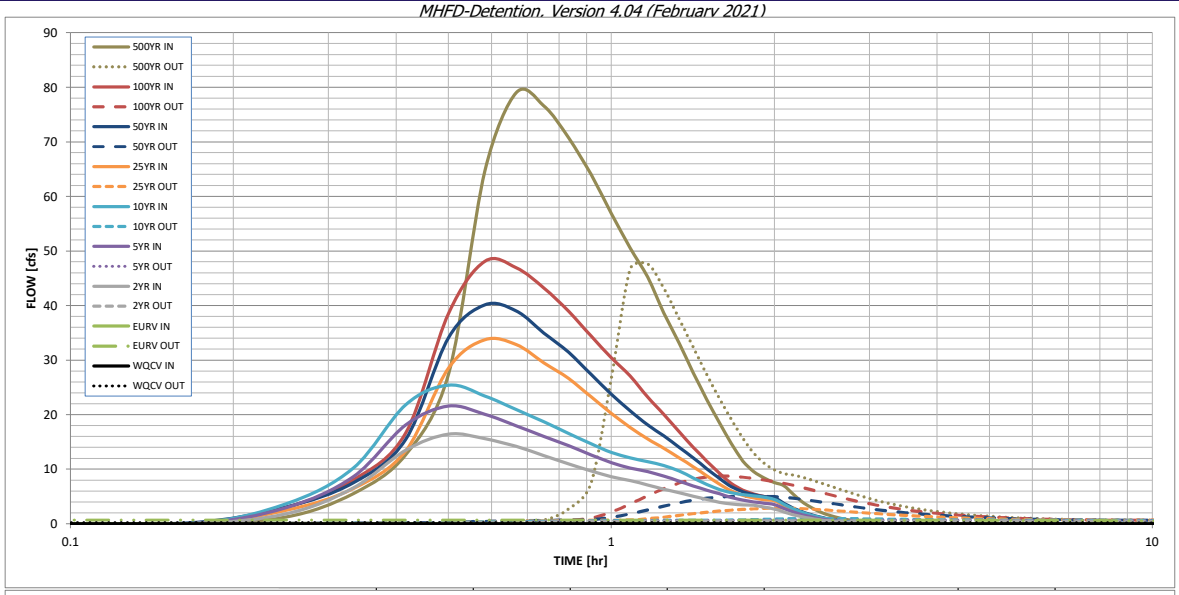
Routed Hydrograph Results

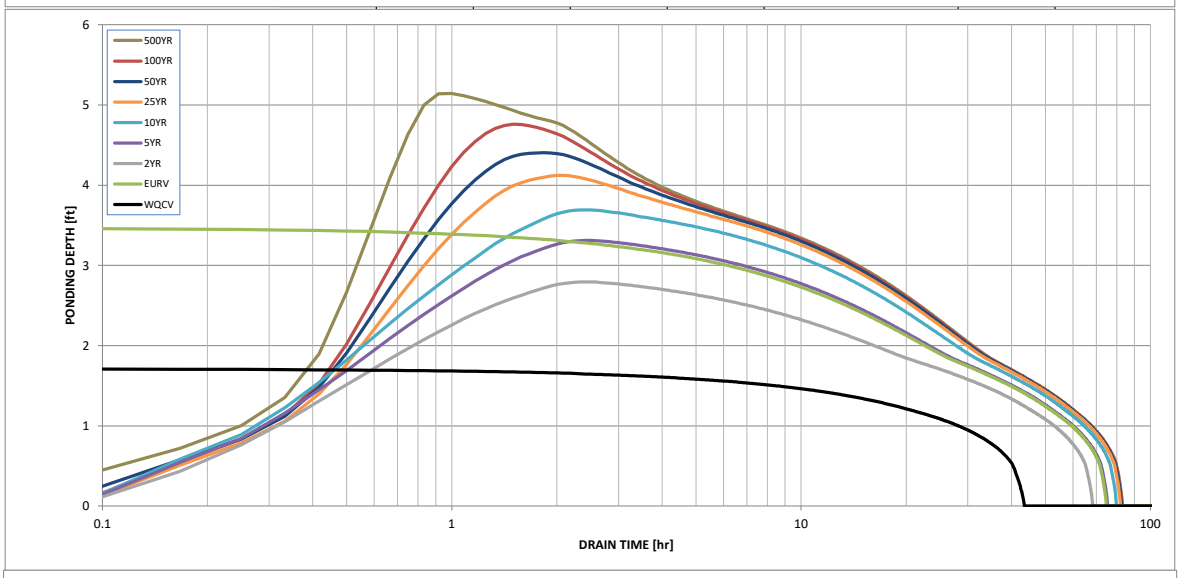
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

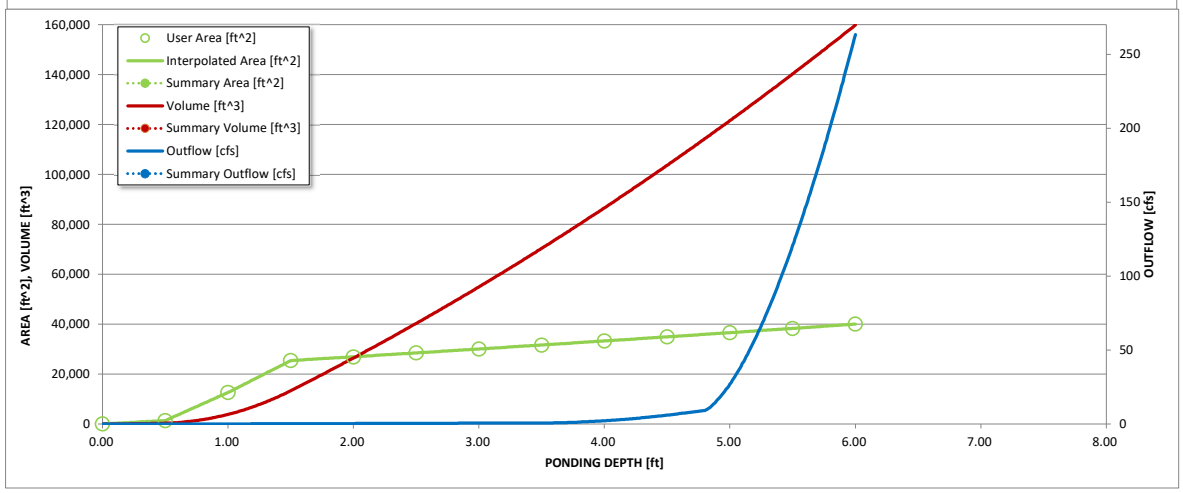
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.431	1.594	1.208	1.585	1.887	2.347	2.751	3.260	5.338
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.208	1.585	1.887	2.347	2.751	3.260	5.338
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.3	0.4	4.6	7.7	12.0	28.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.22	0.36	0.56	1.34
Peak Inflow Q (cfs) =	N/A	N/A	16.4	21.6	25.4	33.7	40.1	48.1	79.0
Peak Outflow Q (cfs) =	0.2	0.7	0.6	0.7	1.0	2.9	5.1	8.8	47.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.5	2.7	0.6	0.7	0.7	1.7
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.3	0.7	1.2	1.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	65	60	65	69	69	68	67	60
Time to Drain 99% of Inflow Volume (hours) =	**42**	70	64	70	74	76	76	75	72
Maximum Ponding Depth (ft) =	1.72	3.48	2.79	3.31	3.69	4.12	4.40	4.76	5.14
Area at Maximum Ponding Depth (acres) =	0.60	0.73	0.67	0.71	0.74	0.77	0.79	0.82	0.85
Maximum Volume Stored (acre-ft) =	0.437	1.601	1.118	1.472	1.755	2.080	2.300	2.583	2.909

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.02	1.22
	0:15:00	0.00	0.00	1.81	2.94	3.65	2.46	3.08	3.00	5.54
	0:20:00	0.00	0.00	6.56	8.65	10.19	6.44	7.52	8.04	12.67
	0:25:00	0.00	0.00	13.50	18.10	21.83	13.40	15.46	16.66	27.54
	0:30:00	0.00	0.00	16.45	21.57	25.41	28.55	34.13	38.59	64.65
	0:35:00	0.00	0.00	15.58	20.07	23.43	33.71	40.14	48.11	78.96
	0:40:00	0.00	0.00	14.18	17.96	20.91	32.82	39.01	46.90	76.61
	0:45:00	0.00	0.00	12.48	15.99	18.69	29.51	34.96	43.23	70.73
	0:50:00	0.00	0.00	11.00	14.33	16.57	26.62	31.43	38.92	64.02
	0:55:00	0.00	0.00	9.71	12.64	14.68	23.28	27.41	34.41	56.89
	1:00:00	0.00	0.00	8.65	11.20	13.09	20.22	23.75	30.43	50.54
	1:05:00	0.00	0.00	7.93	10.23	12.08	17.68	20.71	27.08	45.20
	1:10:00	0.00	0.00	7.11	9.55	11.36	15.54	18.15	23.23	38.67
	1:15:00	0.00	0.00	6.37	8.75	10.68	13.85	16.11	20.05	33.16
	1:20:00	0.00	0.00	5.71	7.84	9.69	12.10	14.03	16.89	27.70
	1:25:00	0.00	0.00	5.07	6.96	8.41	10.46	12.08	14.04	22.81
	1:30:00	0.00	0.00	4.46	6.16	7.25	8.79	10.11	11.53	18.54
	1:35:00	0.00	0.00	3.96	5.50	6.30	7.28	8.32	9.28	14.71
	1:40:00	0.00	0.00	3.63	4.81	5.70	6.02	6.83	7.40	11.53
	1:45:00	0.00	0.00	3.48	4.34	5.35	5.21	5.89	6.19	9.59
	1:50:00	0.00	0.00	3.39	4.03	5.12	4.73	5.34	5.47	8.39
	1:55:00	0.00	0.00	3.04	3.79	4.87	4.43	5.00	5.01	7.58
	2:00:00	0.00	0.00	2.71	3.53	4.49	4.22	4.76	4.68	7.00
	2:05:00	0.00	0.00	2.16	2.81	3.58	3.37	3.79	3.67	5.44
	2:10:00	0.00	0.00	1.67	2.17	2.76	2.58	2.90	2.76	4.05
	2:15:00	0.00	0.00	1.29	1.68	2.12	1.98	2.22	2.08	3.03
	2:20:00	0.00	0.00	0.99	1.28	1.62	1.51	1.69	1.58	2.30
	2:25:00	0.00	0.00	0.75	0.97	1.22	1.14	1.28	1.20	1.74
	2:30:00	0.00	0.00	0.57	0.72	0.91	0.85	0.95	0.90	1.30
	2:35:00	0.00	0.00	0.42	0.53	0.67	0.63	0.70	0.67	0.96
	2:40:00	0.00	0.00	0.31	0.39	0.50	0.47	0.53	0.50	0.73
	2:45:00	0.00	0.00	0.22	0.27	0.36	0.34	0.38	0.37	0.53
	2:50:00	0.00	0.00	0.14	0.19	0.24	0.24	0.26	0.25	0.36
	2:55:00	0.00	0.00	0.08	0.12	0.15	0.15	0.16	0.16	0.22
	3:00:00	0.00	0.00	0.04	0.06	0.08	0.08	0.09	0.08	0.12
	3:05:00	0.00	0.00	0.02	0.03	0.03	0.03	0.04	0.03	0.04
	3:10:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

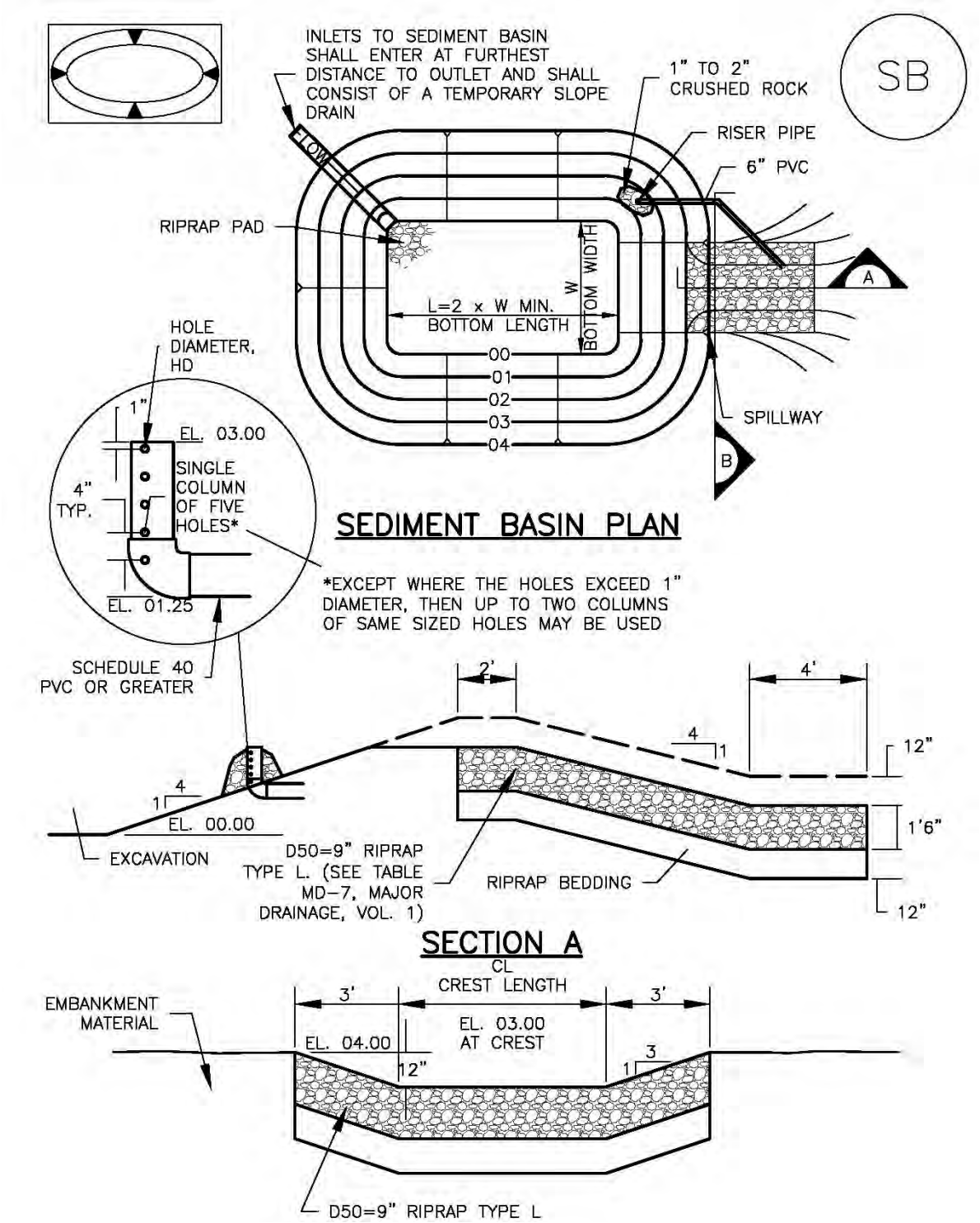
The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

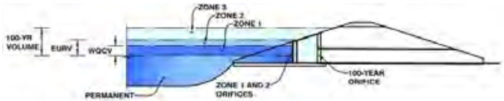

SB
INLETS TO SEDIMENT BASIN SHALL ENTER AT FURTHEST DISTANCE TO OUTLET AND SHALL CONSIST OF A TEMPORARY SLOPE DRAIN
FLOW
1" TO 2" CRUSHED ROCK
RISER PIPE
6" PVC
RIPRAP PAD
L=2 x W MIN. BOTTOM LENGTH
W BOTTOM WIDTH
00
01
02
03
04
A
B
SPILLWAY
SEDIMENT BASIN PLAN
HOLE DIAMETER, HD
1"
EL. 03.00
SINGLE COLUMN OF FIVE HOLES*
4" TYP.
EL. 01.25
*EXCEPT WHERE THE HOLES EXCEED 1" DIAMETER, THEN UP TO TWO COLUMNS OF SAME SIZED HOLES MAY BE USED
SCHEDULE 40 PVC OR GREATER
2'
4'
4
1
12"
1'6"
EL. 00.00
EXCAVATION
D50=9" RIPRAP TYPE L. (SEE TABLE MD-7, MAJOR DRAINAGE, VOL. 1)
RIPRAP BEDDING
12"
SECTION A
CL
CREST LENGTH
3'
3'
EMBANKMENT MATERIAL
EL. 04.00
EL. 03.00 AT CREST
12"
3
D50=9" RIPRAP TYPE L

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview - Proposed**

Basin ID: **SB-2**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	11.67	acres
Watershed Length =	930	ft
Watershed Length to Centroid =	465	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.015	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.011	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.006	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.012	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.016	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.146	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.294	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.496	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.453	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.006	acre-feet		
Approximate 5-yr Detention Volume =	0.009	acre-feet		
Approximate 10-yr Detention Volume =	0.012	acre-feet		
Approximate 25-yr Detention Volume =	0.019	acre-feet		
Approximate 50-yr Detention Volume =	0.046	acre-feet		
Approximate 100-yr Detention Volume =	0.126	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.015	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.015	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Total detention volume is less than 100-year volume.

Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 0.20 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	35	0.001		
	--	0.20	--	--	--	979	0.022	101	0.002
	--	0.40	--	--	--	1,076	0.025	307	0.007
	--	0.60	--	--	--	1,178	0.027	532	0.012
	--	0.80	--	--	--	1,284	0.029	778	0.018
	--	1.00	--	--	--	1,394	0.032	1,046	0.024
	--	1.20	--	--	--	1,508	0.035	1,336	0.031
	--	1.40	--	--	--	1,626	0.037	1,650	0.038
	--	1.60	--	--	--	1,748	0.040	1,987	0.046
	--	1.80	--	--	--	1,874	0.043	2,349	0.054
	--	2.00	--	--	--	2,003	0.046	2,737	0.063
	--	2.20	--	--	--	2,138	0.049	3,151	0.072
	--	2.40	--	--	--	2,276	0.052	3,592	0.082
	--	2.60	--	--	--	2,418	0.056	4,062	0.093
	--	2.80	--	--	--	2,564	0.059	4,560	0.105
	--	3.00	--	--	--	2,714	0.062	5,087	0.117
	--	3.20	--	--	--	2,868	0.066	5,646	0.130
	--	3.40	--	--	--	3,026	0.069	6,235	0.143
	--	3.60	--	--	--	3,188	0.073	6,856	0.157
	--	3.80	--	--	--	3,354	0.077	7,511	0.172
	--	4.00	--	--	--	3,525	0.081	8,199	0.188
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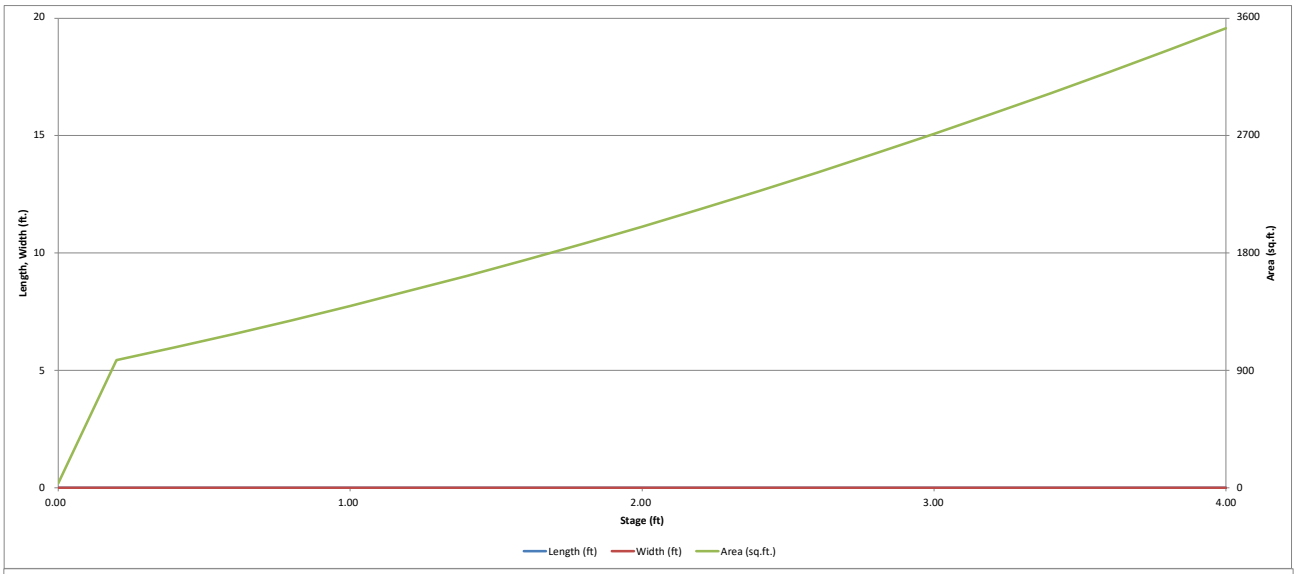
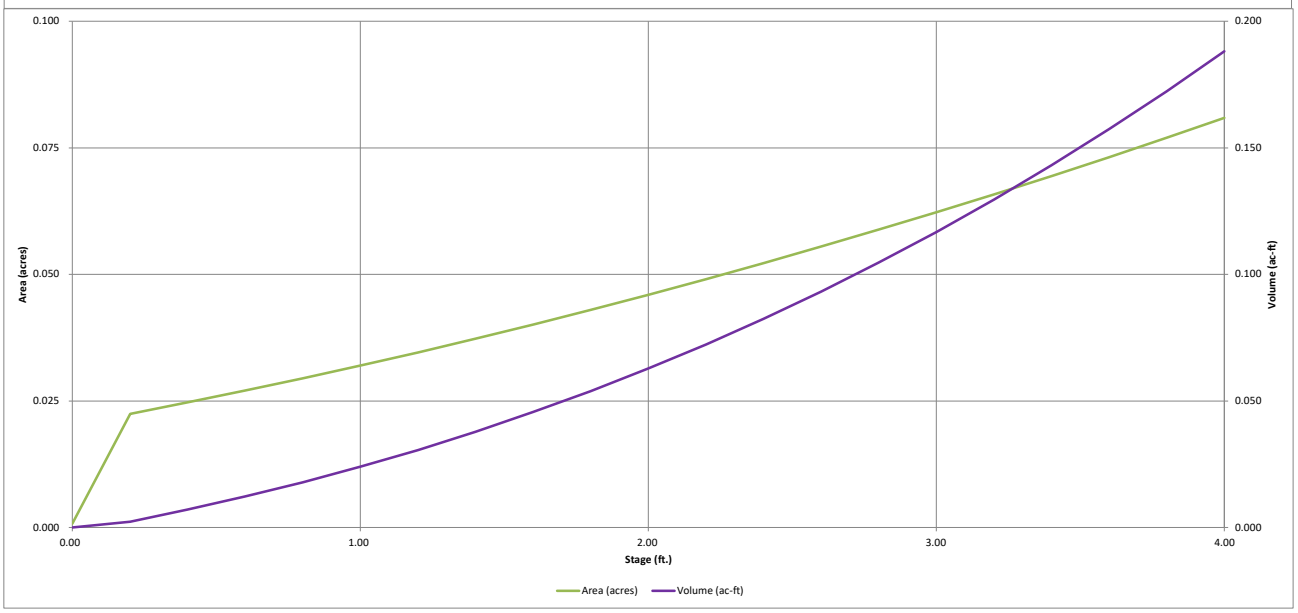

Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

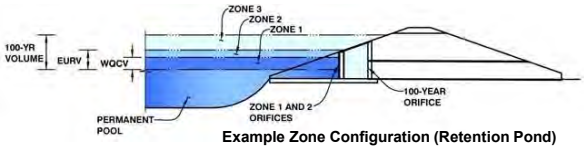

Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Grandview - Proposed**

Basin ID: **SB-2**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.70	0.015	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.015	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.451E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.70	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.79	sq. inches (diameter = 1 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60					
Orifice Area (sq. inches)	0.79	0.79	0.79					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	18.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.26	feet
Stage at Top of Freeboard =	4.26	feet
Basin Area at Top of Freeboard =	0.08	acres
Basin Volume at Top of Freeboard =	0.19	acre-ft

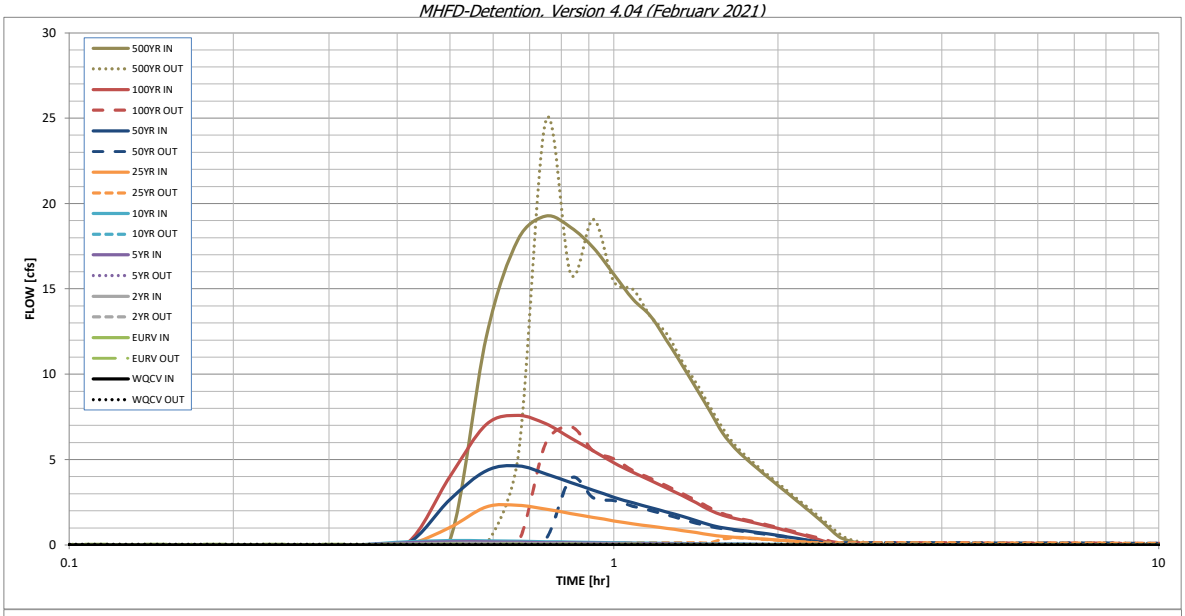
Routed Hydrograph Results

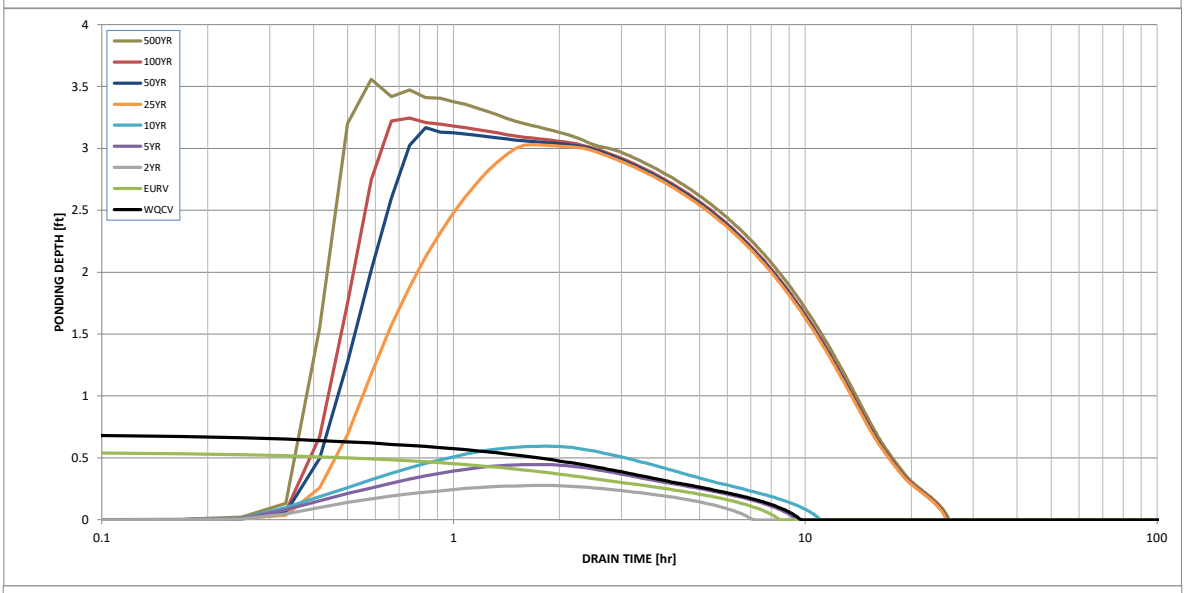
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

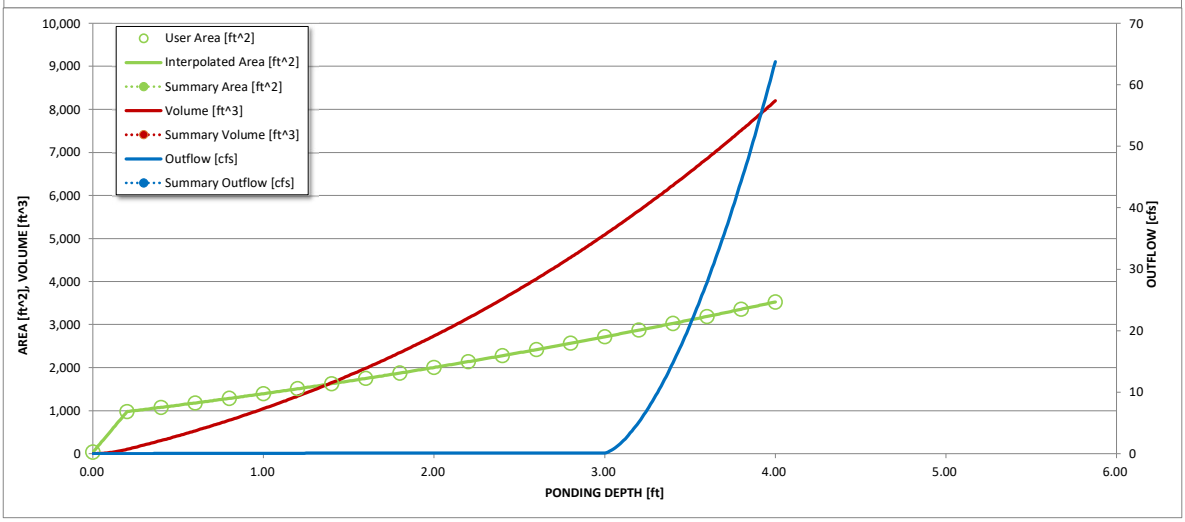
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.015	0.011	0.006	0.012	0.016	0.146	0.294	0.496	1.453
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.006	0.012	0.016	0.146	0.294	0.496	1.453
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.2	0.3	2.3	4.6	7.6	19.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.02	0.20	0.40	0.65	1.65
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.2	0.3	2.3	4.6	7.6	19.3
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.4	3.9	6.9	24.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.1	0.2	0.8	0.9	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	9	8	7	9	10	20	18	16	11
Time to Drain 99% of Inflow Volume (hours) =	9	8	7	9	11	23	21	20	16
Maximum Ponding Depth (ft) =	0.71	0.56	0.28	0.45	0.59	3.03	3.17	3.24	3.56
Area at Maximum Ponding Depth (acres) =	0.03	0.03	0.02	0.03	0.03	0.06	0.07	0.07	0.07
Maximum Volume Stored (acre-ft) =	0.015	0.011	0.004	0.008	0.012	0.119	0.127	0.132	0.154

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.05	0.12	0.18	0.03	0.07	0.09	0.30
	0:30:00	0.00	0.00	0.09	0.19	0.25	1.02	2.66	4.01	12.22
	0:35:00	0.00	0.00	0.09	0.18	0.25	2.23	4.35	7.06	17.90
	0:40:00	0.00	0.00	0.08	0.16	0.22	2.32	4.63	7.58	19.26
	0:45:00	0.00	0.00	0.07	0.14	0.19	2.10	4.16	7.09	18.60
	0:50:00	0.00	0.00	0.06	0.12	0.17	1.84	3.66	6.26	17.41
	0:55:00	0.00	0.00	0.05	0.10	0.15	1.62	3.21	5.51	15.85
	1:00:00	0.00	0.00	0.05	0.09	0.13	1.41	2.79	4.81	14.39
	1:05:00	0.00	0.00	0.04	0.08	0.12	1.23	2.46	4.25	13.42
	1:10:00	0.00	0.00	0.04	0.07	0.10	1.10	2.19	3.77	11.98
	1:15:00	0.00	0.00	0.03	0.06	0.09	0.97	1.93	3.33	10.56
	1:20:00	0.00	0.00	0.03	0.05	0.08	0.85	1.68	2.89	9.17
	1:25:00	0.00	0.00	0.02	0.05	0.07	0.72	1.42	2.46	7.84
	1:30:00	0.00	0.00	0.02	0.04	0.06	0.60	1.17	2.04	6.55
	1:35:00	0.00	0.00	0.02	0.04	0.05	0.50	1.01	1.74	5.68
	1:40:00	0.00	0.00	0.02	0.03	0.05	0.45	0.90	1.56	5.04
	1:45:00	0.00	0.00	0.02	0.03	0.04	0.41	0.82	1.40	4.48
	1:50:00	0.00	0.00	0.01	0.03	0.04	0.37	0.73	1.25	3.97
	1:55:00	0.00	0.00	0.01	0.02	0.03	0.32	0.64	1.11	3.49
	2:00:00	0.00	0.00	0.01	0.02	0.03	0.28	0.56	0.96	3.02
	2:05:00	0.00	0.00	0.01	0.02	0.02	0.24	0.47	0.82	2.58
	2:10:00	0.00	0.00	0.01	0.01	0.02	0.20	0.39	0.67	2.16
	2:15:00	0.00	0.00	0.01	0.01	0.01	0.16	0.30	0.53	1.74
	2:20:00	0.00	0.00	0.00	0.01	0.01	0.11	0.22	0.39	1.32
	2:25:00	0.00	0.00	0.00	0.00	0.00	0.07	0.13	0.25	0.90
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.11	0.50
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.29
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.18
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Worksheet Protected

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

Designer:	**Treven Edwards**
Company:	**Galloway & Company**
Date:	**May 4, 2022**
Project:	**Grandview**
Location:	**Basins C-3 & C-15**

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**C-3**	**C-15**												
Receiving Pervious Area Soil Type	Sandy Loam	Sandy Loam												
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	1.560	0.160												
Directly Connected Impervious Area (DCIA, acres)	0.000	0.000												
Unconnected Impervious Area (UIA, acres)	0.109	0.013												
Receiving Pervious Area (RPA, acres)	1.451	0.147												
Separate Pervious Area (SPA, acres)	0.000	0.000												
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C	C												

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	1.560	0.160												
Directly Connected Impervious Area (DCIA, %)	0.0%	0.0%												
Unconnected Impervious Area (UIA, %)	7.0%	8.2%												
Receiving Pervious Area (RPA, %)	93.0%	91.8%												
Separate Pervious Area (SPA, %)	0.0%	0.0%												
A_R (RPA / UIA)	13.286	11.195												
I_a Check	0.070	0.080												
f / I for WQCV Event:	1.7	1.7												
f / I for 5-Year Event:	0.5	0.5												
f / I for 100-Year Event:	0.3	0.3												
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.18	0.21												
IRF for 5-Year Event:	0.30	0.34												
IRF for 100-Year Event:	0.31	0.35												
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	7.0%	8.2%												
Effective Imperviousness for WQCV Event:	1.3%	1.7%												
Effective Imperviousness for 5-Year Event:	2.1%	2.8%												
Effective Imperviousness for 100-Year Event:	2.2%	2.9%												
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	80.1%	77.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	96.6%	87.1%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**7.1%**
Total Site Effective Imperviousness for WQCV Event:	**1.3%**
Total Site Effective Imperviousness for 5-Year Event:	**2.1%**
Total Site Effective Imperviousness for 100-Year Event:	**2.2%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

Worksheet Protected

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

Designer:	**TJE**
Company:	**Galloway & Co.**
Date:	**May 4, 2022**
Project:	**Grandview Reserve**
Location:	**Basin D-7a**

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**D-7a**													
Receiving Pervious Area Soil Type	Sandy Loam													
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.250													
Directly Connected Impervious Area (DCIA, acres)	0.000													
Unconnected Impervious Area (UIA, acres)	0.025													
Receiving Pervious Area (RPA, acres)	0.226													
Separate Pervious Area (SPA, acres)	0.000													
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C													

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.250													
Directly Connected Impervious Area (DCIA, %)	0.0%													
Unconnected Impervious Area (UIA, %)	9.8%													
Receiving Pervious Area (RPA, %)	90.2%													
Separate Pervious Area (SPA, %)	0.0%													
A_R (RPA / UIA)	9.204													
I_a Check	0.100													
f / I for WQCV Event:	1.7													
f / I for 5-Year Event:	0.5													
f / I for 100-Year Event:	0.3													
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.26													
IRF for 5-Year Event:	0.42													
IRF for 100-Year Event:	0.44													
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	9.8%													
Effective Imperviousness for WQCV Event:	2.6%													
Effective Imperviousness for 5-Year Event:	4.1%													
Effective Imperviousness for 100-Year Event:	4.3%													
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	70.9%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	69.7%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**9.8%**
Total Site Effective Imperviousness for WQCV Event:	**2.6%**
Total Site Effective Imperviousness for 5-Year Event:	**4.1%**
Total Site Effective Imperviousness for 100-Year Event:	**4.3%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

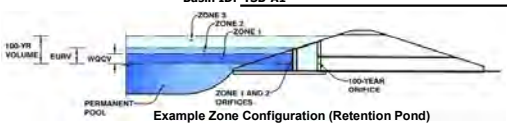
*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-A1**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	10.67	acres
Watershed Length =	1,001	ft
Watershed Length to Centroid =	501	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.013	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.010	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.005	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.011	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.015	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.134	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.269	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.454	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.330	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.006	acre-feet		
Approximate 5-yr Detention Volume =	0.008	acre-feet		
Approximate 10-yr Detention Volume =	0.011	acre-feet		
Approximate 25-yr Detention Volume =	0.017	acre-feet		
Approximate 50-yr Detention Volume =	0.042	acre-feet		
Approximate 100-yr Detention Volume =	0.115	acre-feet		

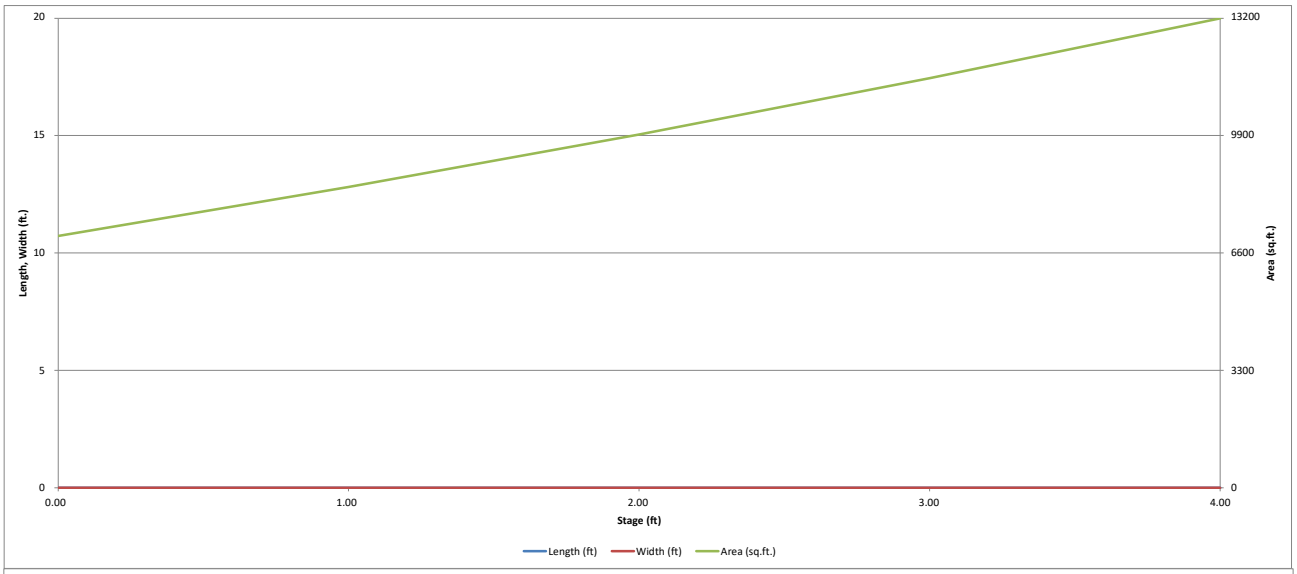
Define Zones and Basin Geometry

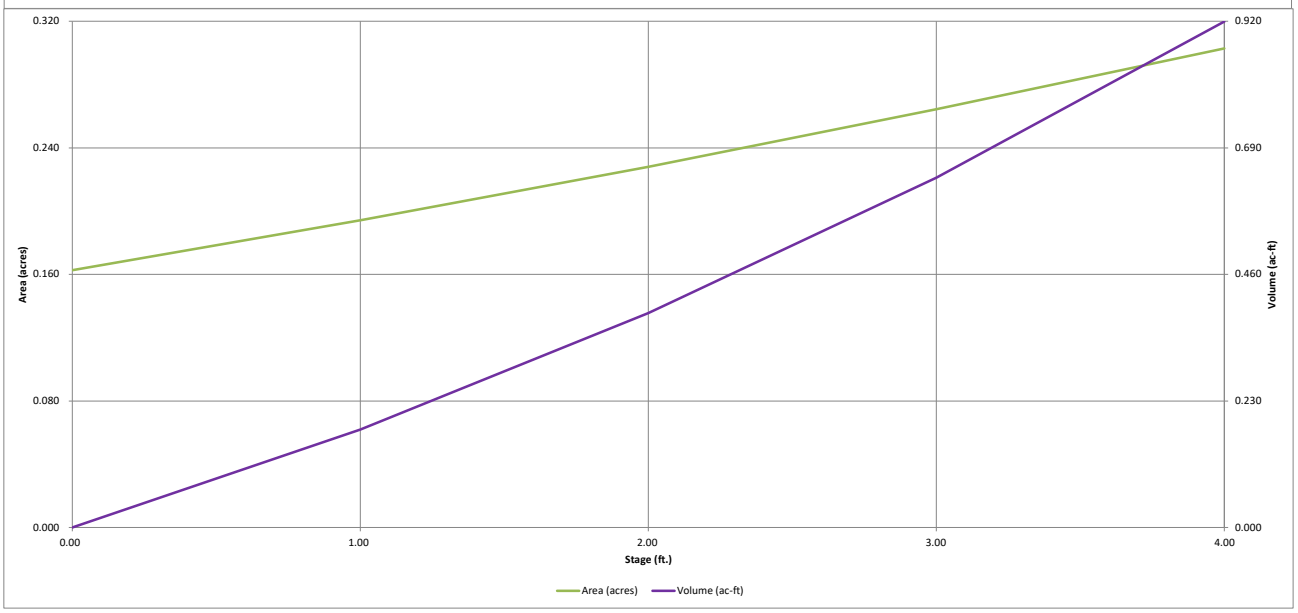
Zone 1 Volume (WQCV) =	0.013	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.013	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	7,084	0.163		
	--	1.00	--	--	--	8,460	0.194	7,772	0.178
	--	2.00	--	--	--	9,937	0.228	16,970	0.390
	--	3.00	--	--	--	11,515	0.264	27,696	0.636
	--	4.00	--	--	--	13,194	0.303	40,051	0.919


20
15
10
5
0
13200
9900
6600
3300
0
0.00
1.00
2.00
3.00
4.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

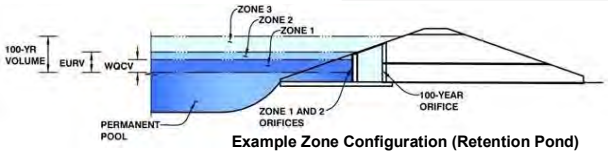

0.320
0.240
0.160
0.080
0.000
0.920
0.690
0.460
0.230
0.000
0.00
1.00
2.00
3.00
4.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-A1**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.09	0.013	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.013	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.139E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.11	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.74	sq. inches (diameter = 15/16 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	0.74	0.74	0.74	0.74	0.74			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.25	feet
Spillway Crest Length =	24.00	feet	Stage at Top of Freeboard =	4.25	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.30	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.92	acre-ft

Calculated Parameters for Spillway

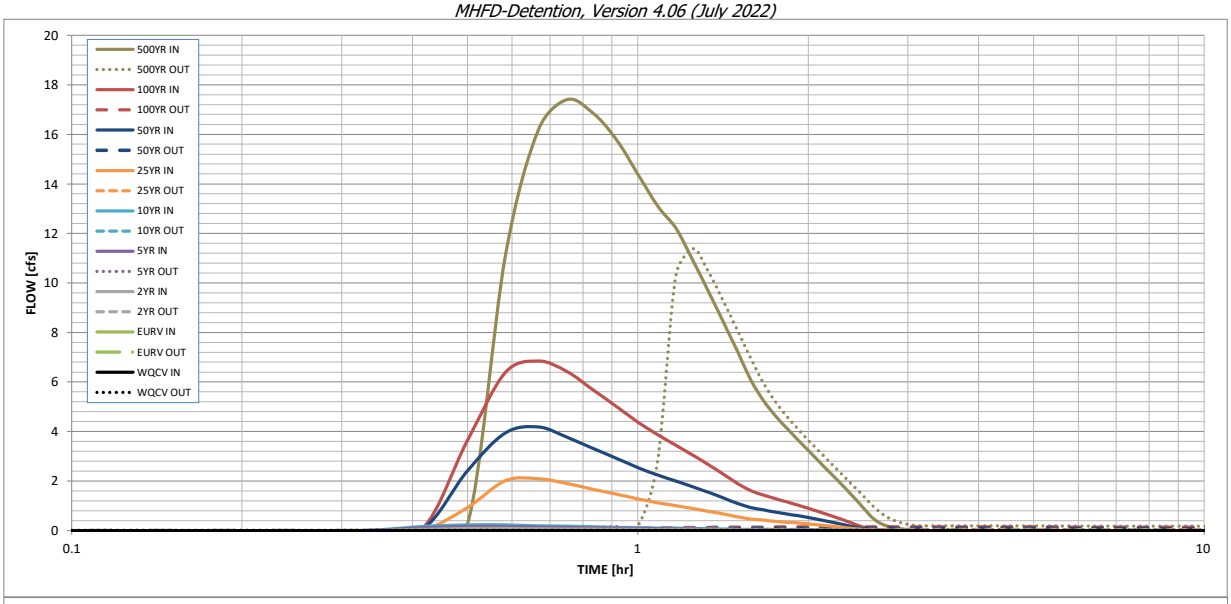
Routed Hydrograph Results

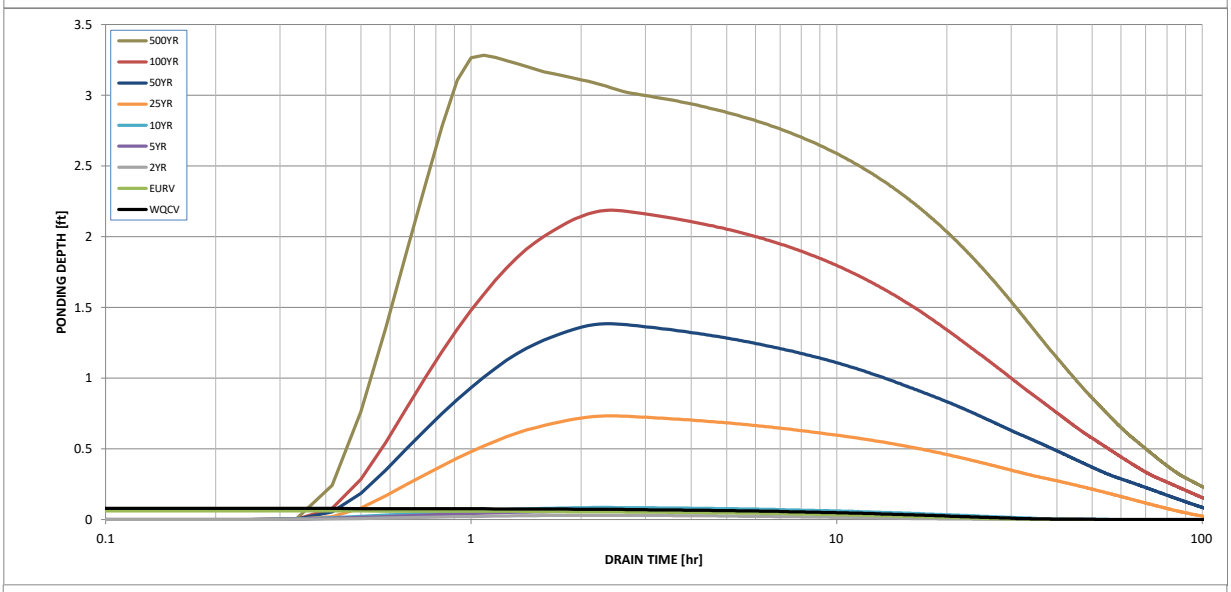
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

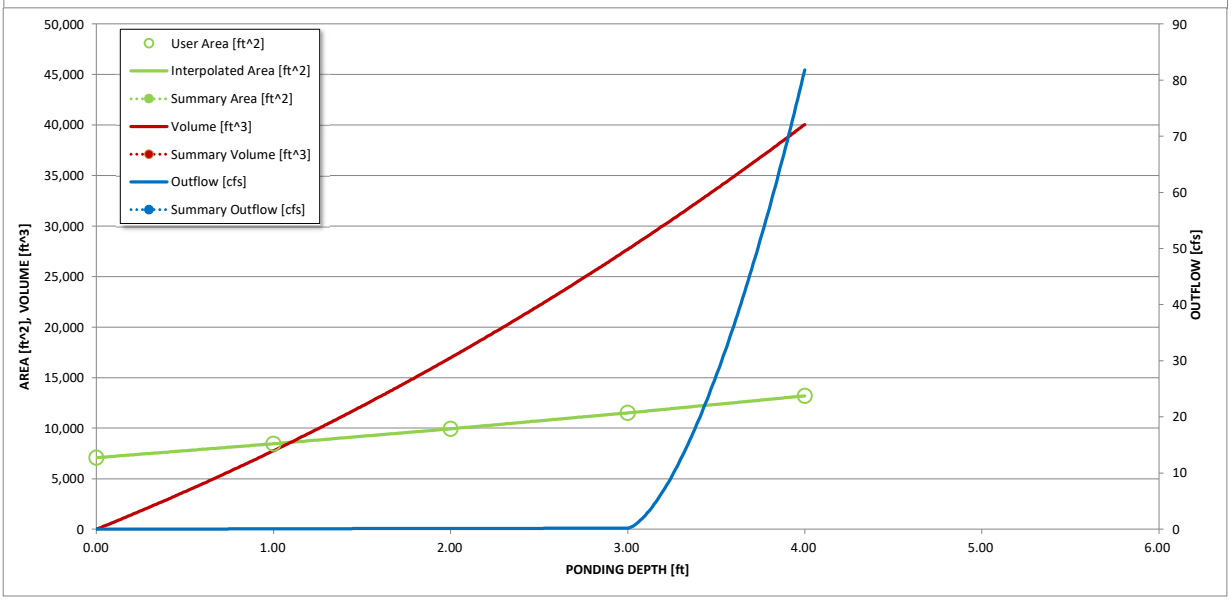
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.013	0.010	0.005	0.011	0.015	0.134	0.269	0.454	1.330
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.005	0.011	0.015	0.134	0.269	0.454	1.330
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.2	0.2	2.1	4.2	6.8	17.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.02	0.20	0.39	0.64	1.63
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.2	0.2	2.1	4.2	6.8	17.4
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	11.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	41	37	32	39	44	100	111	117	99
Time to Drain 99% of Inflow Volume (hours) =	**49**	46	41	47	52	111	>120	>120	>120
Maximum Ponding Depth (ft) =	0.08	0.07	0.03	0.06	0.09	0.73	1.38	2.19	3.28
Area at Maximum Ponding Depth (acres) =	0.17	0.16	0.16	0.16	0.17	0.19	0.21	0.23	0.28
Maximum Volume Stored (acre-ft) =	0.013	0.011	0.003	0.008	0.013	0.127	0.255	0.431	0.711

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.04	0.11	0.17	0.03	0.06	0.08	0.27
	0:30:00	0.00	0.00	0.08	0.17	0.23	0.93	2.41	3.64	11.07
	0:35:00	0.00	0.00	0.08	0.16	0.22	2.02	3.93	6.38	16.17
	0:40:00	0.00	0.00	0.07	0.14	0.20	2.09	4.18	6.85	17.41
	0:45:00	0.00	0.00	0.06	0.12	0.17	1.90	3.76	6.43	16.85
	0:50:00	0.00	0.00	0.06	0.11	0.15	1.67	3.32	5.68	15.79
	0:55:00	0.00	0.00	0.05	0.09	0.13	1.47	2.91	5.01	14.40
	1:00:00	0.00	0.00	0.04	0.08	0.12	1.28	2.54	4.38	13.11
	1:05:00	0.00	0.00	0.04	0.08	0.11	1.13	2.25	3.88	12.22
	1:10:00	0.00	0.00	0.04	0.07	0.10	1.00	2.00	3.45	10.92
	1:15:00	0.00	0.00	0.03	0.06	0.09	0.89	1.77	3.05	9.65
	1:20:00	0.00	0.00	0.03	0.05	0.07	0.78	1.54	2.66	8.41
	1:25:00	0.00	0.00	0.02	0.04	0.06	0.67	1.32	2.28	7.23
	1:30:00	0.00	0.00	0.02	0.04	0.05	0.55	1.09	1.90	6.08
	1:35:00	0.00	0.00	0.02	0.03	0.05	0.47	0.93	1.62	5.25
	1:40:00	0.00	0.00	0.02	0.03	0.04	0.42	0.83	1.43	4.64
	1:45:00	0.00	0.00	0.02	0.03	0.04	0.38	0.75	1.29	4.13
	1:50:00	0.00	0.00	0.01	0.02	0.04	0.34	0.67	1.16	3.67
	1:55:00	0.00	0.00	0.01	0.02	0.03	0.30	0.60	1.03	3.24
	2:00:00	0.00	0.00	0.01	0.02	0.03	0.26	0.52	0.90	2.82
	2:05:00	0.00	0.00	0.01	0.02	0.02	0.23	0.45	0.77	2.43
	2:10:00	0.00	0.00	0.01	0.01	0.02	0.19	0.37	0.64	2.05
	2:15:00	0.00	0.00	0.01	0.01	0.01	0.15	0.30	0.52	1.68
	2:20:00	0.00	0.00	0.00	0.01	0.01	0.11	0.22	0.39	1.30
	2:25:00	0.00	0.00	0.00	0.00	0.01	0.08	0.15	0.26	0.93
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.04	0.07	0.14	0.56
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.32
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.19
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.12
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

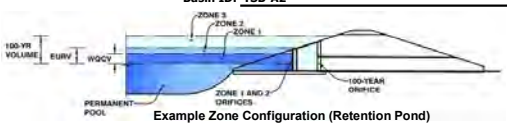
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-A2**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	4.56	acres
Watershed Length =	912	ft
Watershed Length to Centroid =	456	ft
Watershed Slope =	0.025	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.006	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.004	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.002	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.004	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.006	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.057	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.115	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.194	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	0.569	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.002	acre-feet		
Approximate 5-yr Detention Volume =	0.003	acre-feet		
Approximate 10-yr Detention Volume =	0.005	acre-feet		
Approximate 25-yr Detention Volume =	0.007	acre-feet		
Approximate 50-yr Detention Volume =	0.018	acre-feet		
Approximate 100-yr Detention Volume =	0.049	acre-feet		

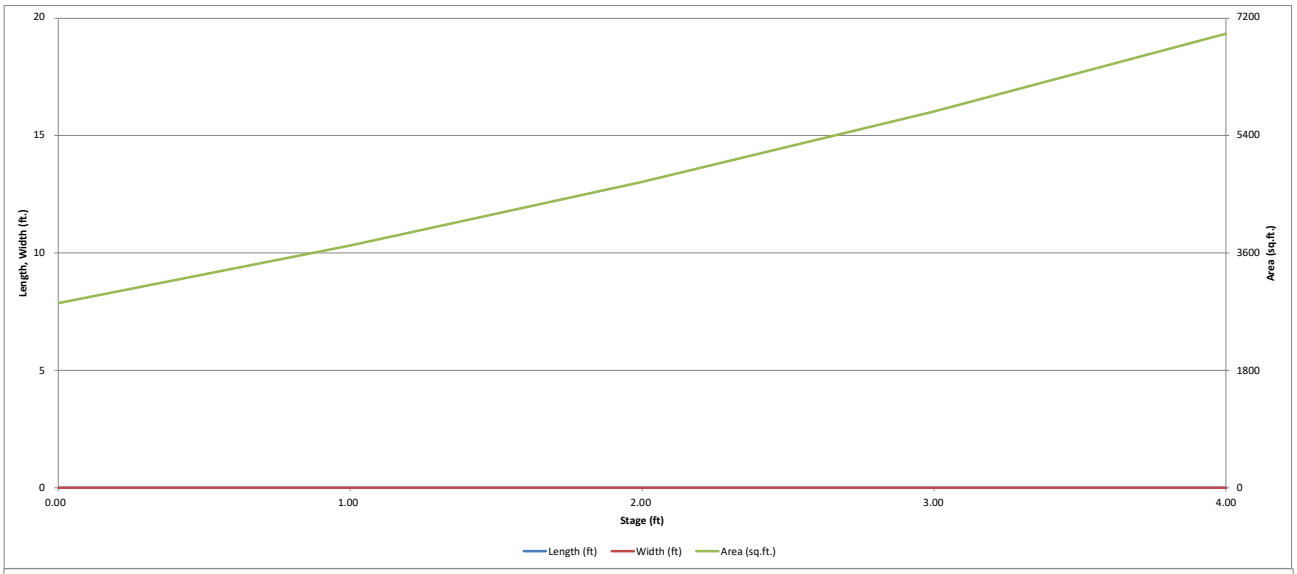
Define Zones and Basin Geometry

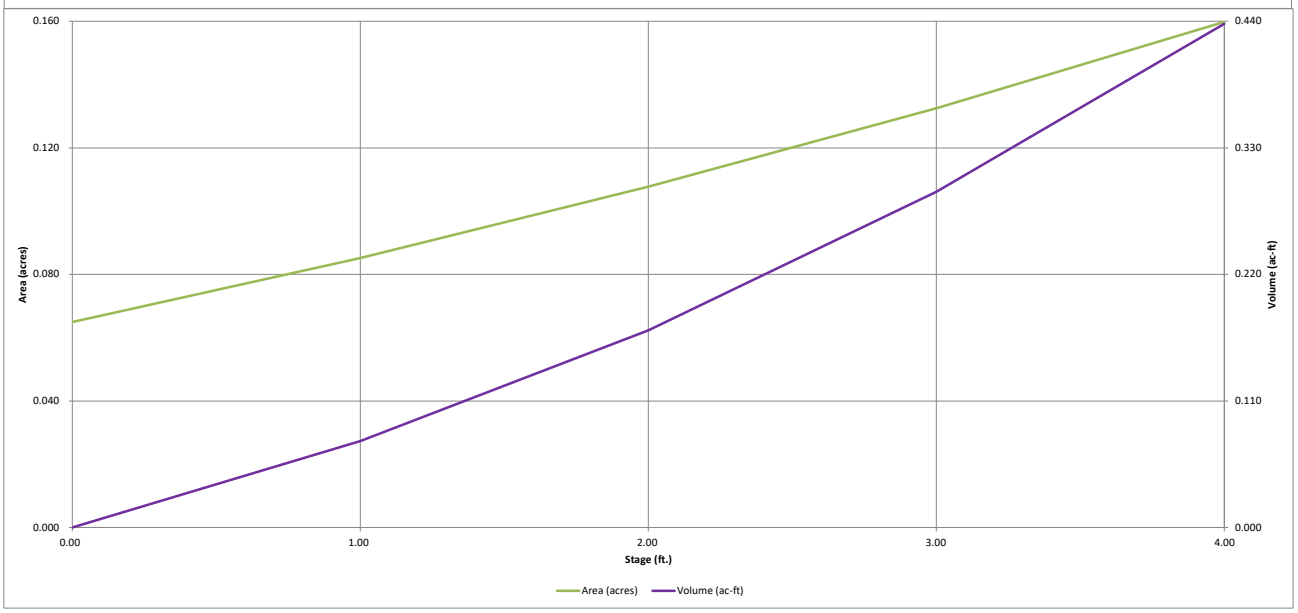
Zone 1 Volume (WQCV) =	0.006	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.006	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	2,830	0.065		
	--	1.00	--	--	--	3,712	0.085	3,271	0.075
	--	2.00	--	--	--	4,693	0.108	7,473	0.172
	--	3.00	--	--	--	5,772	0.133	12,706	0.292
	--	4.00	--	--	--	6,962	0.160	19,073	0.438


20
15
10
5
0
Length, Width (ft.)
7200
5400
3600
1800
0
Area (sq.ft.)
0.00
1.00
2.00
3.00
4.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

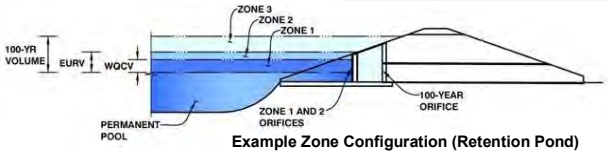

0.160
0.120
0.080
0.040
0.000
Area (acres)
0.440
0.330
0.220
0.110
0.000
Volume (ac-ft)
0.00
1.00
2.00
3.00
4.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-A2**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.09	0.006	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.006	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.361E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.09	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.34	sq. inches (diameter = 5/8 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	0.34	0.34	0.34	0.34	0.34			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.18	feet
Spillway Crest Length =	8.00	feet	Stage at Top of Freeboard =	4.18	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.16	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.44	acre-ft

Calculated Parameters for Spillway

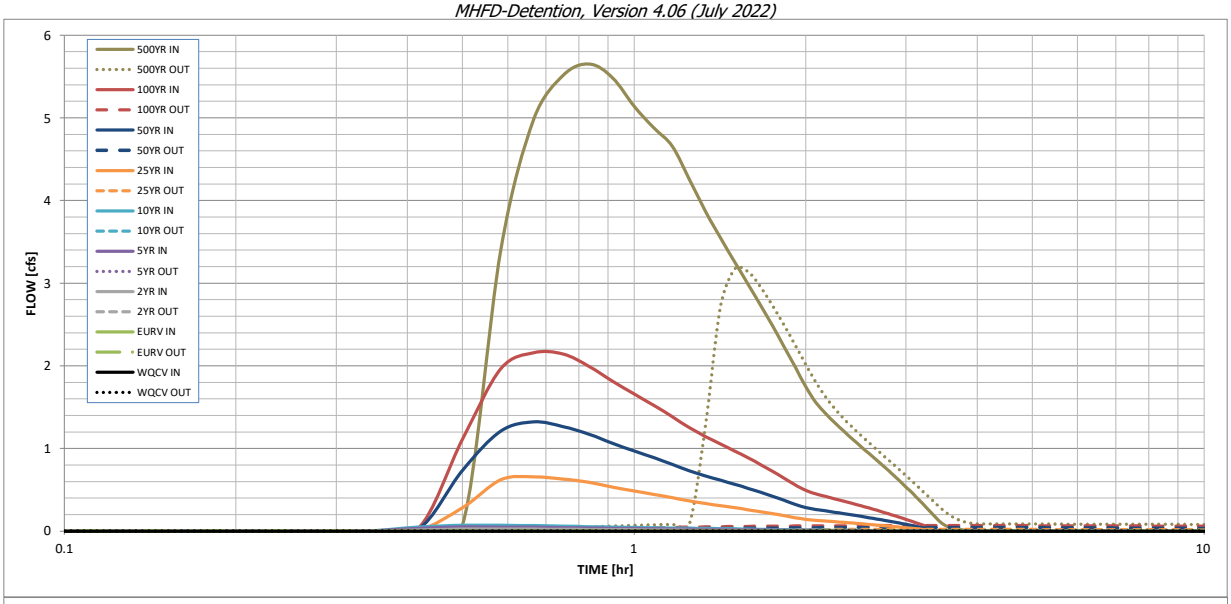
Routed Hydrograph Results

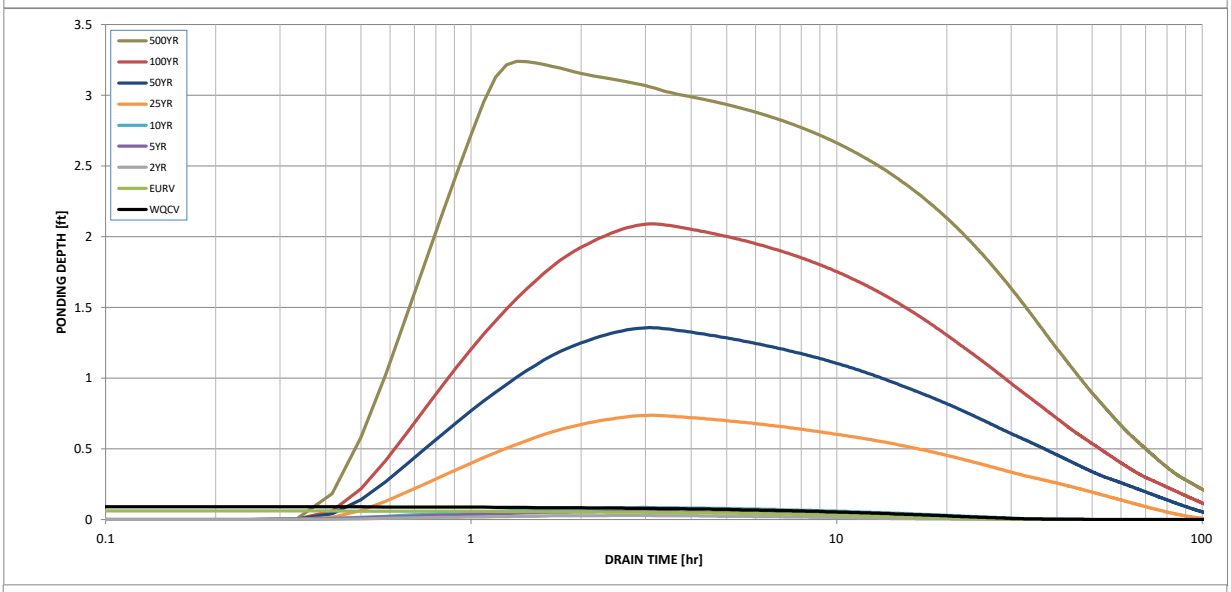
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

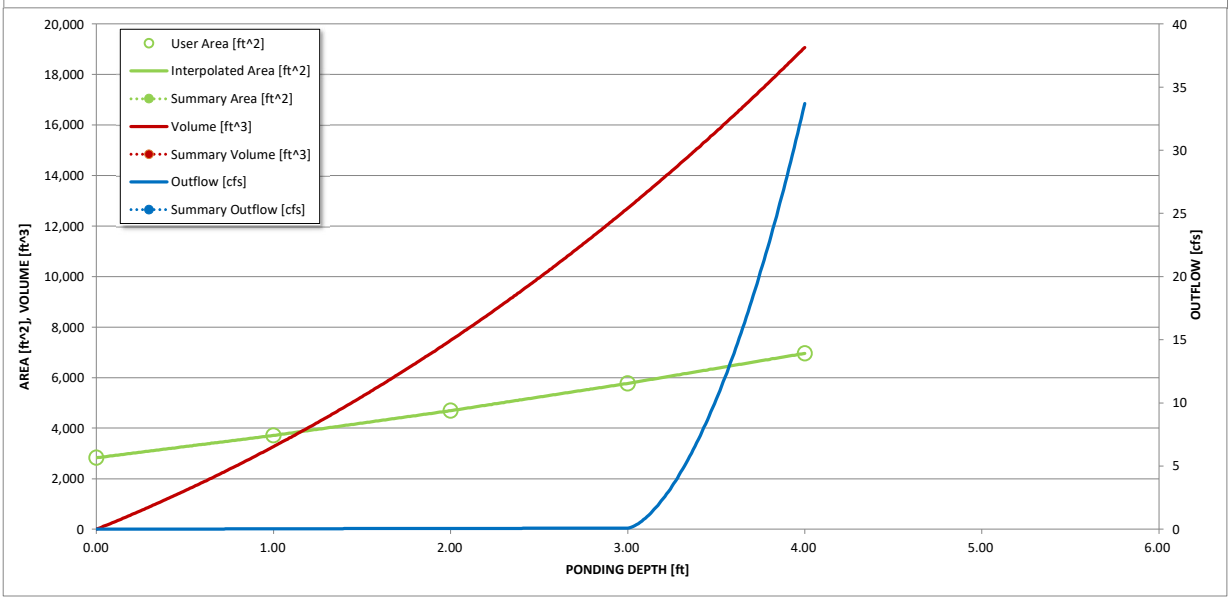
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.006	0.004	0.002	0.004	0.006	0.057	0.115	0.194	0.569
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.002	0.004	0.006	0.057	0.115	0.194	0.569
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.1	0.7	1.3	2.2	5.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.14	0.29	0.47	1.24
Peak Inflow Q (cfs) =	N/A	N/A	0.0	0.1	0.1	0.7	1.3	2.2	5.7
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.0	0.0	0.0	0.0	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	37	32	28	34	39	90	101	106	94
Time to Drain 99% of Inflow Volume (hours) =	**45**	40	36	42	46	99	114	>120	>120
Maximum Ponding Depth (ft) =	0.10	0.07	0.03	0.06	0.08	0.74	1.36	2.09	3.24
Area at Maximum Ponding Depth (acres) =	0.07	0.07	0.07	0.07	0.07	0.08	0.09	0.11	0.14
Maximum Volume Stored (acre-ft) =	0.007	0.005	0.001	0.003	0.005	0.053	0.106	0.181	0.323

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:25:00	0.00	0.00	0.01	0.03	0.05	0.01	0.02	0.03	0.08
	0:30:00	0.00	0.00	0.03	0.05	0.07	0.29	0.74	1.12	3.40
	0:35:00	0.00	0.00	0.03	0.05	0.07	0.62	1.21	1.96	4.98
	0:40:00	0.00	0.00	0.02	0.05	0.07	0.66	1.32	2.16	5.51
	0:45:00	0.00	0.00	0.02	0.04	0.06	0.63	1.27	2.14	5.65
	0:50:00	0.00	0.00	0.02	0.04	0.06	0.59	1.17	1.99	5.49
	0:55:00	0.00	0.00	0.02	0.04	0.05	0.53	1.06	1.81	5.14
	1:00:00	0.00	0.00	0.02	0.03	0.05	0.49	0.97	1.66	4.88
	1:05:00	0.00	0.00	0.02	0.03	0.04	0.45	0.89	1.52	4.66
	1:10:00	0.00	0.00	0.01	0.03	0.04	0.40	0.81	1.38	4.26
	1:15:00	0.00	0.00	0.01	0.02	0.04	0.37	0.73	1.25	3.87
	1:20:00	0.00	0.00	0.01	0.02	0.03	0.33	0.67	1.15	3.55
	1:25:00	0.00	0.00	0.01	0.02	0.03	0.31	0.62	1.06	3.26
	1:30:00	0.00	0.00	0.01	0.02	0.03	0.28	0.57	0.97	2.99
	1:35:00	0.00	0.00	0.01	0.02	0.03	0.26	0.52	0.89	2.73
	1:40:00	0.00	0.00	0.01	0.02	0.02	0.24	0.47	0.81	2.48
	1:45:00	0.00	0.00	0.01	0.01	0.02	0.21	0.42	0.72	2.23
	1:50:00	0.00	0.00	0.01	0.01	0.02	0.19	0.37	0.64	1.99
	1:55:00	0.00	0.00	0.01	0.01	0.02	0.16	0.32	0.56	1.75
	2:00:00	0.00	0.00	0.00	0.01	0.01	0.14	0.29	0.49	1.56
	2:05:00	0.00	0.00	0.00	0.01	0.01	0.13	0.26	0.45	1.42
	2:10:00	0.00	0.00	0.00	0.01	0.01	0.12	0.25	0.42	1.31
	2:15:00	0.00	0.00	0.00	0.01	0.01	0.11	0.23	0.39	1.21
	2:20:00	0.00	0.00	0.00	0.01	0.01	0.11	0.21	0.36	1.12
	2:25:00	0.00	0.00	0.00	0.01	0.01	0.10	0.20	0.34	1.03
	2:30:00	0.00	0.00	0.00	0.01	0.01	0.09	0.18	0.31	0.94
	2:35:00	0.00	0.00	0.00	0.01	0.01	0.08	0.16	0.28	0.86
	2:40:00	0.00	0.00	0.00	0.00	0.01	0.07	0.15	0.25	0.78
	2:45:00	0.00	0.00	0.00	0.00	0.01	0.07	0.13	0.23	0.70
	2:50:00	0.00	0.00	0.00	0.00	0.01	0.06	0.11	0.20	0.62
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.05	0.10	0.17	0.54
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.14	0.45
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.12	0.37
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.09	0.29
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.06	0.21
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.13
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.08
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

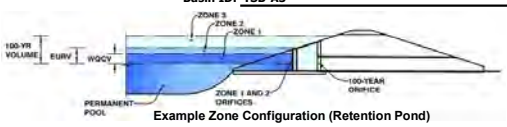
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-A3**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	13.72	acres
Watershed Length =	1,379	ft
Watershed Length to Centroid =	690	ft
Watershed Slope =	0.023	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.017	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.013	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.007	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.014	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.019	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.172	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.346	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.585	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.715	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.007	acre-feet		
Approximate 5-yr Detention Volume =	0.010	acre-feet		
Approximate 10-yr Detention Volume =	0.015	acre-feet		
Approximate 25-yr Detention Volume =	0.022	acre-feet		
Approximate 50-yr Detention Volume =	0.054	acre-feet		
Approximate 100-yr Detention Volume =	0.148	acre-feet		

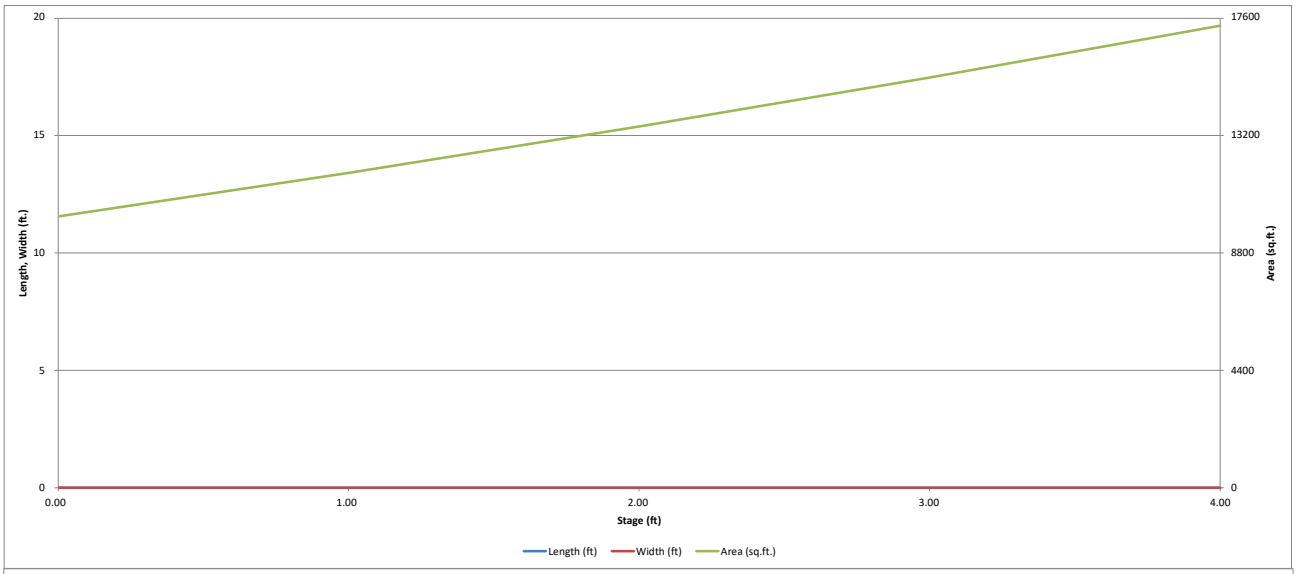
Define Zones and Basin Geometry

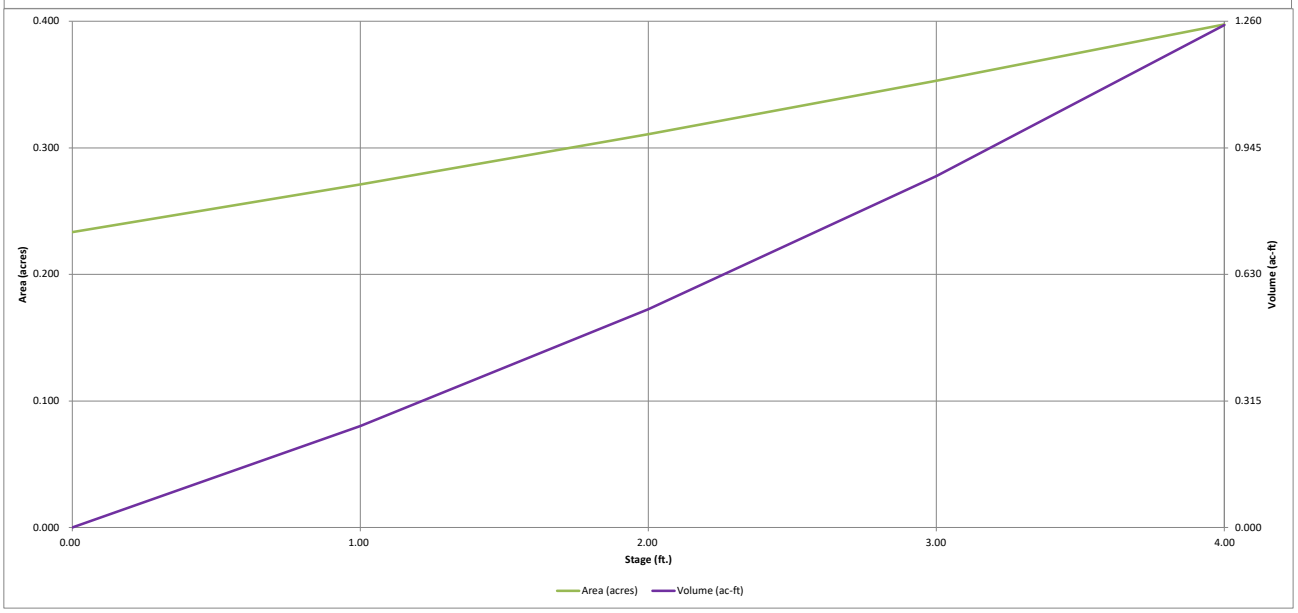
Zone 1 Volume (WQCV) =	0.017	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.017	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10,173	0.234		
	--	1.00	--	--	--	11,808	0.271	10,990	0.252
	--	2.00	--	--	--	13,544	0.311	23,666	0.543
	--	3.00	--	--	--	15,382	0.353	38,129	0.875
	--	4.00	--	--	--	17,320	0.398	54,480	1.251


20
15
10
5
0
17600
13200
8800
4400
0
0.00
1.00
2.00
3.00
4.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

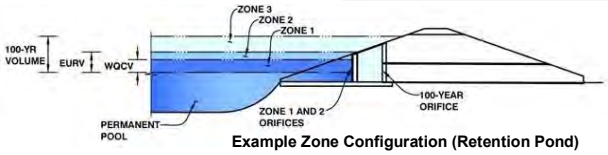

0.400
0.300
0.200
0.100
0.000
1.260
0.945
0.630
0.315
0.000
0.00
1.00
2.00
3.00
4.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-A3**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.08	0.017	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.017	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.875E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.08	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.99	sq. inches (diameter = 1-1/8 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	0.99	0.99	0.99	0.99	0.99			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.19	feet
Spillway Crest Length =	13.00	feet	Stage at Top of Freeboard =	4.19	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.40	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.25	acre-ft

Calculated Parameters for Spillway

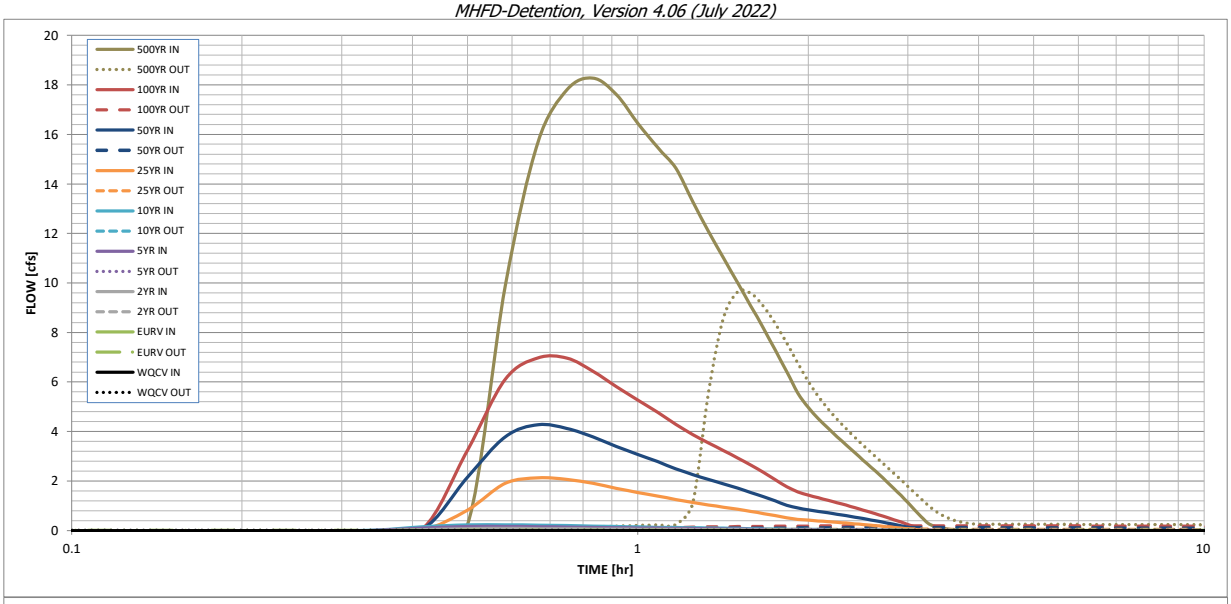
Routed Hydrograph Results

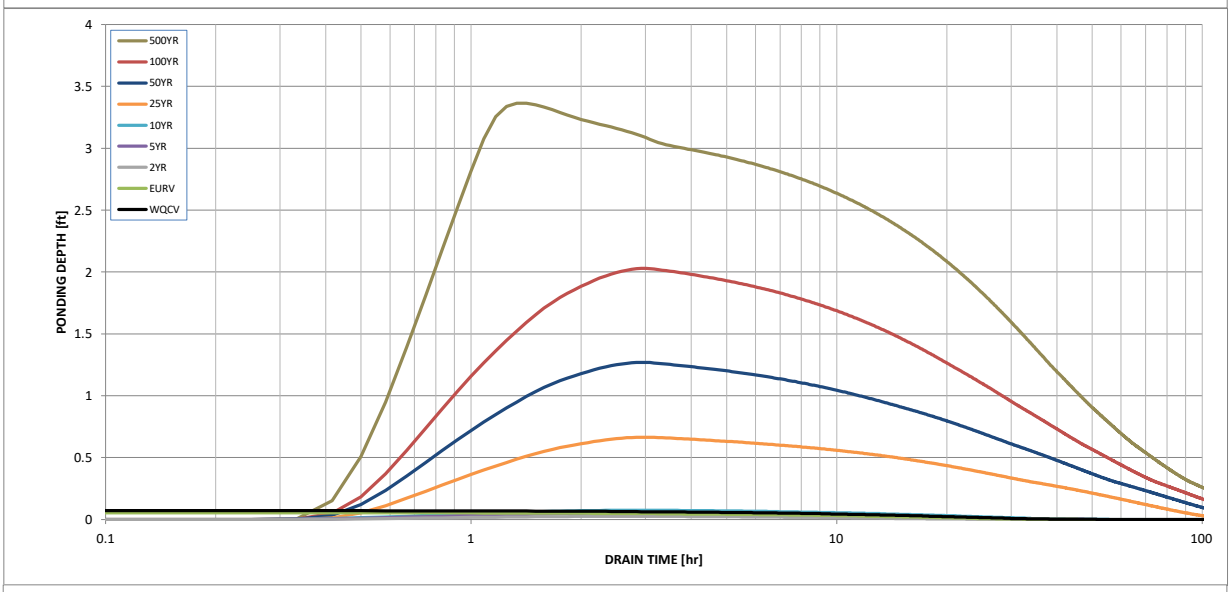
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

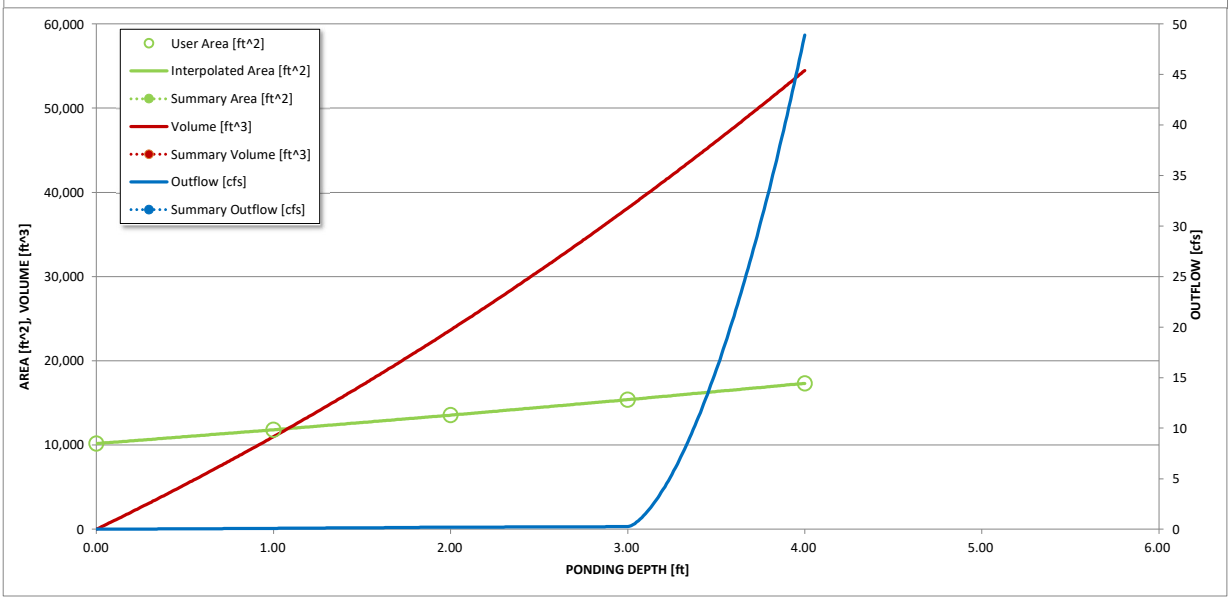
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.017	0.013	0.007	0.014	0.019	0.172	0.346	0.585	1.715
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.007	0.014	0.019	0.172	0.346	0.585	1.715
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.2	0.2	2.1	4.3	7.0	18.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.16	0.31	0.51	1.33
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.2	0.2	2.1	4.3	7.0	18.3
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	9.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.5
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	42	39	34	40	45	104	117	>120	108
Time to Drain 99% of Inflow Volume (hours) =	**52**	48	44	49	54	115	>120	>120	>120
Maximum Ponding Depth (ft) =	0.08	0.06	0.03	0.05	0.08	0.66	1.27	2.03	3.36
Area at Maximum Ponding Depth (acres) =	0.24	0.24	0.23	0.24	0.24	0.26	0.28	0.31	0.37
Maximum Volume Stored (acre-ft) =	0.019	0.014	0.005	0.012	0.016	0.162	0.324	0.550	1.005

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.04	0.10	0.15	0.03	0.06	0.07	0.24
	0:30:00	0.00	0.00	0.08	0.16	0.22	0.83	2.15	3.24	9.88
	0:35:00	0.00	0.00	0.08	0.17	0.23	1.90	3.79	6.11	15.71
	0:40:00	0.00	0.00	0.08	0.16	0.22	2.13	4.28	6.98	17.80
	0:45:00	0.00	0.00	0.07	0.14	0.20	2.06	4.12	6.96	18.27
	0:50:00	0.00	0.00	0.07	0.13	0.18	1.90	3.78	6.43	17.61
	0:55:00	0.00	0.00	0.06	0.12	0.16	1.71	3.40	5.81	16.44
	1:00:00	0.00	0.00	0.05	0.10	0.15	1.54	3.07	5.27	15.47
	1:05:00	0.00	0.00	0.05	0.09	0.13	1.40	2.78	4.78	14.63
	1:10:00	0.00	0.00	0.05	0.09	0.12	1.26	2.50	4.29	13.28
	1:15:00	0.00	0.00	0.04	0.08	0.11	1.13	2.26	3.88	12.08
	1:20:00	0.00	0.00	0.04	0.07	0.11	1.03	2.06	3.54	11.01
	1:25:00	0.00	0.00	0.04	0.07	0.10	0.95	1.89	3.23	10.01
	1:30:00	0.00	0.00	0.03	0.06	0.09	0.86	1.71	2.94	9.07
	1:35:00	0.00	0.00	0.03	0.05	0.08	0.77	1.54	2.64	8.17
	1:40:00	0.00	0.00	0.03	0.05	0.07	0.69	1.37	2.35	7.28
	1:45:00	0.00	0.00	0.02	0.04	0.06	0.60	1.19	2.06	6.41
	1:50:00	0.00	0.00	0.02	0.04	0.05	0.52	1.02	1.77	5.55
	1:55:00	0.00	0.00	0.02	0.03	0.05	0.45	0.91	1.56	4.97
	2:00:00	0.00	0.00	0.02	0.03	0.05	0.42	0.84	1.43	4.53
	2:05:00	0.00	0.00	0.02	0.03	0.04	0.39	0.78	1.32	4.14
	2:10:00	0.00	0.00	0.01	0.03	0.04	0.36	0.72	1.22	3.79
	2:15:00	0.00	0.00	0.01	0.02	0.04	0.33	0.66	1.12	3.46
	2:20:00	0.00	0.00	0.01	0.02	0.03	0.30	0.60	1.03	3.15
	2:25:00	0.00	0.00	0.01	0.02	0.03	0.27	0.54	0.93	2.84
	2:30:00	0.00	0.00	0.01	0.02	0.03	0.24	0.48	0.83	2.56
	2:35:00	0.00	0.00	0.01	0.01	0.02	0.21	0.43	0.73	2.27
	2:40:00	0.00	0.00	0.01	0.01	0.02	0.19	0.37	0.63	1.98
	2:45:00	0.00	0.00	0.01	0.01	0.01	0.16	0.31	0.54	1.70
	2:50:00	0.00	0.00	0.00	0.01	0.01	0.13	0.25	0.44	1.41
	2:55:00	0.00	0.00	0.00	0.01	0.01	0.10	0.20	0.34	1.13
	3:00:00	0.00	0.00	0.00	0.00	0.01	0.07	0.14	0.25	0.84
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.15	0.56
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.06	0.31
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.18
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

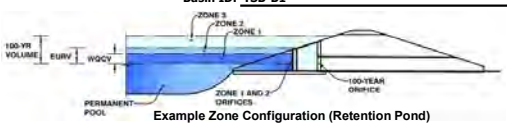
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-B1**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	14.03	acres
Watershed Length =	1,247	ft
Watershed Length to Centroid =	624	ft
Watershed Slope =	0.032	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.018	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.013	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.007	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.014	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.020	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.176	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.354	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.598	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.753	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.007	acre-feet		
Approximate 5-yr Detention Volume =	0.010	acre-feet		
Approximate 10-yr Detention Volume =	0.015	acre-feet		
Approximate 25-yr Detention Volume =	0.022	acre-feet		
Approximate 50-yr Detention Volume =	0.055	acre-feet		
Approximate 100-yr Detention Volume =	0.152	acre-feet		

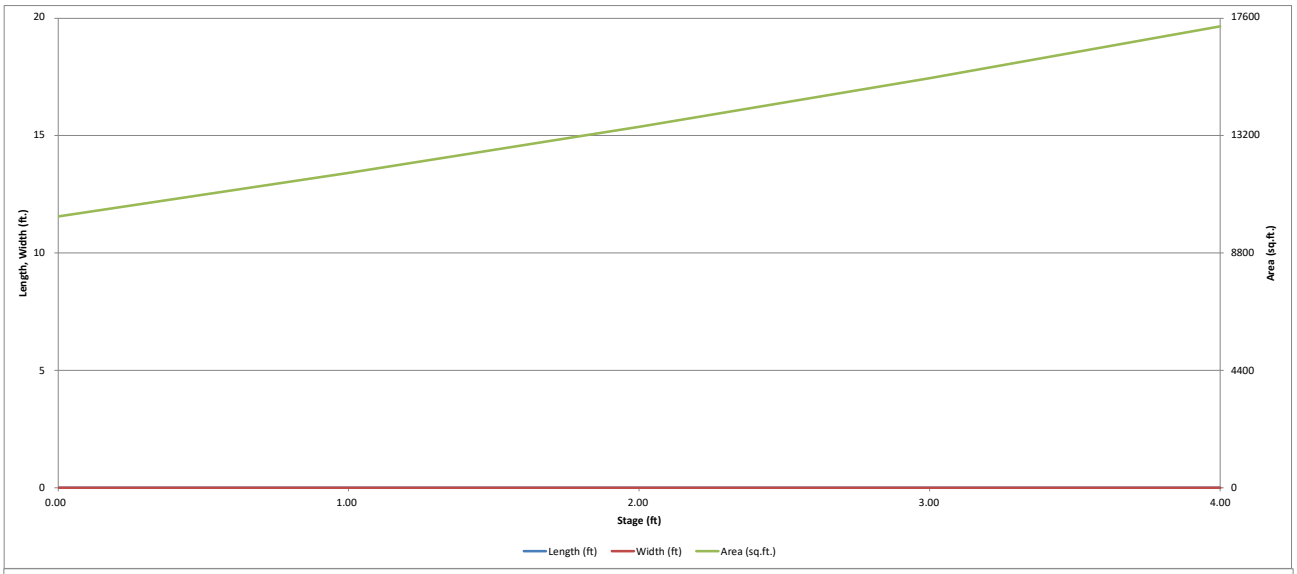
Define Zones and Basin Geometry

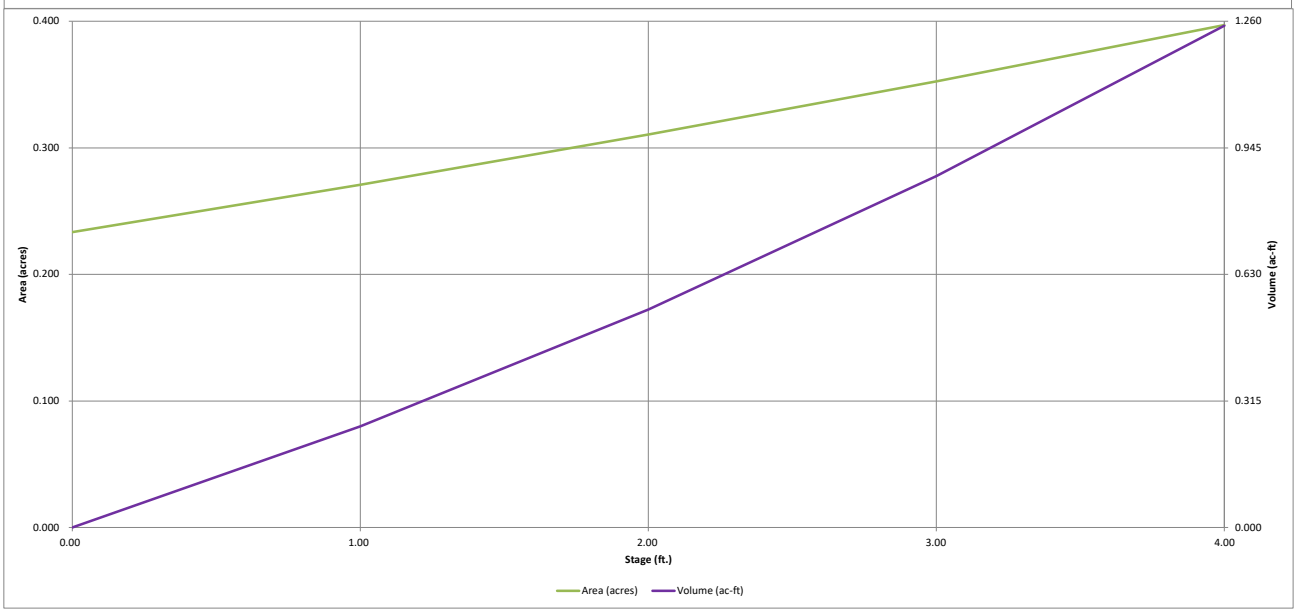
Zone 1 Volume (WQCV) =	0.018	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.018	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10,172	0.234		
	--	1.00	--	--	--	11,801	0.271	10,986	0.252
	--	2.00	--	--	--	13,529	0.311	23,651	0.543
	--	3.00	--	--	--	15,357	0.353	38,094	0.875
	--	4.00	--	--	--	17,293	0.397	54,419	1.249


20
15
10
5
0
17600
13200
8800
4400
0
0.00
1.00
2.00
3.00
4.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

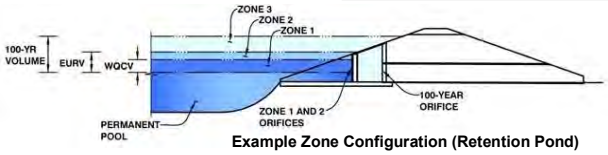

0.400
0.300
0.200
0.100
0.000
1.260
0.945
0.630
0.315
0.000
0.00
1.00
2.00
3.00
4.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-B1**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.08	0.018	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.018	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.875E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.08	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.99	sq. inches (diameter = 1-1/8 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	0.99	0.99	0.99	0.99	0.99			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.20	feet
Spillway Crest Length =	21.00	feet	Stage at Top of Freeboard =	4.20	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.40	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.25	acre-ft

Calculated Parameters for Spillway

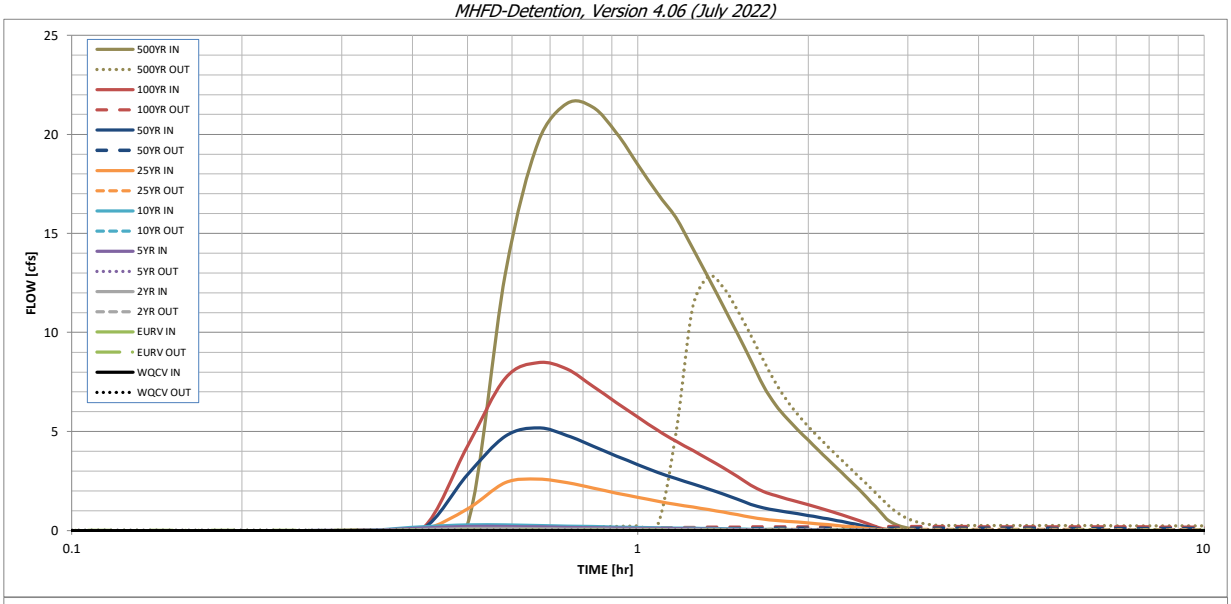
Routed Hydrograph Results

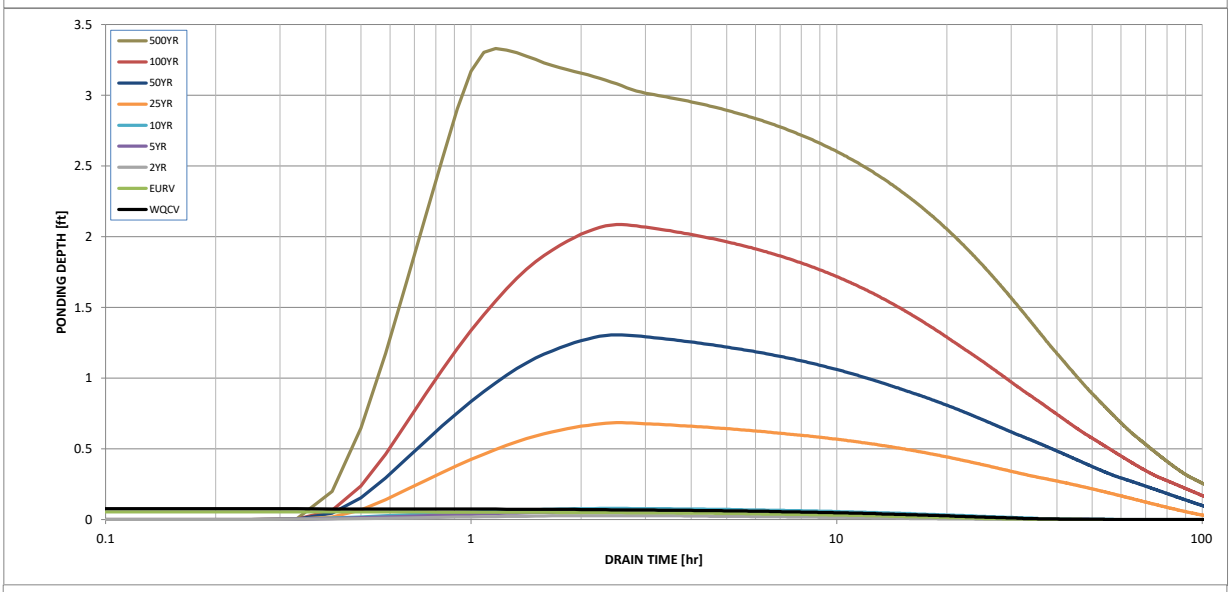
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

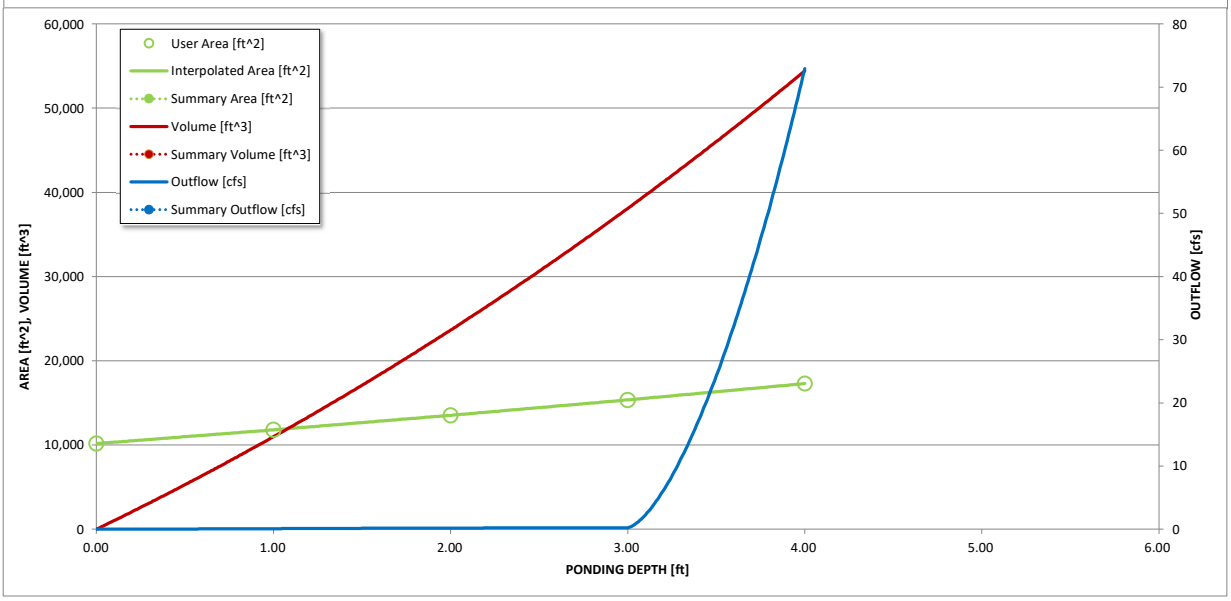
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.018	0.013	0.007	0.014	0.020	0.176	0.354	0.598	1.753
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.007	0.014	0.020	0.176	0.354	0.598	1.753
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.2	0.3	2.6	5.2	8.5	21.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.18	0.37	0.60	1.54
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.2	0.3	2.6	5.2	8.5	21.6
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	12.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	43	39	34	40	45	105	118	>120	106
Time to Drain 99% of Inflow Volume (hours) =	**52**	48	44	50	55	116	>120	>120	>120
Maximum Ponding Depth (ft) =	0.08	0.06	0.03	0.05	0.08	0.68	1.31	2.09	3.33
Area at Maximum Ponding Depth (acres) =	0.24	0.24	0.23	0.24	0.24	0.26	0.28	0.31	0.37
Maximum Volume Stored (acre-ft) =	0.019	0.014	0.005	0.012	0.016	0.167	0.335	0.568	0.993

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.05	0.13	0.19	0.03	0.07	0.10	0.32
	0:30:00	0.00	0.00	0.10	0.20	0.28	1.09	2.82	4.25	12.95
	0:35:00	0.00	0.00	0.10	0.20	0.28	2.42	4.75	7.69	19.61
	0:40:00	0.00	0.00	0.09	0.18	0.25	2.59	5.18	8.47	21.57
	0:45:00	0.00	0.00	0.08	0.16	0.22	2.41	4.79	8.15	21.36
	0:50:00	0.00	0.00	0.07	0.14	0.20	2.15	4.26	7.28	20.08
	0:55:00	0.00	0.00	0.07	0.12	0.17	1.89	3.76	6.46	18.47
	1:00:00	0.00	0.00	0.06	0.11	0.15	1.67	3.33	5.72	17.01
	1:05:00	0.00	0.00	0.05	0.10	0.14	1.48	2.94	5.06	15.80
	1:10:00	0.00	0.00	0.05	0.09	0.13	1.31	2.62	4.52	14.24
	1:15:00	0.00	0.00	0.04	0.08	0.12	1.18	2.35	4.05	12.75
	1:20:00	0.00	0.00	0.04	0.07	0.10	1.05	2.09	3.60	11.31
	1:25:00	0.00	0.00	0.03	0.06	0.09	0.92	1.83	3.16	9.93
	1:30:00	0.00	0.00	0.03	0.05	0.08	0.80	1.58	2.72	8.60
	1:35:00	0.00	0.00	0.02	0.05	0.07	0.67	1.32	2.29	7.29
	1:40:00	0.00	0.00	0.02	0.04	0.06	0.57	1.14	1.97	6.35
	1:45:00	0.00	0.00	0.02	0.04	0.06	0.51	1.02	1.76	5.67
	1:50:00	0.00	0.00	0.02	0.03	0.05	0.47	0.93	1.60	5.08
	1:55:00	0.00	0.00	0.02	0.03	0.05	0.43	0.85	1.45	4.56
	2:00:00	0.00	0.00	0.02	0.03	0.04	0.38	0.76	1.30	4.07
	2:05:00	0.00	0.00	0.01	0.02	0.04	0.34	0.67	1.15	3.59
	2:10:00	0.00	0.00	0.01	0.02	0.03	0.30	0.59	1.01	3.14
	2:15:00	0.00	0.00	0.01	0.02	0.02	0.25	0.50	0.86	2.71
	2:20:00	0.00	0.00	0.01	0.01	0.02	0.21	0.41	0.72	2.29
	2:25:00	0.00	0.00	0.01	0.01	0.01	0.17	0.33	0.57	1.86
	2:30:00	0.00	0.00	0.00	0.01	0.01	0.13	0.24	0.43	1.44
	2:35:00	0.00	0.00	0.00	0.00	0.01	0.08	0.16	0.28	1.02
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.04	0.07	0.14	0.60
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.34
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.21
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

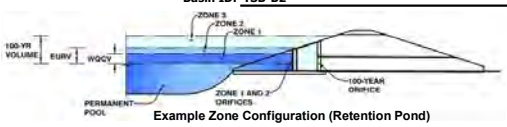
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-B2**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	14.48	acres
Watershed Length =	1,305	ft
Watershed Length to Centroid =	653	ft
Watershed Slope =	0.028	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.018	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.014	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.007	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.014	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.021	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.182	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.365	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.617	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.809	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.008	acre-feet		
Approximate 5-yr Detention Volume =	0.011	acre-feet		
Approximate 10-yr Detention Volume =	0.015	acre-feet		
Approximate 25-yr Detention Volume =	0.023	acre-feet		
Approximate 50-yr Detention Volume =	0.057	acre-feet		
Approximate 100-yr Detention Volume =	0.156	acre-feet		

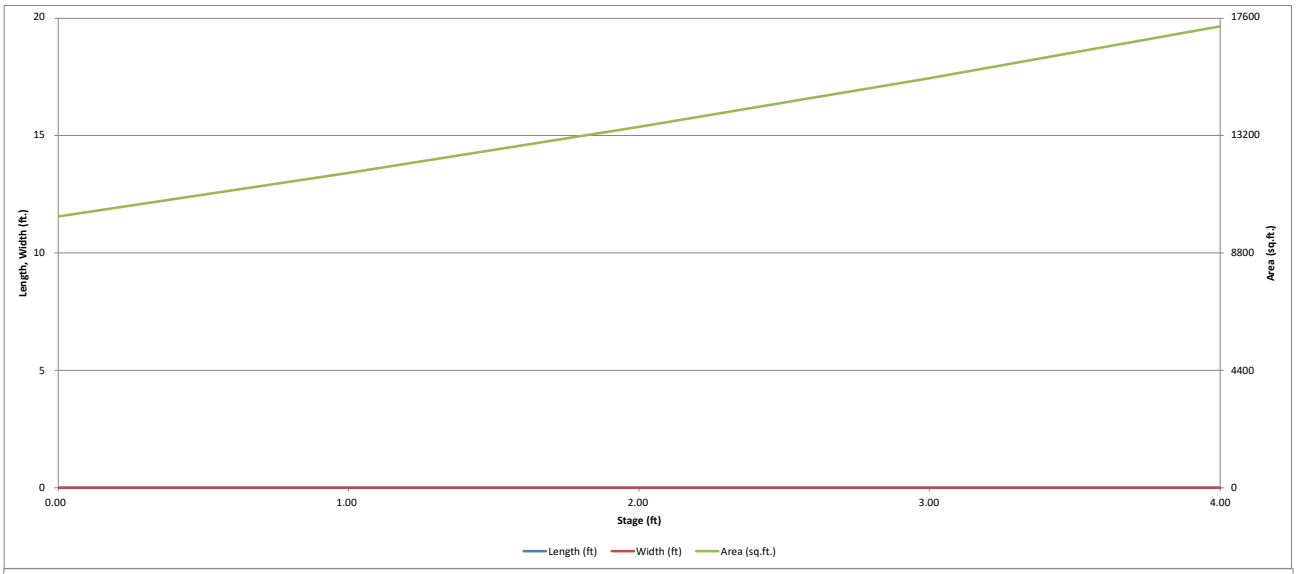
Define Zones and Basin Geometry

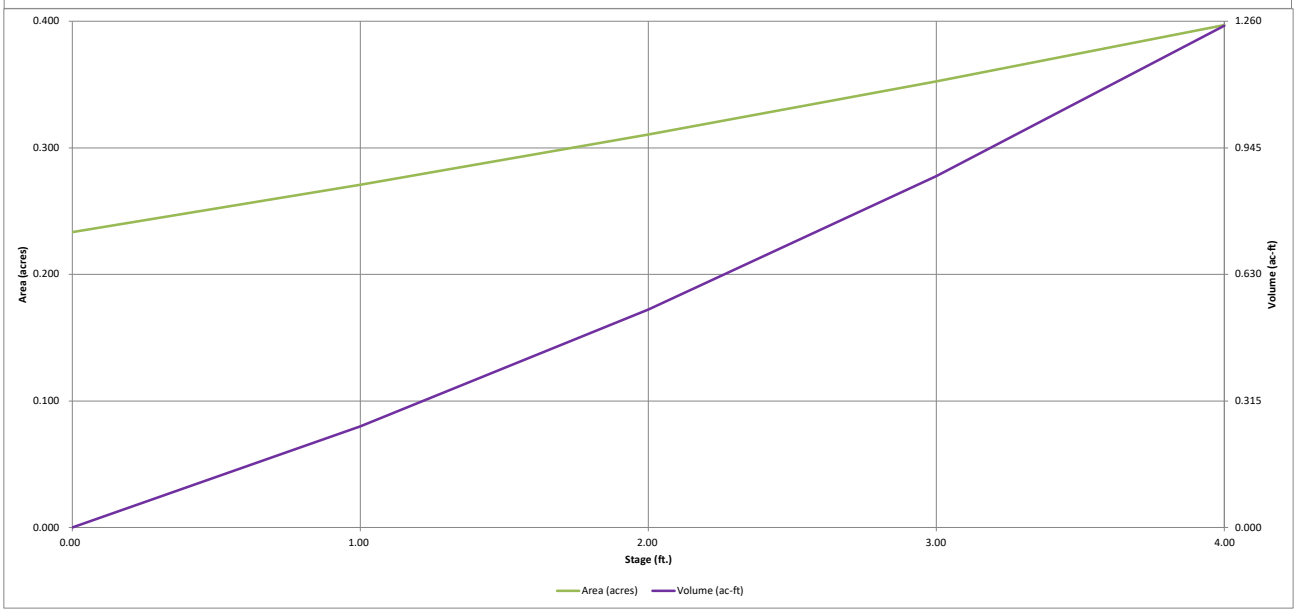
Zone 1 Volume (WQCV) =	0.018	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.018	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10,172	0.234		
	--	1.00	--	--	--	11,801	0.271	10,986	0.252
	--	2.00	--	--	--	13,529	0.311	23,651	0.543
	--	3.00	--	--	--	15,357	0.353	38,094	0.875
	--	4.00	--	--	--	17,293	0.397	54,419	1.249


20
15
10
5
0
17600
13200
8800
4400
0
0.00
1.00
2.00
3.00
4.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

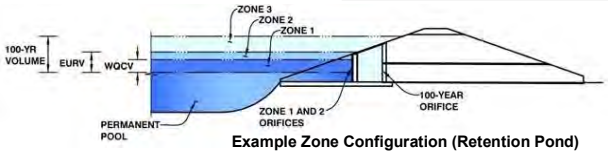

0.400
0.300
0.200
0.100
0.000
1.260
0.945
0.630
0.315
0.000
0.00
1.00
2.00
3.00
4.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-B2**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.08	0.018	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.018	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.875E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.08	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.99	sq. inches (diameter = 1-1/8 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	0.99	0.99	0.99	0.99	0.99			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected			Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =			feet
Overflow Weir Front Edge Length =			feet	Overflow Weir Slope Length =			feet
Overflow Weir Grate Slope =			H:V	Grate Open Area / 100-yr Orifice Area =			
Horiz. Length of Weir Sides =			feet	Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Type =				Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

Calculated Parameters for Overflow Weir

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.18	feet
Spillway Crest Length =	8.00	feet	Stage at Top of Freeboard =	4.18	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.40	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.25	acre-ft

Calculated Parameters for Spillway

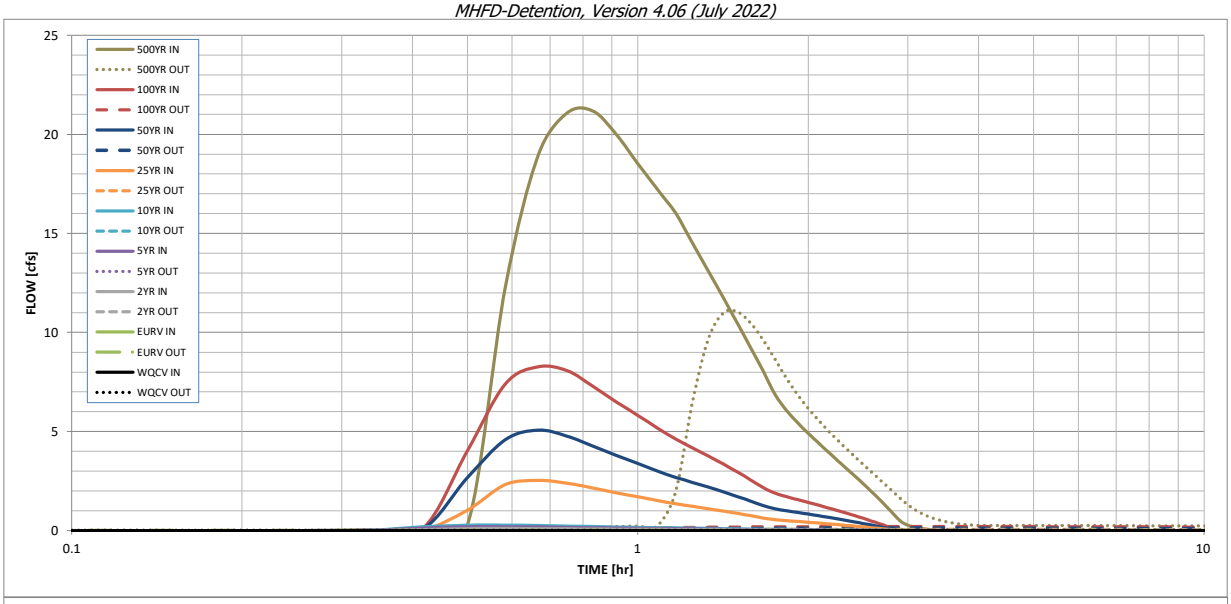
Routed Hydrograph Results

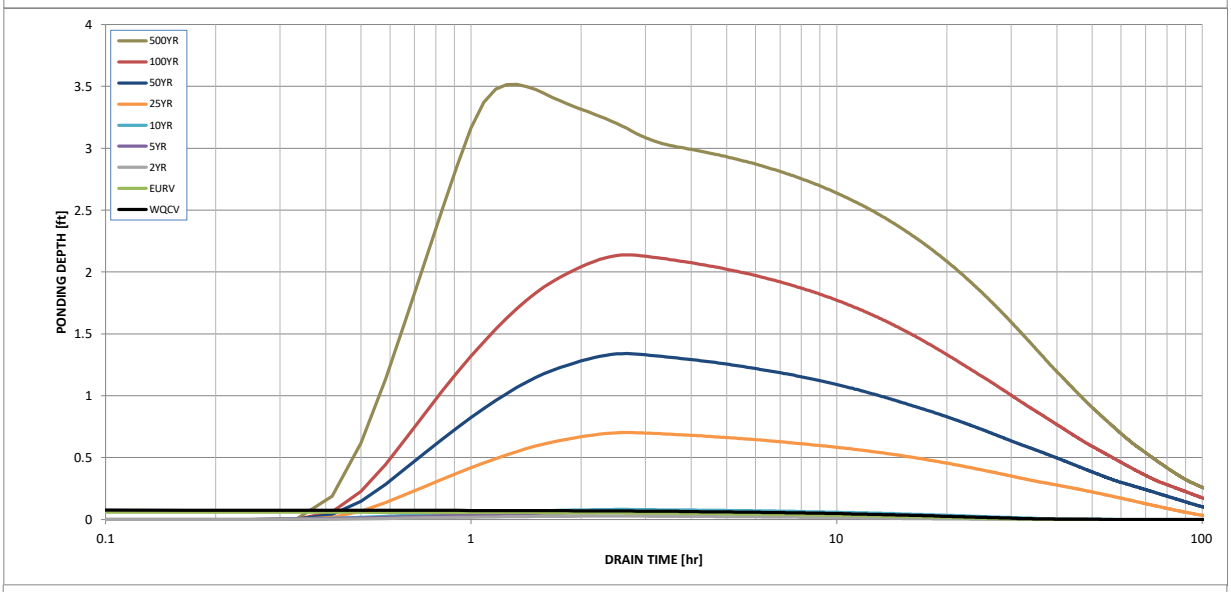
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

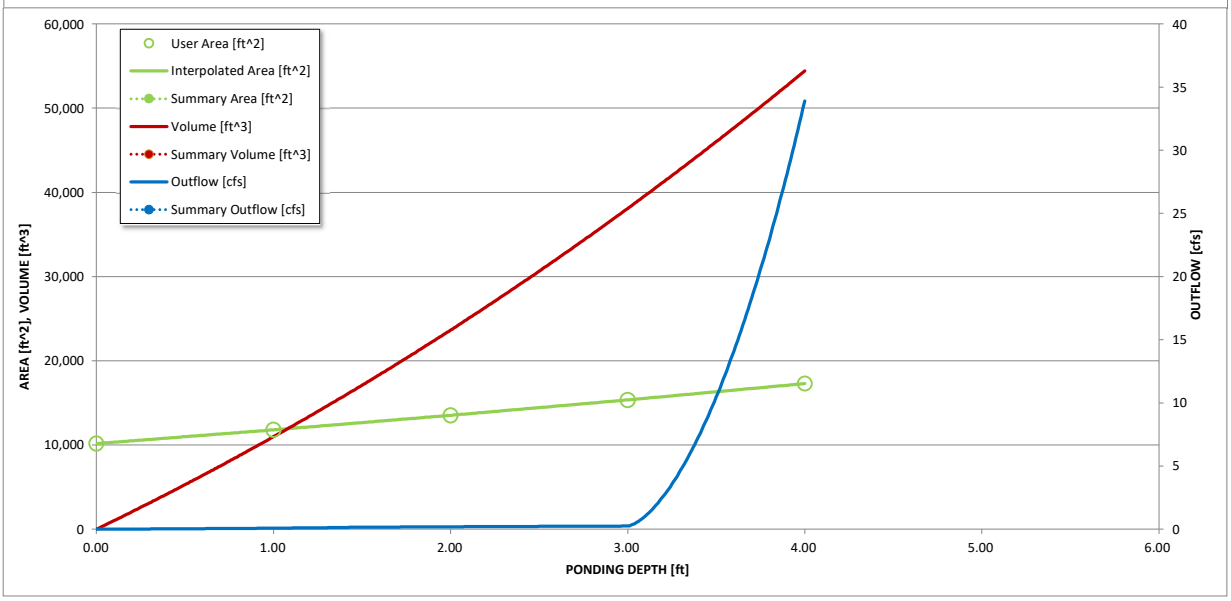
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.018	0.014	0.007	0.014	0.021	0.182	0.365	0.617	1.809
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.007	0.014	0.021	0.182	0.365	0.617	1.809
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.2	0.3	2.5	5.1	8.3	21.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.17	0.35	0.57	1.46
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.2	0.3	2.5	5.1	8.3	21.2
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	11.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.5
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	43	40	34	41	46	106	118	>120	106
Time to Drain 99% of Inflow Volume (hours) =	**52**	49	44	50	55	117	>120	>120	>120
Maximum Ponding Depth (ft) =	0.08	0.06	0.03	0.06	0.08	0.70	1.34	2.14	3.52
Area at Maximum Ponding Depth (acres) =	0.24	0.24	0.23	0.24	0.24	0.26	0.28	0.32	0.38
Maximum Volume Stored (acre-ft) =	0.019	0.014	0.005	0.012	0.019	0.173	0.347	0.584	1.060

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.05	0.12	0.18	0.03	0.07	0.09	0.30
	0:30:00	0.00	0.00	0.10	0.20	0.27	1.03	2.67	4.03	12.27
	0:35:00	0.00	0.00	0.10	0.20	0.27	2.32	4.58	7.40	18.94
	0:40:00	0.00	0.00	0.09	0.18	0.25	2.53	5.06	8.27	21.08
	0:45:00	0.00	0.00	0.08	0.16	0.22	2.39	4.76	8.07	21.18
	0:50:00	0.00	0.00	0.07	0.14	0.20	2.15	4.26	7.27	19.99
	0:55:00	0.00	0.00	0.07	0.13	0.18	1.90	3.79	6.49	18.52
	1:00:00	0.00	0.00	0.06	0.11	0.16	1.70	3.38	5.81	17.21
	1:05:00	0.00	0.00	0.05	0.10	0.14	1.51	3.00	5.17	16.01
	1:10:00	0.00	0.00	0.05	0.09	0.13	1.35	2.68	4.62	14.48
	1:15:00	0.00	0.00	0.04	0.08	0.12	1.22	2.42	4.17	13.08
	1:20:00	0.00	0.00	0.04	0.08	0.11	1.10	2.18	3.75	11.73
	1:25:00	0.00	0.00	0.04	0.07	0.10	0.98	1.95	3.35	10.45
	1:30:00	0.00	0.00	0.03	0.06	0.08	0.86	1.71	2.95	9.22
	1:35:00	0.00	0.00	0.03	0.05	0.07	0.75	1.48	2.55	8.02
	1:40:00	0.00	0.00	0.02	0.04	0.06	0.63	1.25	2.16	6.84
	1:45:00	0.00	0.00	0.02	0.04	0.06	0.55	1.09	1.88	6.04
	1:50:00	0.00	0.00	0.02	0.04	0.05	0.50	0.99	1.70	5.43
	1:55:00	0.00	0.00	0.02	0.03	0.05	0.46	0.91	1.55	4.91
	2:00:00	0.00	0.00	0.02	0.03	0.05	0.42	0.83	1.42	4.43
	2:05:00	0.00	0.00	0.02	0.03	0.04	0.38	0.75	1.28	3.98
	2:10:00	0.00	0.00	0.01	0.02	0.04	0.34	0.67	1.15	3.56
	2:15:00	0.00	0.00	0.01	0.02	0.03	0.30	0.59	1.01	3.14
	2:20:00	0.00	0.00	0.01	0.02	0.03	0.26	0.51	0.88	2.76
	2:25:00	0.00	0.00	0.01	0.01	0.02	0.22	0.43	0.75	2.37
	2:30:00	0.00	0.00	0.01	0.01	0.02	0.18	0.36	0.62	1.98
	2:35:00	0.00	0.00	0.00	0.01	0.01	0.14	0.28	0.49	1.59
	2:40:00	0.00	0.00	0.00	0.01	0.01	0.10	0.20	0.35	1.21
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.06	0.12	0.22	0.82
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.10	0.45
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.27
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.17
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.10
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

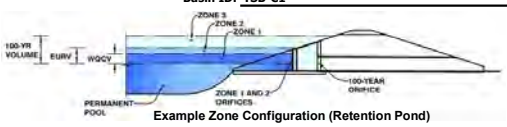
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-C1**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	11.26	acres
Watershed Length =	1,405	ft
Watershed Length to Centroid =	703	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.014	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.011	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.006	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.011	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.016	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.141	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.284	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.480	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.408	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.006	acre-feet		
Approximate 5-yr Detention Volume =	0.008	acre-feet		
Approximate 10-yr Detention Volume =	0.012	acre-feet		
Approximate 25-yr Detention Volume =	0.018	acre-feet		
Approximate 50-yr Detention Volume =	0.044	acre-feet		
Approximate 100-yr Detention Volume =	0.122	acre-feet		

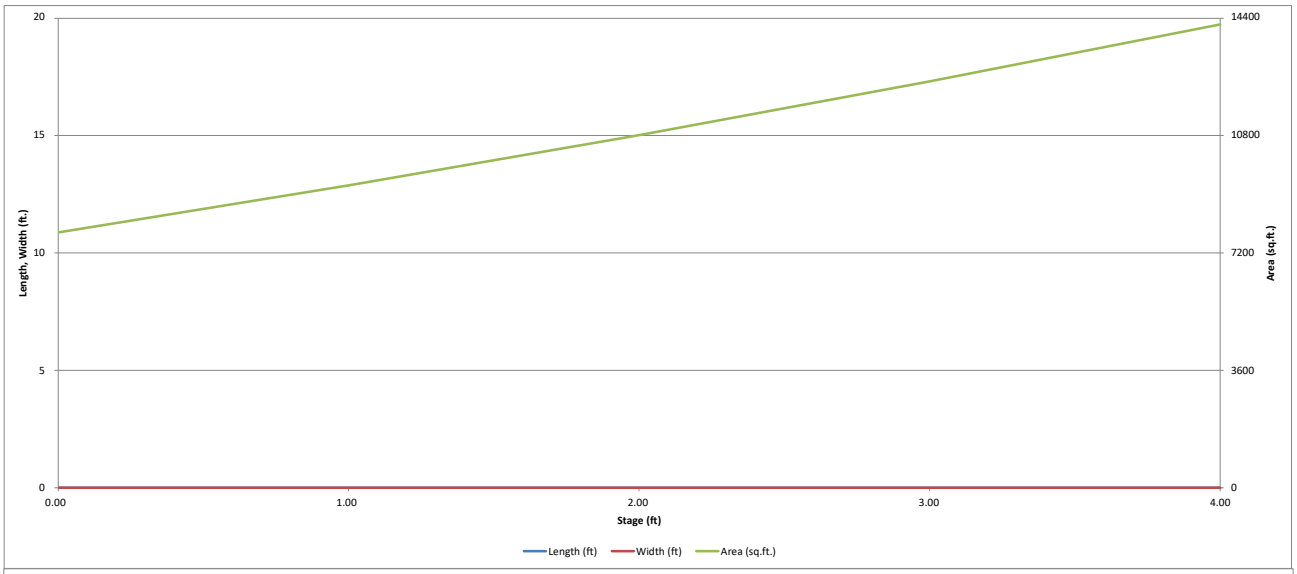
Define Zones and Basin Geometry

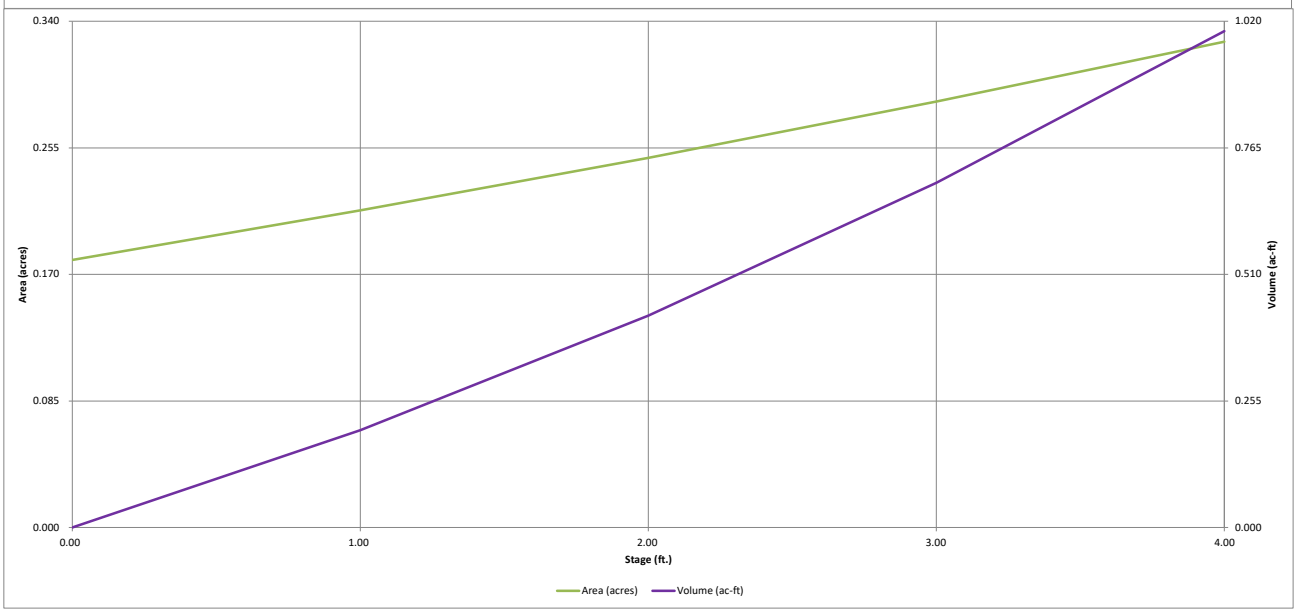
Zone 1 Volume (WQCV) =	0.014	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.014	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	7,834	0.180		
	--	1.00	--	--	--	9,277	0.213	8,555	0.196
	--	2.00	--	--	--	10,819	0.248	18,603	0.427
	--	3.00	--	--	--	12,467	0.286	30,246	0.694
	--	4.00	--	--	--	14,216	0.326	43,588	1.001


20
15
10
5
0
14400
10800
7200
3600
0
0.00
1.00
2.00
3.00
4.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

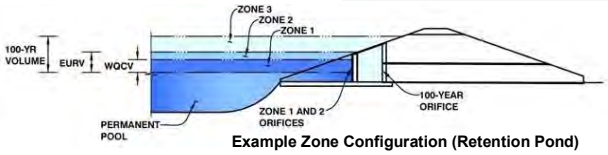

0.340
0.255
0.170
0.085
0.000
1.020
0.765
0.510
0.255
0.000
0.00
1.00
2.00
3.00
4.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-C1**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.08	0.014	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.014	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.727E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.08	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.97	sq. inches (diameter = 1-1/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	0.97	0.97	0.97	0.97	0.97			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected			Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =			feet
Overflow Weir Front Edge Length =			feet	Overflow Weir Slope Length =			feet
Overflow Weir Grate Slope =			H:V	Grate Open Area / 100-yr Orifice Area =			
Horiz. Length of Weir Sides =			feet	Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Type =				Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

Calculated Parameters for Overflow Weir

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.17	feet
Spillway Crest Length =	11.00	feet	Stage at Top of Freeboard =	4.17	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.33	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.00	acre-ft

Calculated Parameters for Spillway

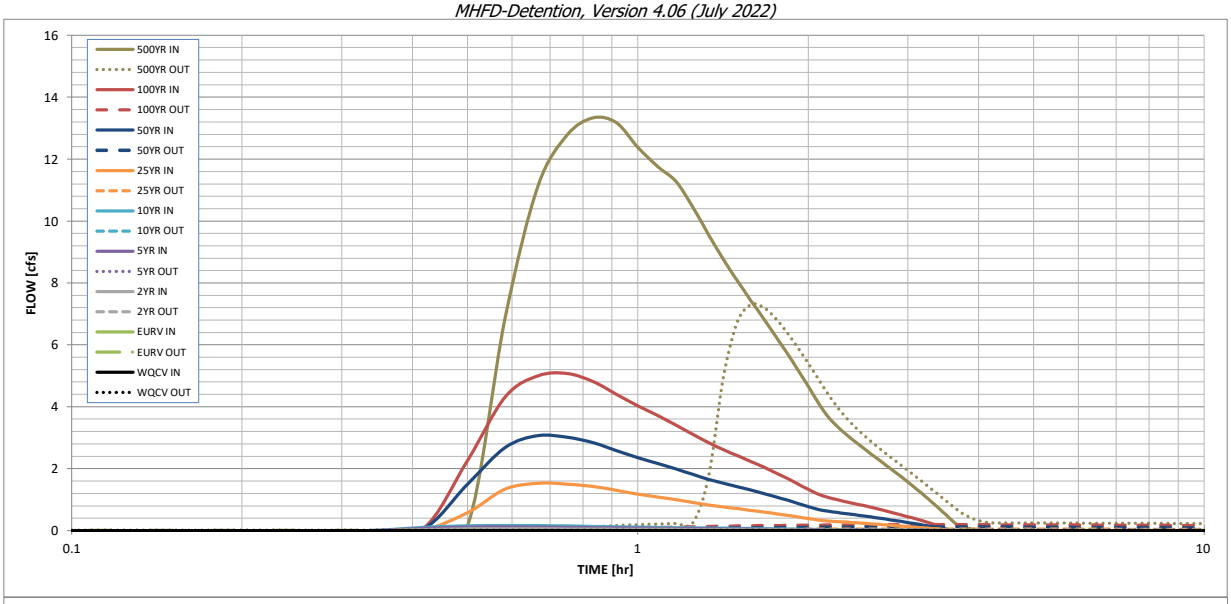
Routed Hydrograph Results

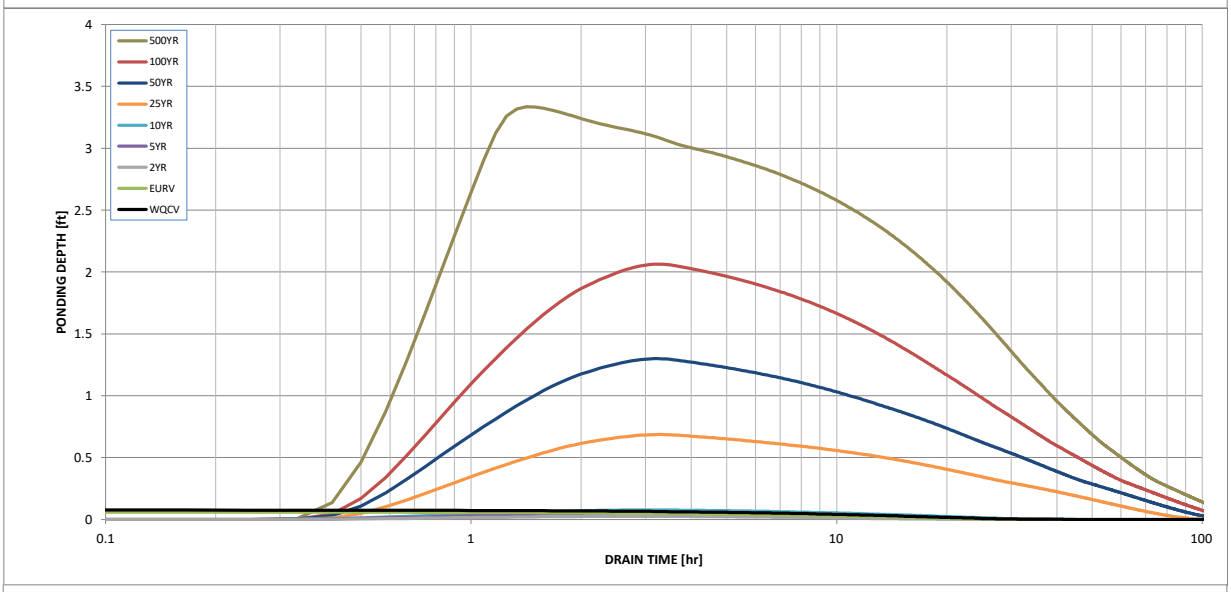
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

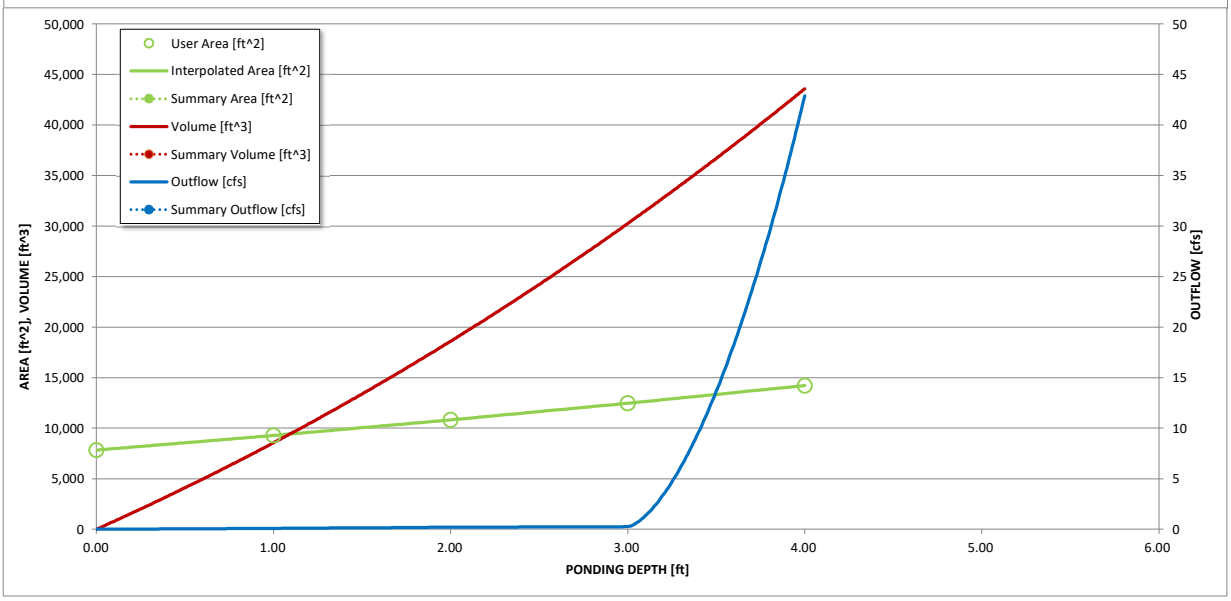
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.014	0.011	0.006	0.011	0.016	0.141	0.284	0.480	1.408
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.006	0.011	0.016	0.141	0.284	0.480	1.408
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.1	0.2	1.5	3.1	5.1	13.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.01	0.14	0.27	0.45	1.18
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.1	0.2	1.5	3.1	5.1	13.3
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	7.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.1	0.0	0.0	0.0	0.5
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	34	31	27	32	37	84	94	99	86
Time to Drain 99% of Inflow Volume (hours) =	**41**	39	35	40	44	93	106	115	113
Maximum Ponding Depth (ft) =	0.08	0.07	0.03	0.05	0.08	0.69	1.30	2.06	3.34
Area at Maximum Ponding Depth (acres) =	0.18	0.18	0.18	0.18	0.18	0.20	0.22	0.25	0.30
Maximum Volume Stored (acre-ft) =	0.014	0.013	0.004	0.009	0.013	0.130	0.260	0.442	0.791

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.03	0.07	0.10	0.02	0.04	0.05	0.17
	0:30:00	0.00	0.00	0.06	0.12	0.16	0.58	1.50	2.26	6.89
	0:35:00	0.00	0.00	0.06	0.12	0.17	1.34	2.68	4.32	11.15
	0:40:00	0.00	0.00	0.06	0.11	0.16	1.53	3.07	5.00	12.78
	0:45:00	0.00	0.00	0.06	0.11	0.15	1.50	3.01	5.08	13.33
	0:50:00	0.00	0.00	0.05	0.10	0.14	1.42	2.84	4.82	13.17
	0:55:00	0.00	0.00	0.05	0.09	0.12	1.30	2.58	4.40	12.38
	1:00:00	0.00	0.00	0.04	0.08	0.12	1.18	2.36	4.03	11.76
	1:05:00	0.00	0.00	0.04	0.08	0.11	1.09	2.17	3.72	11.29
	1:10:00	0.00	0.00	0.04	0.07	0.10	1.00	1.99	3.41	10.45
	1:15:00	0.00	0.00	0.03	0.06	0.09	0.91	1.82	3.11	9.56
	1:20:00	0.00	0.00	0.03	0.06	0.09	0.83	1.66	2.84	8.75
	1:25:00	0.00	0.00	0.03	0.06	0.08	0.76	1.53	2.61	8.06
	1:30:00	0.00	0.00	0.03	0.05	0.07	0.71	1.42	2.42	7.43
	1:35:00	0.00	0.00	0.02	0.05	0.07	0.66	1.31	2.24	6.85
	1:40:00	0.00	0.00	0.02	0.04	0.06	0.60	1.20	2.05	6.29
	1:45:00	0.00	0.00	0.02	0.04	0.06	0.55	1.09	1.87	5.74
	1:50:00	0.00	0.00	0.02	0.03	0.05	0.50	0.99	1.69	5.20
	1:55:00	0.00	0.00	0.02	0.03	0.04	0.44	0.88	1.51	4.66
	2:00:00	0.00	0.00	0.01	0.03	0.04	0.39	0.77	1.33	4.14
	2:05:00	0.00	0.00	0.01	0.03	0.04	0.34	0.68	1.18	3.68
	2:10:00	0.00	0.00	0.01	0.02	0.03	0.31	0.63	1.07	3.37
	2:15:00	0.00	0.00	0.01	0.02	0.03	0.29	0.59	1.00	3.11
	2:20:00	0.00	0.00	0.01	0.02	0.03	0.27	0.55	0.93	2.88
	2:25:00	0.00	0.00	0.01	0.02	0.03	0.26	0.51	0.87	2.67
	2:30:00	0.00	0.00	0.01	0.02	0.03	0.24	0.48	0.81	2.47
	2:35:00	0.00	0.00	0.01	0.02	0.02	0.22	0.44	0.75	2.28
	2:40:00	0.00	0.00	0.01	0.01	0.02	0.20	0.40	0.69	2.10
	2:45:00	0.00	0.00	0.01	0.01	0.02	0.19	0.37	0.63	1.92
	2:50:00	0.00	0.00	0.01	0.01	0.02	0.17	0.33	0.57	1.75
	2:55:00	0.00	0.00	0.01	0.01	0.02	0.15	0.30	0.51	1.57
	3:00:00	0.00	0.00	0.00	0.01	0.01	0.13	0.26	0.45	1.39
	3:05:00	0.00	0.00	0.00	0.01	0.01	0.11	0.23	0.39	1.22
	3:10:00	0.00	0.00	0.00	0.01	0.01	0.10	0.19	0.33	1.04
	3:15:00	0.00	0.00	0.00	0.00	0.01	0.08	0.15	0.27	0.86
	3:20:00	0.00	0.00	0.00	0.00	0.01	0.06	0.12	0.21	0.69
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.15	0.51
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.09	0.34
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.04	0.19
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

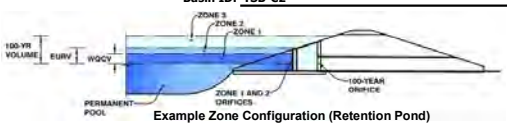
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-C2**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	11.92	acres
Watershed Length =	1,201	ft
Watershed Length to Centroid =	601	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.015	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.011	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.006	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.012	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.017	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.150	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.301	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.508	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.489	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.006	acre-feet		
Approximate 5-yr Detention Volume =	0.009	acre-feet		
Approximate 10-yr Detention Volume =	0.013	acre-feet		
Approximate 25-yr Detention Volume =	0.019	acre-feet		
Approximate 50-yr Detention Volume =	0.047	acre-feet		
Approximate 100-yr Detention Volume =	0.129	acre-feet		

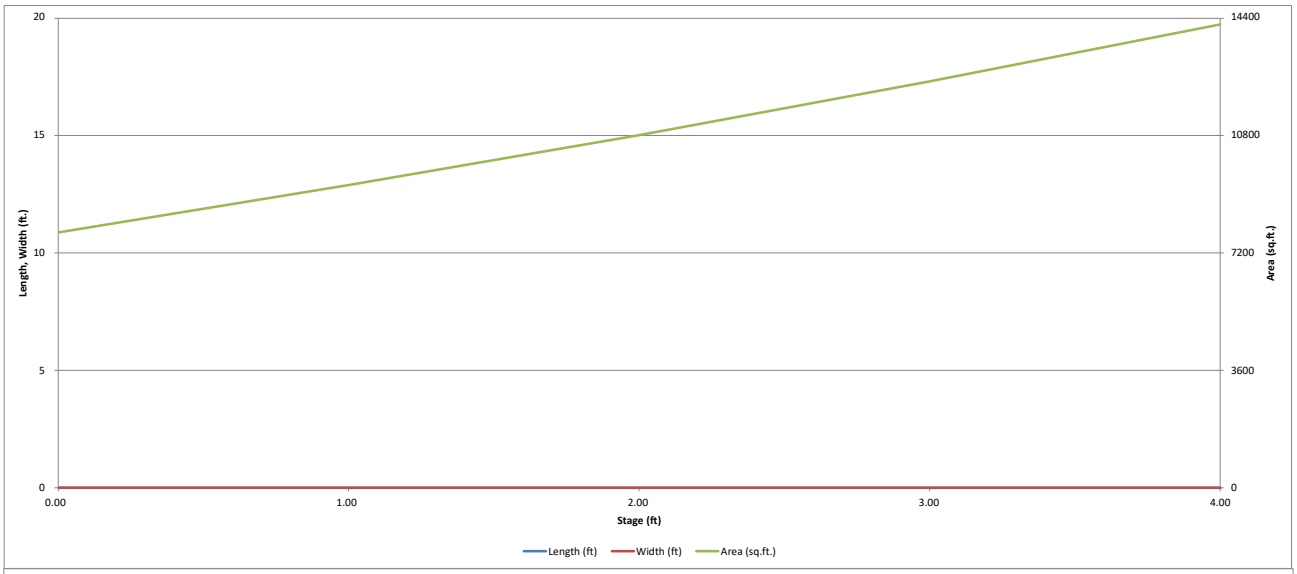
Define Zones and Basin Geometry

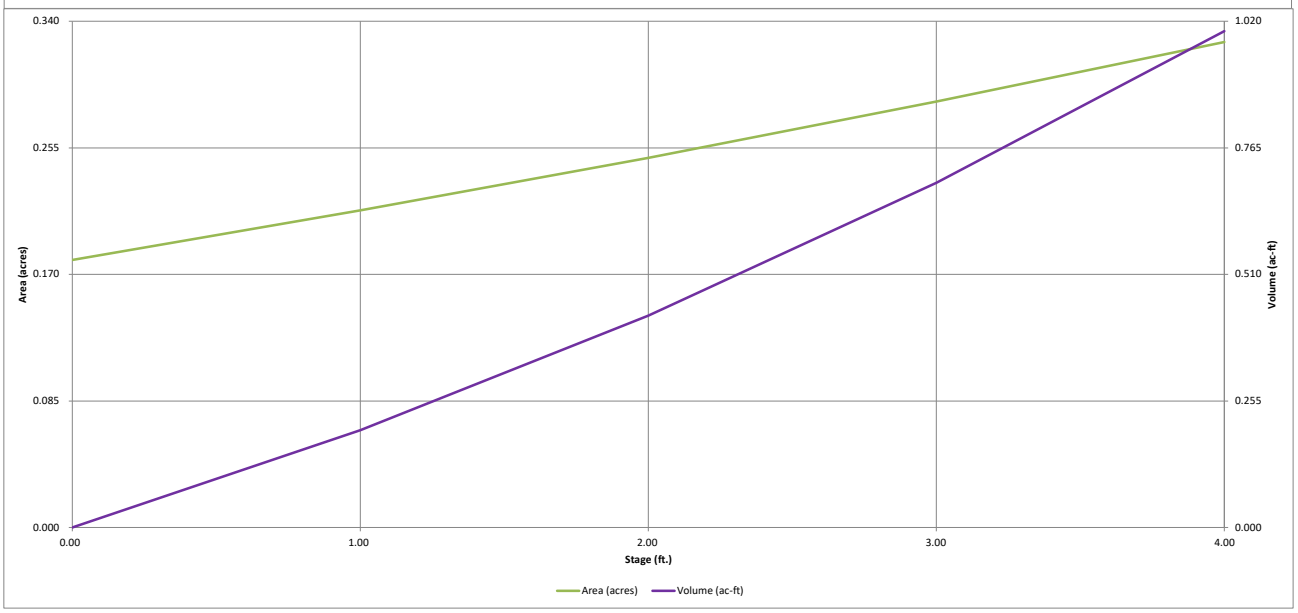
Zone 1 Volume (WQCV) =	0.015	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.015	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	7,834	0.180		
	--	1.00	--	--	--	9,282	0.213	8,558	0.196
	--	2.00	--	--	--	10,819	0.248	18,608	0.427
	--	3.00	--	--	--	12,460	0.286	30,248	0.694
	--	4.00	--	--	--	14,209	0.326	43,582	1.001


20
15
10
5
0
14400
10800
7200
3600
0
0.00
1.00
2.00
3.00
4.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

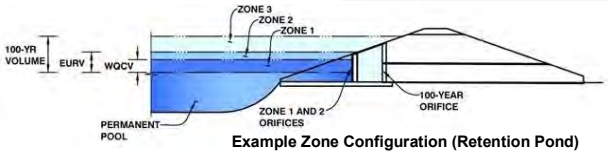

0.340
0.255
0.170
0.085
0.000
1.020
0.765
0.510
0.255
0.000
0.00
1.00
2.00
3.00
4.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-C2**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.09	0.015	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.015	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.486E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.11	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.79	sq. inches (diameter = 1 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	0.79	0.79	0.79	0.79	0.79			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.24	feet
Spillway Crest Length =	24.00	feet	Stage at Top of Freeboard =	4.24	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.33	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.00	acre-ft

Calculated Parameters for Spillway

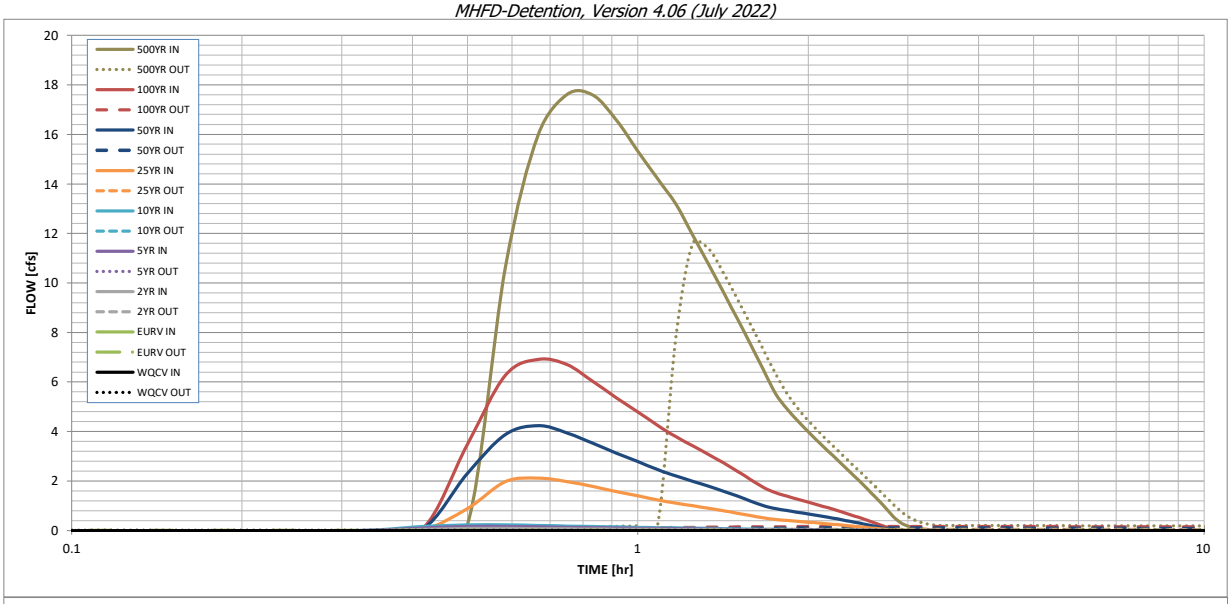
Routed Hydrograph Results

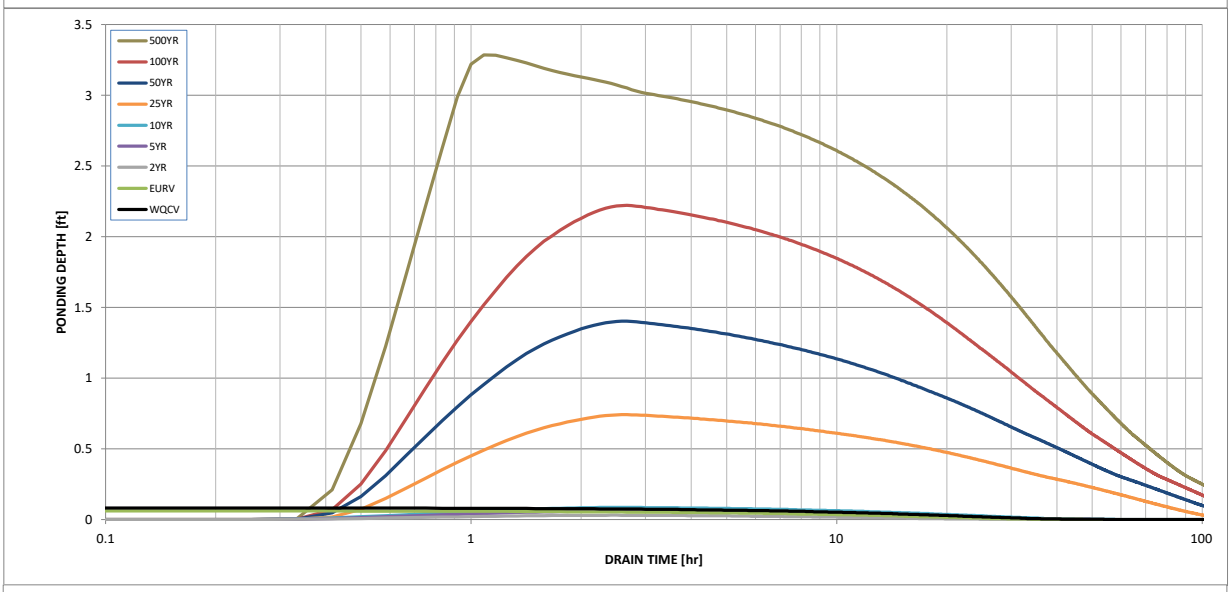
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

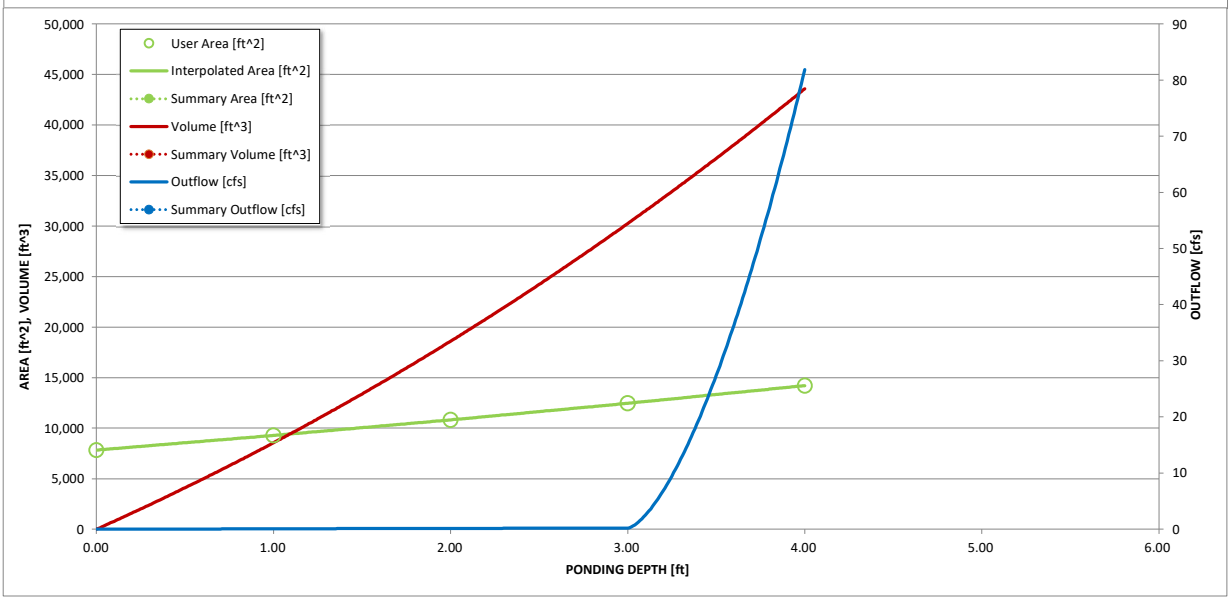
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.015	0.011	0.006	0.012	0.017	0.150	0.301	0.508	1.489
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.006	0.012	0.017	0.150	0.301	0.508	1.489
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.2	0.2	2.1	4.2	6.9	17.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.18	0.35	0.58	1.48
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.2	0.2	2.1	4.2	6.9	17.6
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	11.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	43	38	34	40	45	104	115	>120	101
Time to Drain 99% of Inflow Volume (hours) =	**52**	48	43	49	54	115	>120	>120	>120
Maximum Ponding Depth (ft) =	0.09	0.07	0.03	0.06	0.09	0.74	1.40	2.22	3.29
Area at Maximum Ponding Depth (acres) =	0.18	0.18	0.18	0.18	0.18	0.20	0.23	0.26	0.30
Maximum Volume Stored (acre-ft) =	0.016	0.013	0.004	0.009	0.014	0.142	0.285	0.483	0.776

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.04	0.11	0.16	0.03	0.06	0.08	0.26
	0:30:00	0.00	0.00	0.08	0.17	0.23	0.89	2.31	3.48	10.61
	0:35:00	0.00	0.00	0.08	0.16	0.23	1.97	3.87	6.27	15.98
	0:40:00	0.00	0.00	0.08	0.15	0.21	2.11	4.23	6.91	17.61
	0:45:00	0.00	0.00	0.07	0.13	0.18	1.98	3.94	6.70	17.58
	0:50:00	0.00	0.00	0.06	0.12	0.16	1.78	3.52	6.02	16.57
	0:55:00	0.00	0.00	0.05	0.10	0.15	1.57	3.13	5.36	15.32
	1:00:00	0.00	0.00	0.05	0.09	0.13	1.40	2.79	4.79	14.21
	1:05:00	0.00	0.00	0.04	0.08	0.12	1.24	2.46	4.25	13.19
	1:10:00	0.00	0.00	0.04	0.08	0.11	1.10	2.20	3.79	11.92
	1:15:00	0.00	0.00	0.04	0.07	0.10	1.00	1.99	3.42	10.76
	1:20:00	0.00	0.00	0.03	0.06	0.09	0.90	1.79	3.07	9.62
	1:25:00	0.00	0.00	0.03	0.05	0.08	0.80	1.59	2.73	8.54
	1:30:00	0.00	0.00	0.02	0.05	0.07	0.70	1.39	2.39	7.50
	1:35:00	0.00	0.00	0.02	0.04	0.06	0.60	1.19	2.06	6.48
	1:40:00	0.00	0.00	0.02	0.04	0.05	0.51	1.01	1.74	5.55
	1:45:00	0.00	0.00	0.02	0.03	0.05	0.44	0.89	1.53	4.92
	1:50:00	0.00	0.00	0.02	0.03	0.04	0.41	0.81	1.39	4.42
	1:55:00	0.00	0.00	0.02	0.03	0.04	0.37	0.74	1.27	3.99
	2:00:00	0.00	0.00	0.01	0.03	0.04	0.34	0.67	1.15	3.59
	2:05:00	0.00	0.00	0.01	0.02	0.03	0.30	0.60	1.04	3.22
	2:10:00	0.00	0.00	0.01	0.02	0.03	0.27	0.54	0.92	2.86
	2:15:00	0.00	0.00	0.01	0.02	0.02	0.24	0.47	0.81	2.52
	2:20:00	0.00	0.00	0.01	0.01	0.02	0.20	0.40	0.70	2.19
	2:25:00	0.00	0.00	0.01	0.01	0.02	0.17	0.34	0.58	1.86
	2:30:00	0.00	0.00	0.00	0.01	0.01	0.14	0.27	0.47	1.53
	2:35:00	0.00	0.00	0.00	0.01	0.01	0.11	0.20	0.36	1.20
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.07	0.14	0.25	0.87
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.04	0.07	0.14	0.54
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.31
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.18
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

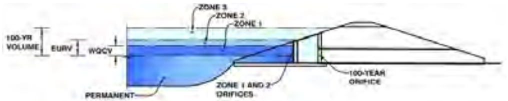
For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**
Basin ID: **TSB-C3**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type = **EDB**
Watershed Area = 15.29 acres
Watershed Length = 1,926 ft
Watershed Length to Centroid = 963 ft
Watershed Slope = 0.026 ft/ft
Watershed Imperviousness = 2.00% percent
Percentage Hydrologic Soil Group A = 100.0% percent
Percentage Hydrologic Soil Group B = 0.0% percent
Percentage Hydrologic Soil Groups C/D = 0.0% percent
Target WQCV Drain Time = 40.0 hours
Location for 1-hr Rainfall Depths = User Input

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.019	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.014	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.008	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.015	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.022	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.192	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.386	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.653	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.913	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.008	acre-feet		
Approximate 5-yr Detention Volume =	0.011	acre-feet		
Approximate 10-yr Detention Volume =	0.016	acre-feet		
Approximate 25-yr Detention Volume =	0.024	acre-feet		
Approximate 50-yr Detention Volume =	0.060	acre-feet		
Approximate 100-yr Detention Volume =	0.165	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) = 0.019 acre-feet
Select Zone 2 Storage Volume (Optional) = acre-feet
Select Zone 3 Storage Volume (Optional) = acre-feet
Total Detention Basin Volume = 0.019 acre-feet

Total detention volume is less than 100-year volume.

Initial Surcharge Volume (ISV) = user ft^3
Initial Surcharge Depth (ISD) = user ft
Total Available Detention Depth (H_{total}) = user ft
Depth of Trickle Channel (H_{TC}) = user ft
Slope of Trickle Channel (S_{TC}) = user ft/ft
Slopes of Main Basin Sides (S_{main}) = user H:V
Basin Length-to-Width Ratio ($R_{L/W}$) = user

Initial Surcharge Area (A_{ISV}) = user ft^2
Surcharge Volume Length (L_{ISV}) = user ft
Surcharge Volume Width (W_{ISV}) = user ft
Depth of Basin Floor (H_{FLOOR}) = user ft
Length of Basin Floor (L_{FLOOR}) = user ft
Width of Basin Floor (W_{FLOOR}) = user ft
Area of Basin Floor (A_{FLOOR}) = user ft^2
Volume of Basin Floor (V_{FLOOR}) = user ft^3
Depth of Main Basin (H_{MAIN}) = user ft
Length of Main Basin (L_{MAIN}) = user ft
Width of Main Basin (W_{MAIN}) = user ft
Area of Main Basin (A_{MAIN}) = user ft^2
Volume of Main Basin (V_{MAIN}) = user ft^3
Calculated Total Basin Volume (V_{total}) = **user** acre-feet

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10,172	0.234		
	--	1.00	--	--	--	11,807	0.271	10,989	0.252
	--	2.00	--	--	--	13,543	0.311	23,664	0.543
	--	3.00	--	--	--	15,380	0.353	38,126	0.875
	--	4.00	--	--	--	17,319	0.398	54,475	1.251
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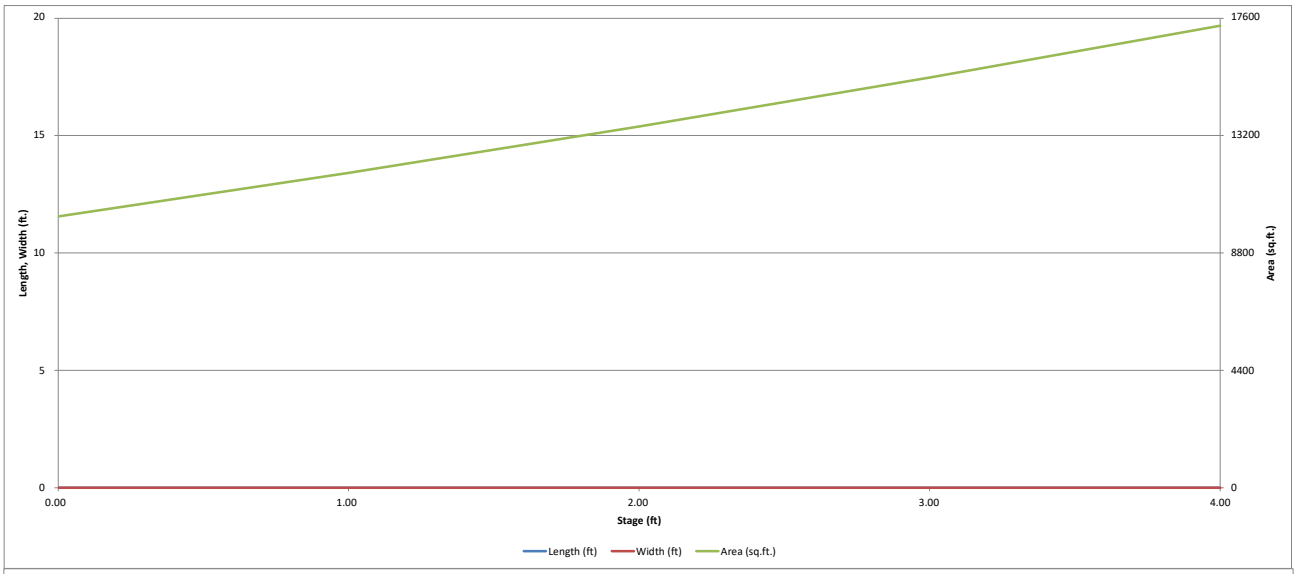
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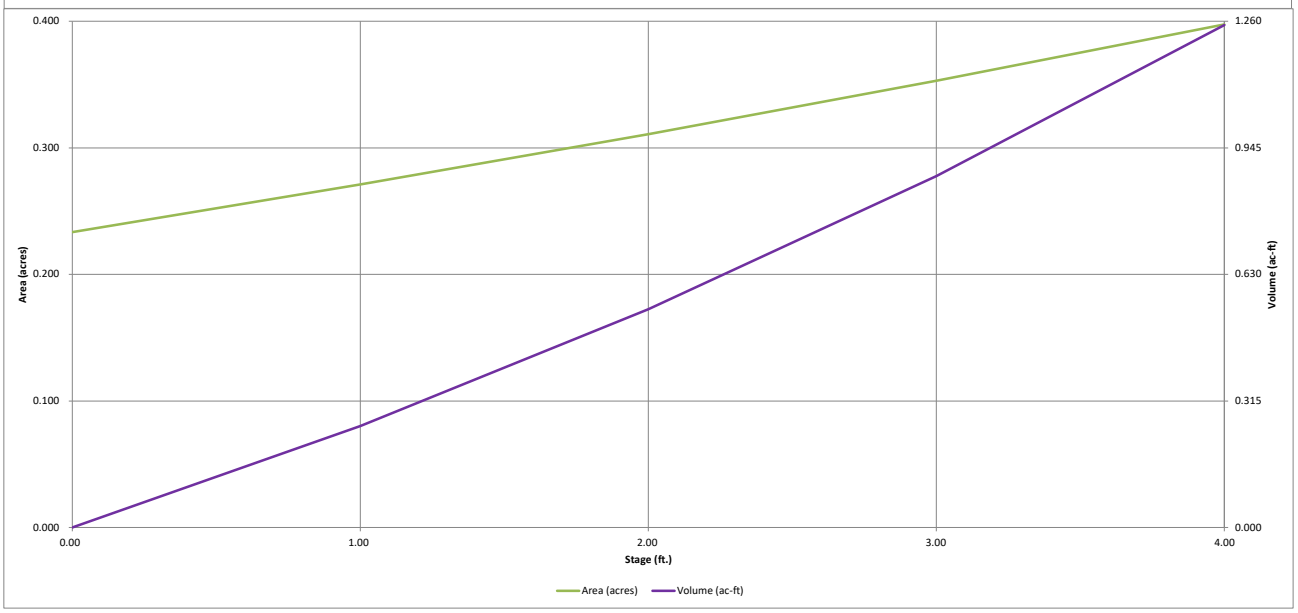
13200
8800
4400
0
0.00
1.00
2.00
3.00
4.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)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1.00
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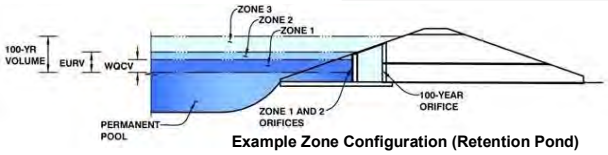
3.00
4.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-C3**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.09	0.019	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.019	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	7.708E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.09	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.11	sq. inches (diameter = 1-3/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	1.11	1.11	1.11	1.11	1.11			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected			Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =			feet
Overflow Weir Front Edge Length =			feet	Overflow Weir Slope Length =			feet
Overflow Weir Grate Slope =			H:V	Grate Open Area / 100-yr Orifice Area =			
Horiz. Length of Weir Sides =			feet	Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Type =				Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

Calculated Parameters for Overflow Weir

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.22	feet
Spillway Crest Length =	26.00	feet	Stage at Top of Freeboard =	4.22	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.40	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.25	acre-ft

Calculated Parameters for Spillway

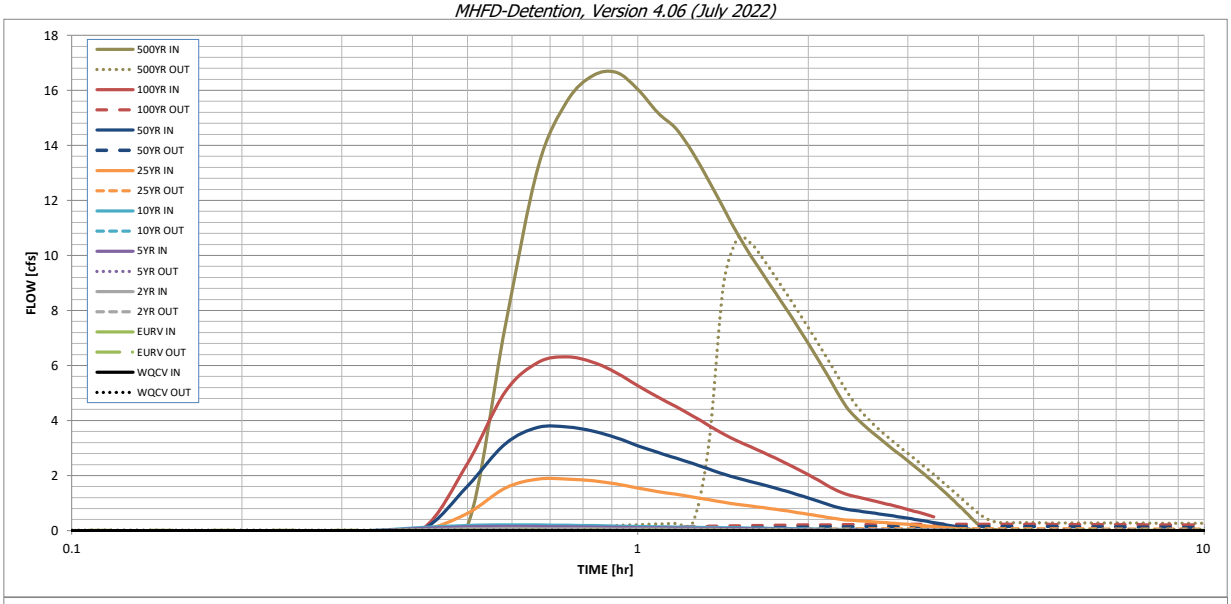
Routed Hydrograph Results

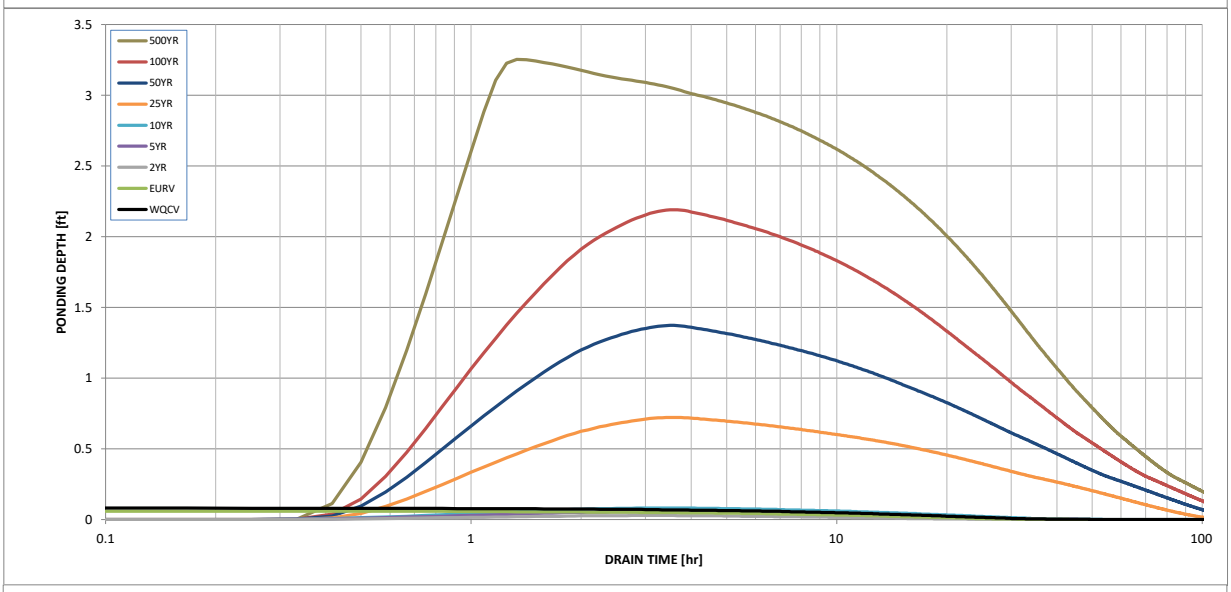
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

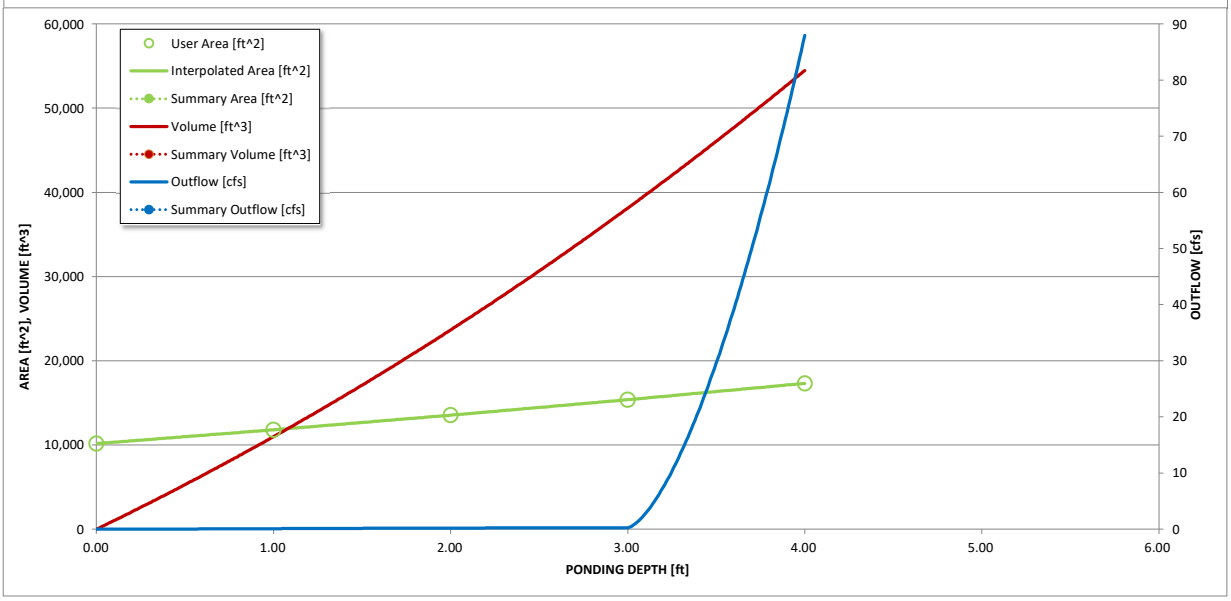
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.019	0.014	0.008	0.015	0.022	0.192	0.386	0.653	1.913
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.008	0.015	0.022	0.192	0.386	0.653	1.913
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.1	0.2	1.9	3.8	6.3	16.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.01	0.12	0.25	0.41	1.09
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.1	0.2	1.9	3.8	6.3	16.7
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	10.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.1	0.0	0.0	0.0	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	35	31	37	42	96	106	112	93
Time to Drain 99% of Inflow Volume (hours) =	**48**	44	40	46	50	106	>120	>120	>120
Maximum Ponding Depth (ft) =	0.09	0.06	0.03	0.06	0.08	0.72	1.37	2.19	3.25
Area at Maximum Ponding Depth (acres) =	0.24	0.24	0.23	0.24	0.24	0.26	0.29	0.32	0.36
Maximum Volume Stored (acre-ft) =	0.021	0.014	0.005	0.012	0.019	0.178	0.355	0.603	0.965

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.03	0.07	0.11	0.02	0.04	0.06	0.18
	0:30:00	0.00	0.00	0.07	0.14	0.19	0.62	1.62	2.44	7.43
	0:35:00	0.00	0.00	0.08	0.15	0.21	1.55	3.15	5.05	13.22
	0:40:00	0.00	0.00	0.07	0.14	0.20	1.87	3.75	6.11	15.60
	0:45:00	0.00	0.00	0.07	0.14	0.19	1.87	3.77	6.31	16.54
	0:50:00	0.00	0.00	0.07	0.13	0.18	1.81	3.62	6.12	16.65
	0:55:00	0.00	0.00	0.06	0.12	0.16	1.69	3.37	5.74	16.04
	1:00:00	0.00	0.00	0.06	0.11	0.15	1.55	3.08	5.27	15.20
	1:05:00	0.00	0.00	0.05	0.10	0.14	1.42	2.84	4.86	14.62
	1:10:00	0.00	0.00	0.05	0.09	0.13	1.32	2.63	4.51	13.73
	1:15:00	0.00	0.00	0.04	0.09	0.12	1.22	2.44	4.16	12.73
	1:20:00	0.00	0.00	0.04	0.08	0.11	1.12	2.24	3.83	11.72
	1:25:00	0.00	0.00	0.04	0.07	0.11	1.03	2.05	3.51	10.78
	1:30:00	0.00	0.00	0.04	0.07	0.10	0.95	1.91	3.26	9.99
	1:35:00	0.00	0.00	0.03	0.07	0.09	0.89	1.78	3.04	9.29
	1:40:00	0.00	0.00	0.03	0.06	0.09	0.83	1.66	2.83	8.65
	1:45:00	0.00	0.00	0.03	0.06	0.08	0.77	1.54	2.63	8.02
	1:50:00	0.00	0.00	0.03	0.05	0.07	0.71	1.42	2.43	7.41
	1:55:00	0.00	0.00	0.03	0.05	0.07	0.66	1.31	2.23	6.81
	2:00:00	0.00	0.00	0.02	0.04	0.06	0.60	1.19	2.03	6.21
	2:05:00	0.00	0.00	0.02	0.04	0.05	0.54	1.07	1.83	5.62
	2:10:00	0.00	0.00	0.02	0.03	0.05	0.48	0.95	1.63	5.04
	2:15:00	0.00	0.00	0.02	0.03	0.05	0.43	0.84	1.45	4.51
	2:20:00	0.00	0.00	0.02	0.03	0.04	0.39	0.78	1.33	4.15
	2:25:00	0.00	0.00	0.01	0.03	0.04	0.37	0.73	1.25	3.86
	2:30:00	0.00	0.00	0.01	0.03	0.04	0.34	0.69	1.17	3.60
	2:35:00	0.00	0.00	0.01	0.02	0.04	0.32	0.65	1.10	3.37
	2:40:00	0.00	0.00	0.01	0.02	0.03	0.30	0.61	1.04	3.15
	2:45:00	0.00	0.00	0.01	0.02	0.03	0.29	0.57	0.97	2.93
	2:50:00	0.00	0.00	0.01	0.02	0.03	0.27	0.53	0.90	2.73
	2:55:00	0.00	0.00	0.01	0.02	0.03	0.25	0.49	0.84	2.53
	3:00:00	0.00	0.00	0.01	0.02	0.02	0.23	0.45	0.77	2.34
	3:05:00	0.00	0.00	0.01	0.01	0.02	0.21	0.41	0.70	2.14
	3:10:00	0.00	0.00	0.01	0.01	0.02	0.19	0.37	0.63	1.95
	3:15:00	0.00	0.00	0.01	0.01	0.02	0.17	0.33	0.57	1.75
	3:20:00	0.00	0.00	0.01	0.01	0.01	0.15	0.29	0.50	1.55
	3:25:00	0.00	0.00	0.00	0.01	0.01	0.13	0.25	0.43	1.36
	3:30:00	0.00	0.00	0.00	0.01	0.01	0.11	0.21	0.37	1.16
	3:35:00	0.00	0.00	0.00	0.01	0.01	0.09	0.17	0.30	0.97
	3:40:00	0.00	0.00	0.00	0.00	0.01	0.07	0.13	0.23	0.77
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.05	0.09	0.17	0.58
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.10	0.38
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.04	0.21
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.13
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.08
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

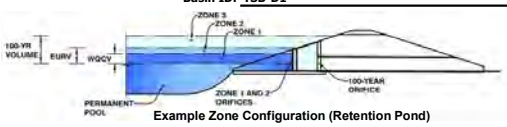
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-D1**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	10.09	acres
Watershed Length =	1,605	ft
Watershed Length to Centroid =	803	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.013	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.009	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.005	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.010	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.014	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.127	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.255	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.431	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.262	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.005	acre-feet		
Approximate 5-yr Detention Volume =	0.008	acre-feet		
Approximate 10-yr Detention Volume =	0.011	acre-feet		
Approximate 25-yr Detention Volume =	0.016	acre-feet		
Approximate 50-yr Detention Volume =	0.040	acre-feet		
Approximate 100-yr Detention Volume =	0.109	acre-feet		

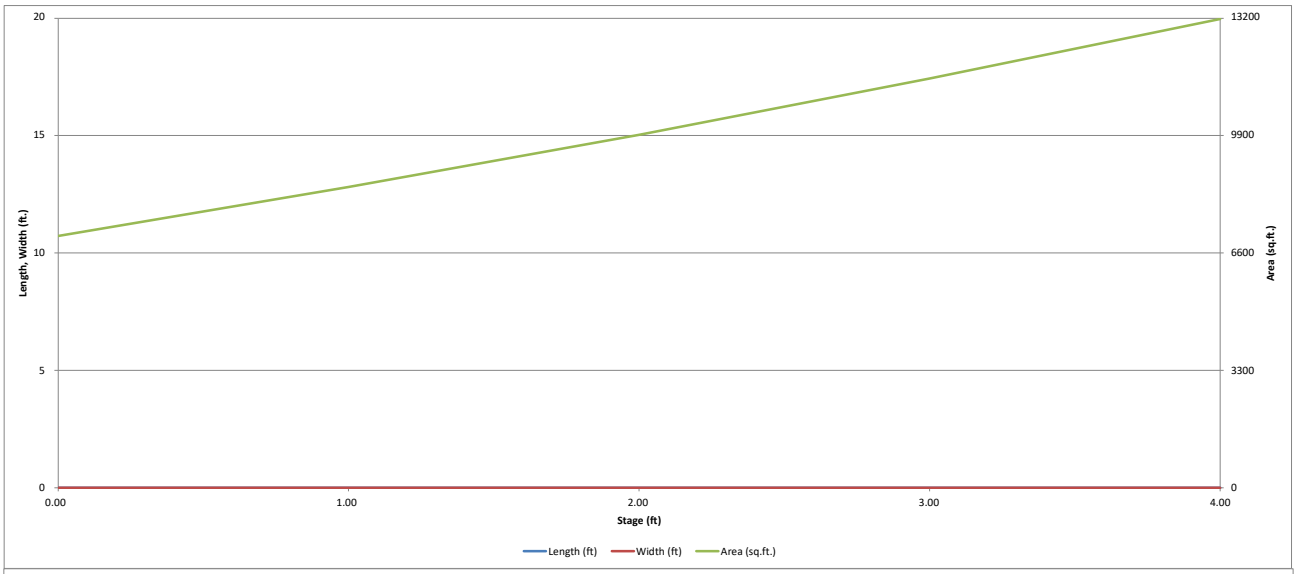
Define Zones and Basin Geometry

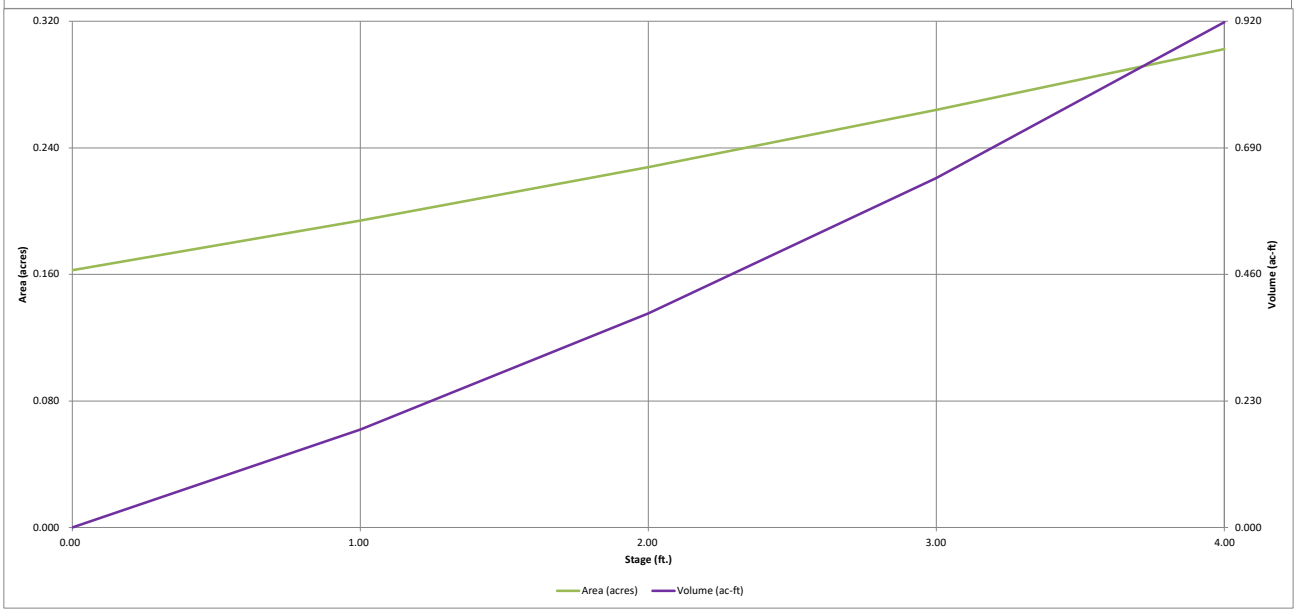
Zone 1 Volume (WQCV) =	0.013	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.013	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	7,084	0.163		
	--	1.00	--	--	--	8,455	0.194	7,769	0.178
	--	2.00	--	--	--	9,924	0.228	16,959	0.389
	--	3.00	--	--	--	11,501	0.264	27,671	0.635
	--	4.00	--	--	--	13,178	0.303	40,011	0.919


20
15
10
5
0
13200
9900
6600
3300
0
0.00
1.00
2.00
3.00
4.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

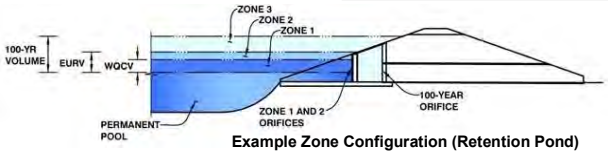

0.320
0.240
0.160
0.080
0.000
0.920
0.690
0.460
0.230
0.000
0.00
1.00
2.00
3.00
4.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-D1**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.08	0.013	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.013	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	4.792E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.08	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.69	sq. inches (diameter = 15/16 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	0.69	0.69	0.69	0.69	0.69			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.17	feet
Spillway Crest Length =	16.00	feet	Stage at Top of Freeboard =	4.17	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.30	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.92	acre-ft

Calculated Parameters for Spillway

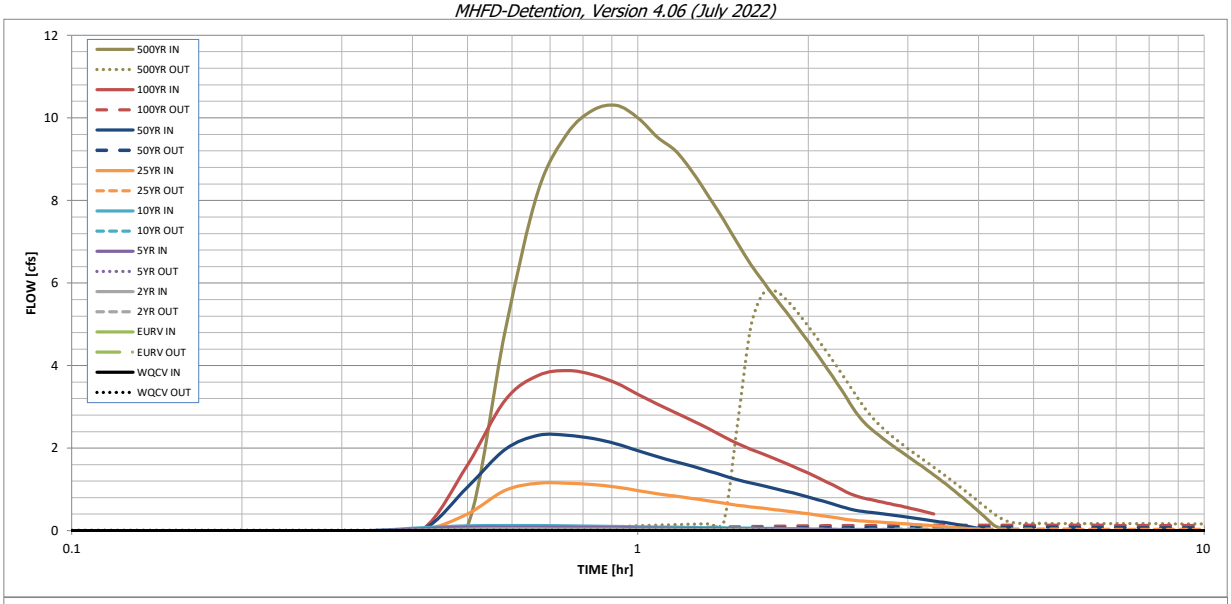
Routed Hydrograph Results

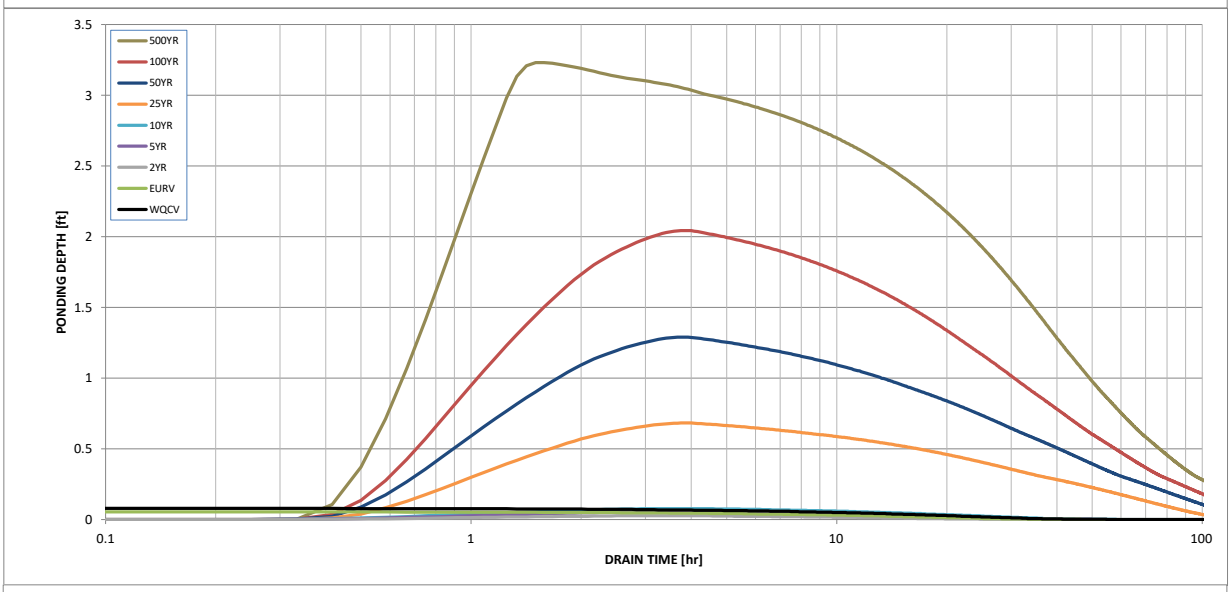
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

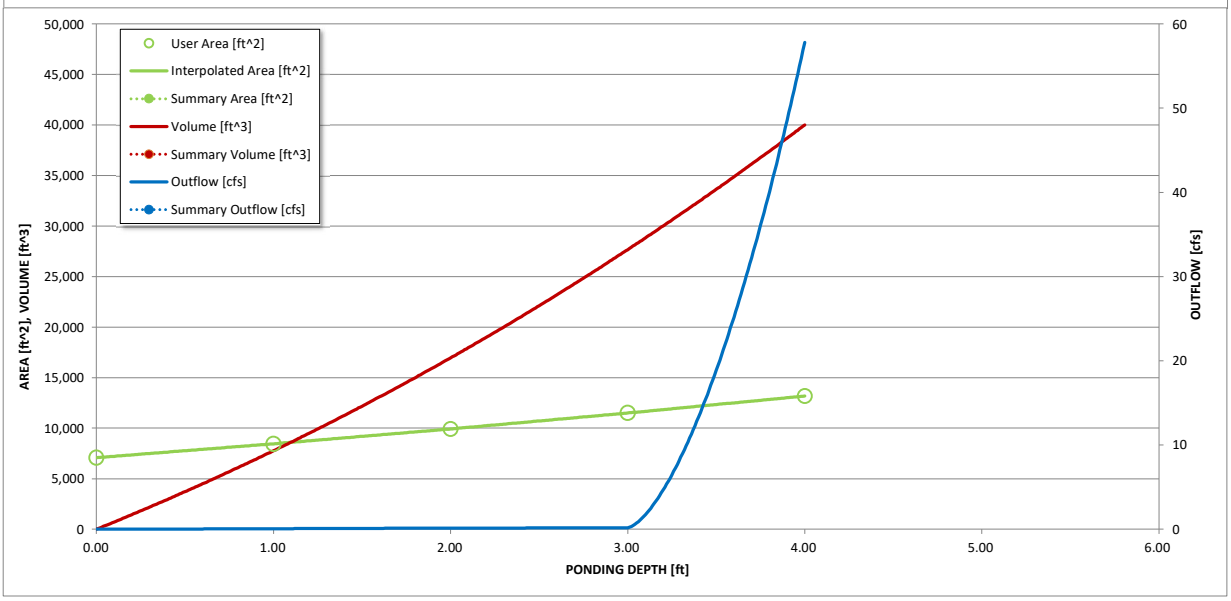
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.013	0.009	0.005	0.010	0.014	0.127	0.255	0.431	1.262
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.005	0.010	0.014	0.127	0.255	0.431	1.262
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.1	1.2	2.3	3.9	10.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.01	0.11	0.23	0.38	1.02
Peak Inflow Q (cfs) =	N/A	N/A	0.0	0.1	0.1	1.2	2.3	3.9	10.3
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	5.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.1	0.0	0.0	0.0	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	44	39	35	41	46	106	119	>120	109
Time to Drain 99% of Inflow Volume (hours) =	**53**	48	44	50	56	118	>120	>120	>120
Maximum Ponding Depth (ft) =	0.08	0.06	0.03	0.05	0.08	0.68	1.29	2.04	3.23
Area at Maximum Ponding Depth (acres) =	0.17	0.16	0.16	0.16	0.16	0.18	0.20	0.23	0.27
Maximum Volume Stored (acre-ft) =	0.013	0.010	0.003	0.008	0.011	0.118	0.234	0.398	0.697

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.02	0.05	0.07	0.01	0.03	0.04	0.12
	0:30:00	0.00	0.00	0.04	0.08	0.12	0.41	1.06	1.59	4.86
	0:35:00	0.00	0.00	0.05	0.09	0.13	0.98	1.97	3.17	8.23
	0:40:00	0.00	0.00	0.05	0.09	0.12	1.15	2.31	3.76	9.61
	0:45:00	0.00	0.00	0.04	0.08	0.12	1.15	2.31	3.88	10.19
	0:50:00	0.00	0.00	0.04	0.08	0.11	1.12	2.23	3.78	10.30
	0:55:00	0.00	0.00	0.04	0.07	0.10	1.05	2.11	3.57	10.00
	1:00:00	0.00	0.00	0.04	0.07	0.10	0.97	1.94	3.31	9.53
	1:05:00	0.00	0.00	0.03	0.06	0.09	0.90	1.79	3.07	9.20
	1:10:00	0.00	0.00	0.03	0.06	0.08	0.84	1.67	2.86	8.68
	1:15:00	0.00	0.00	0.03	0.06	0.08	0.78	1.56	2.66	8.10
	1:20:00	0.00	0.00	0.03	0.05	0.07	0.72	1.45	2.47	7.53
	1:25:00	0.00	0.00	0.03	0.05	0.07	0.67	1.34	2.28	6.97
	1:30:00	0.00	0.00	0.02	0.05	0.07	0.62	1.24	2.11	6.45
	1:35:00	0.00	0.00	0.02	0.04	0.06	0.58	1.16	1.97	6.02
	1:40:00	0.00	0.00	0.02	0.04	0.06	0.54	1.09	1.85	5.64
	1:45:00	0.00	0.00	0.02	0.04	0.05	0.51	1.02	1.74	5.28
	1:50:00	0.00	0.00	0.02	0.04	0.05	0.48	0.95	1.62	4.93
	1:55:00	0.00	0.00	0.02	0.03	0.05	0.44	0.88	1.51	4.58
	2:00:00	0.00	0.00	0.02	0.03	0.04	0.41	0.82	1.40	4.24
	2:05:00	0.00	0.00	0.01	0.03	0.04	0.38	0.75	1.28	3.90
	2:10:00	0.00	0.00	0.01	0.02	0.04	0.34	0.68	1.17	3.57
	2:15:00	0.00	0.00	0.01	0.02	0.03	0.31	0.62	1.06	3.24
	2:20:00	0.00	0.00	0.01	0.02	0.03	0.28	0.55	0.94	2.91
	2:25:00	0.00	0.00	0.01	0.02	0.03	0.25	0.50	0.85	2.65
	2:30:00	0.00	0.00	0.01	0.02	0.03	0.23	0.47	0.80	2.46
	2:35:00	0.00	0.00	0.01	0.02	0.02	0.22	0.44	0.75	2.31
	2:40:00	0.00	0.00	0.01	0.02	0.02	0.21	0.42	0.71	2.17
	2:45:00	0.00	0.00	0.01	0.02	0.02	0.20	0.40	0.67	2.04
	2:50:00	0.00	0.00	0.01	0.01	0.02	0.19	0.37	0.63	1.92
	2:55:00	0.00	0.00	0.01	0.01	0.02	0.18	0.35	0.60	1.80
	3:00:00	0.00	0.00	0.01	0.01	0.02	0.16	0.33	0.56	1.68
	3:05:00	0.00	0.00	0.01	0.01	0.02	0.15	0.31	0.52	1.57
	3:10:00	0.00	0.00	0.01	0.01	0.01	0.14	0.28	0.48	1.46
	3:15:00	0.00	0.00	0.01	0.01	0.01	0.13	0.26	0.44	1.35
	3:20:00	0.00	0.00	0.00	0.01	0.01	0.12	0.24	0.41	1.24
	3:25:00	0.00	0.00	0.00	0.01	0.01	0.11	0.22	0.37	1.13
	3:30:00	0.00	0.00	0.00	0.01	0.01	0.10	0.19	0.33	1.02
	3:35:00	0.00	0.00	0.00	0.01	0.01	0.09	0.17	0.29	0.91
	3:40:00	0.00	0.00	0.00	0.01	0.01	0.08	0.15	0.26	0.80
	3:45:00	0.00	0.00	0.00	0.00	0.01	0.06	0.13	0.22	0.69
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.05	0.10	0.18	0.58
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.14	0.47
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.10	0.36
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.07	0.25
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.14
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.08
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

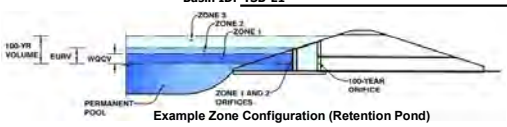
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-E1**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	8.21	acres
Watershed Length =	992	ft
Watershed Length to Centroid =	496	ft
Watershed Slope =	0.041	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.010	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.008	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.004	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.008	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.012	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.103	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.207	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.349	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.023	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.004	acre-feet		
Approximate 5-yr Detention Volume =	0.006	acre-feet		
Approximate 10-yr Detention Volume =	0.009	acre-feet		
Approximate 25-yr Detention Volume =	0.013	acre-feet		
Approximate 50-yr Detention Volume =	0.032	acre-feet		
Approximate 100-yr Detention Volume =	0.089	acre-feet		

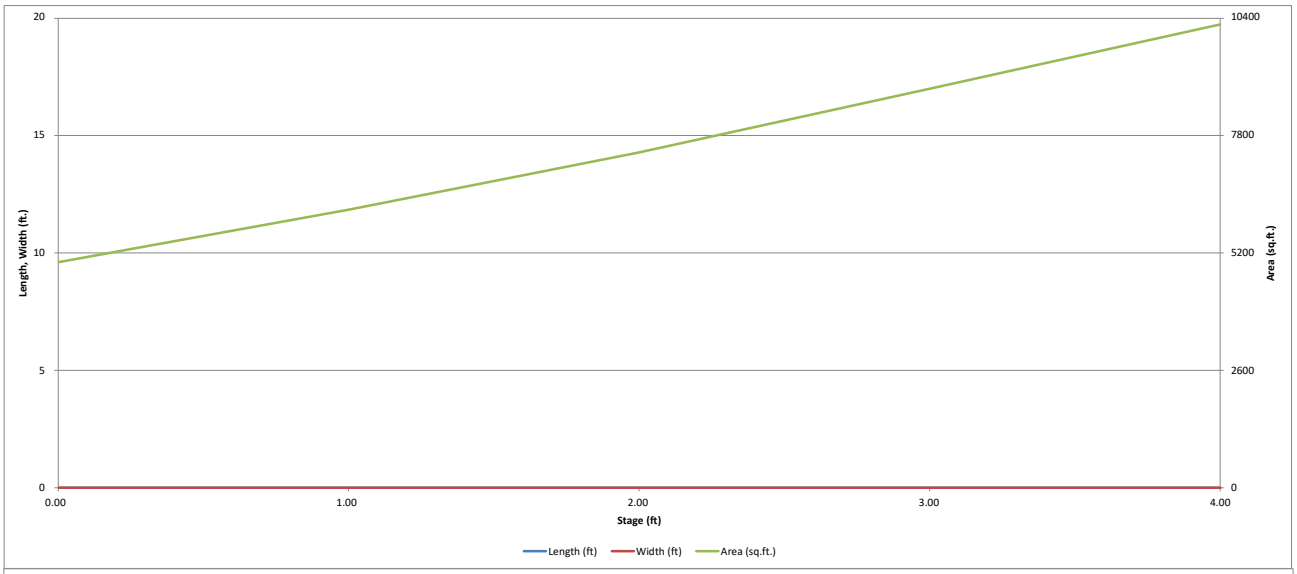
Define Zones and Basin Geometry

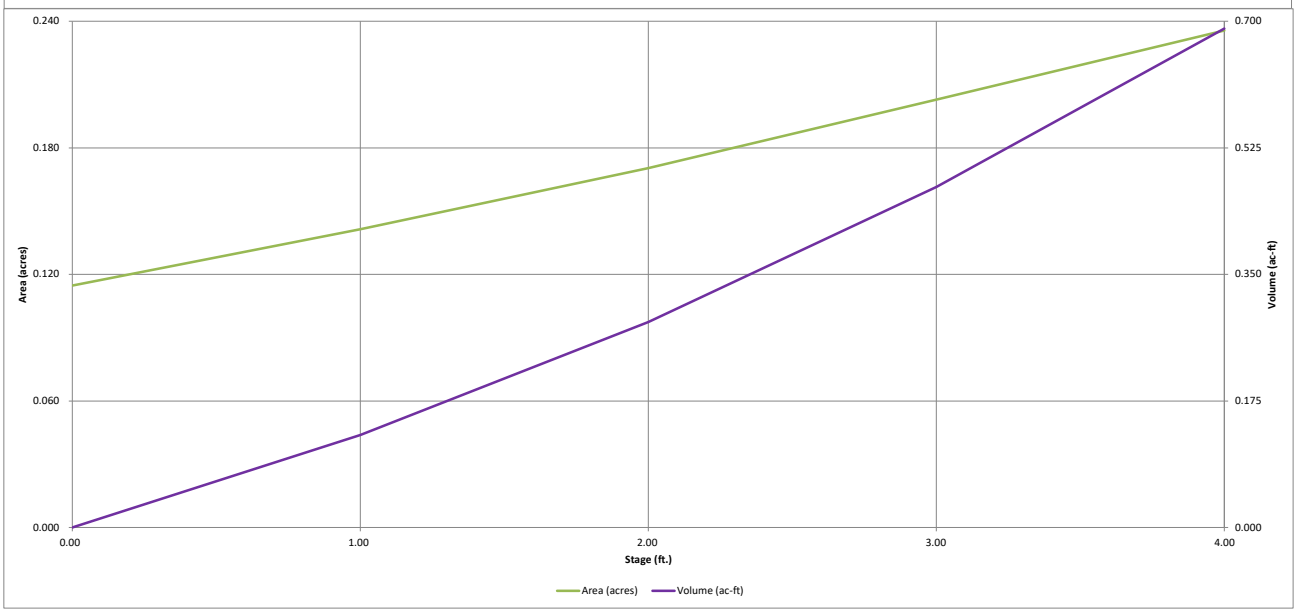
Zone 1 Volume (WQCV) =	0.010	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.010	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	4,997	0.115		
	--	1.00	--	--	--	6,162	0.141	5,579	0.128
	--	2.00	--	--	--	7,425	0.170	12,373	0.284
	--	3.00	--	--	--	8,839	0.203	20,505	0.471
	--	4.00	--	--	--	10,267	0.236	30,058	0.690


20
15
10
5
0
10400
7800
5200
2600
0
0.00
1.00
2.00
3.00
4.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

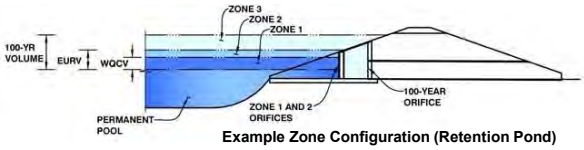

0.240
0.180
0.120
0.060
0.000
0.700
0.525
0.350
0.175
0.000
0.00
1.00
2.00
3.00
4.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-E1**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.09	0.010	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.010	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	3.889E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.12	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.56	sq. inches (diameter = 13/16 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	0.56	0.56	0.56	0.56	0.56			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.21	feet
Spillway Crest Length =	28.00	feet	Stage at Top of Freeboard =	4.21	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.24	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.69	acre-ft

Calculated Parameters for Spillway

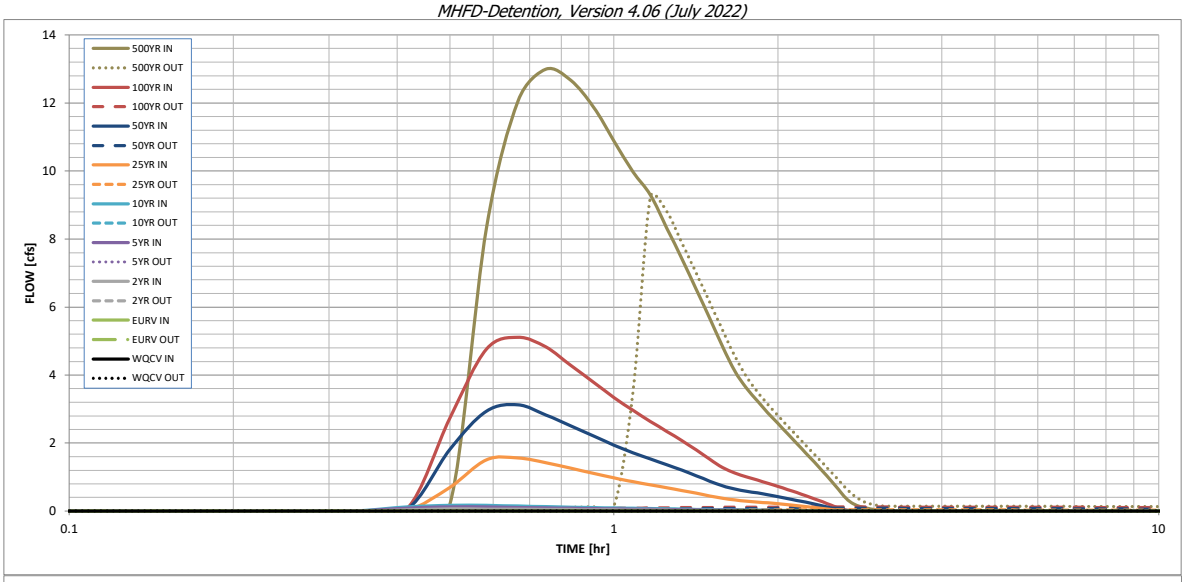
Routed Hydrograph Results

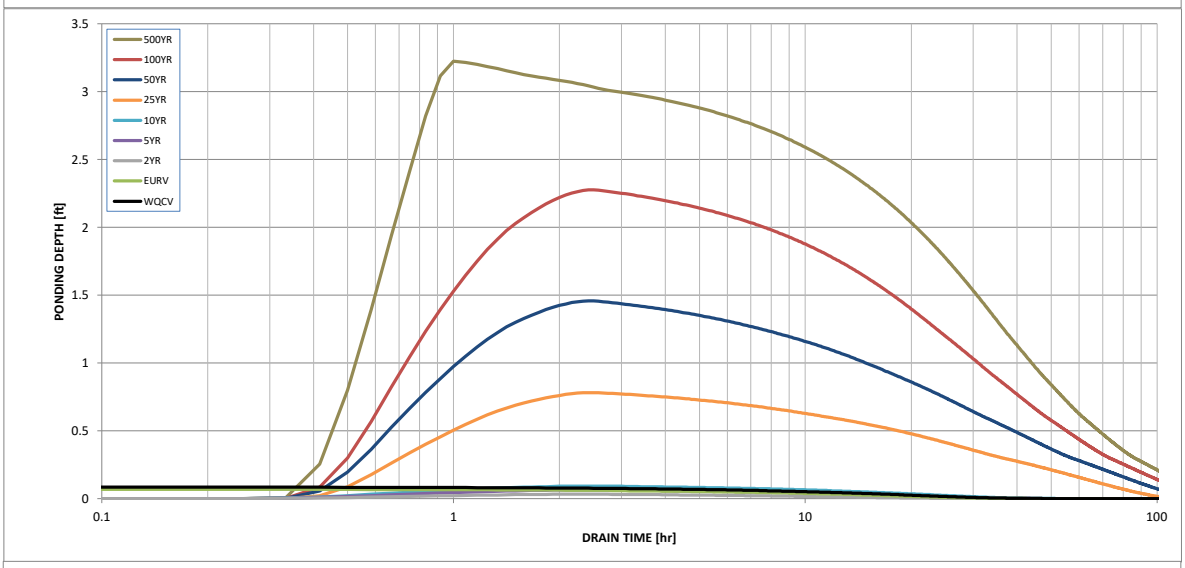
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

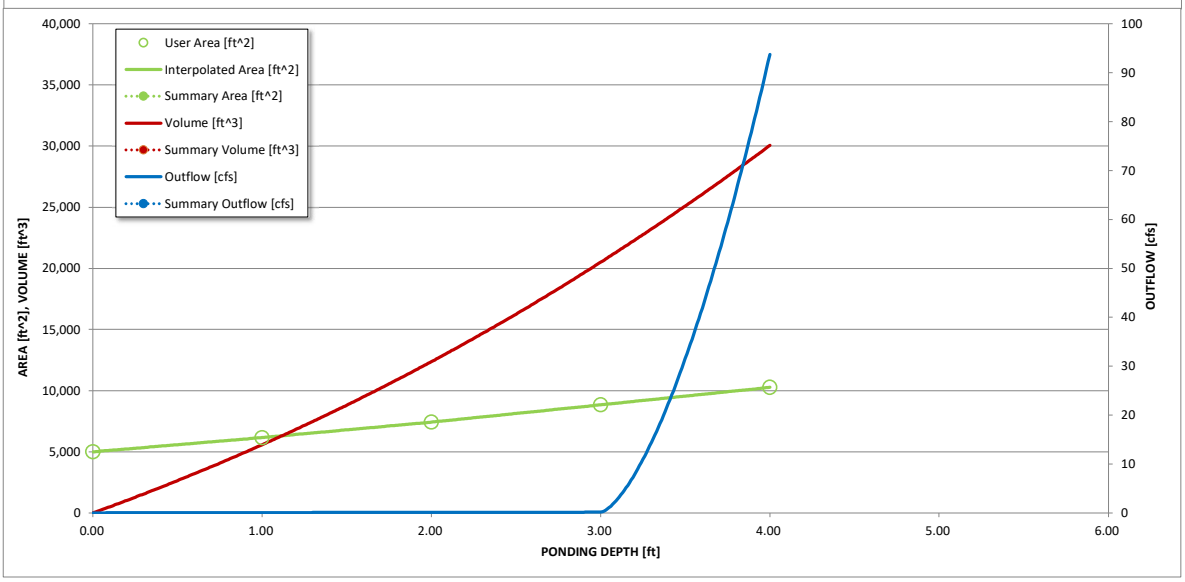
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.010	0.008	0.004	0.008	0.012	0.103	0.207	0.349	1.023
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.004	0.008	0.012	0.103	0.207	0.349	1.023
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.1	0.2	1.6	3.1	5.1	13.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.02	0.19	0.38	0.62	1.58
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.1	0.2	1.6	3.1	5.1	13.0
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	9.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	36	31	37	42	95	106	112	92
Time to Drain 99% of Inflow Volume (hours) =	**47**	44	39	45	50	106	>120	>120	>120
Maximum Ponding Depth (ft) =	0.09	0.07	0.03	0.06	0.09	0.78	1.46	2.28	3.22
Area at Maximum Ponding Depth (acres) =	0.12	0.12	0.12	0.12	0.12	0.14	0.15	0.18	0.21
Maximum Volume Stored (acre-ft) =	0.010	0.008	0.003	0.007	0.010	0.098	0.195	0.331	0.516

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.03	0.08	0.12	0.02	0.05	0.06	0.20
	0:30:00	0.00	0.00	0.06	0.12	0.17	0.70	1.81	2.74	8.32
	0:35:00	0.00	0.00	0.06	0.12	0.17	1.51	2.94	4.76	12.06
	0:40:00	0.00	0.00	0.06	0.11	0.15	1.56	3.12	5.11	12.99
	0:45:00	0.00	0.00	0.05	0.09	0.13	1.42	2.83	4.82	12.67
	0:50:00	0.00	0.00	0.04	0.08	0.12	1.26	2.50	4.28	11.89
	0:55:00	0.00	0.00	0.04	0.07	0.10	1.11	2.21	3.79	10.88
	1:00:00	0.00	0.00	0.03	0.06	0.09	0.98	1.94	3.34	9.97
	1:05:00	0.00	0.00	0.03	0.06	0.08	0.86	1.72	2.96	9.30
	1:10:00	0.00	0.00	0.03	0.05	0.07	0.77	1.53	2.64	8.33
	1:15:00	0.00	0.00	0.02	0.05	0.07	0.69	1.36	2.35	7.41
	1:20:00	0.00	0.00	0.02	0.04	0.06	0.60	1.20	2.07	6.52
	1:25:00	0.00	0.00	0.02	0.03	0.05	0.52	1.04	1.79	5.66
	1:30:00	0.00	0.00	0.02	0.03	0.04	0.44	0.88	1.52	4.83
	1:35:00	0.00	0.00	0.01	0.03	0.04	0.37	0.74	1.28	4.12
	1:40:00	0.00	0.00	0.01	0.02	0.03	0.33	0.65	1.12	3.63
	1:45:00	0.00	0.00	0.01	0.02	0.03	0.30	0.59	1.01	3.24
	1:50:00	0.00	0.00	0.01	0.02	0.03	0.27	0.53	0.91	2.89
	1:55:00	0.00	0.00	0.01	0.02	0.03	0.24	0.48	0.82	2.57
	2:00:00	0.00	0.00	0.01	0.02	0.02	0.21	0.42	0.73	2.27
	2:05:00	0.00	0.00	0.01	0.01	0.02	0.19	0.37	0.63	1.98
	2:10:00	0.00	0.00	0.01	0.01	0.02	0.16	0.31	0.54	1.71
	2:15:00	0.00	0.00	0.00	0.01	0.01	0.13	0.26	0.45	1.44
	2:20:00	0.00	0.00	0.00	0.01	0.01	0.11	0.21	0.36	1.17
	2:25:00	0.00	0.00	0.00	0.00	0.01	0.08	0.15	0.27	0.90
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.05	0.10	0.18	0.64
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.09	0.37
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.21
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

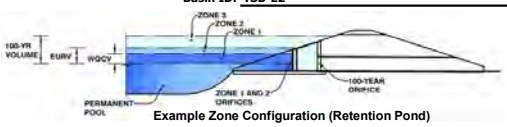
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-E2**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	13.57	acres
Watershed Length =	1,289	ft
Watershed Length to Centroid =	645	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.017	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.013	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.007	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.013	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.019	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.170	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.343	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.579	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	1.696	acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.007	acre-feet		
Approximate 5-yr Detention Volume =	0.010	acre-feet		
Approximate 10-yr Detention Volume =	0.014	acre-feet		
Approximate 25-yr Detention Volume =	0.022	acre-feet		
Approximate 50-yr Detention Volume =	0.053	acre-feet		
Approximate 100-yr Detention Volume =	0.147	acre-feet		

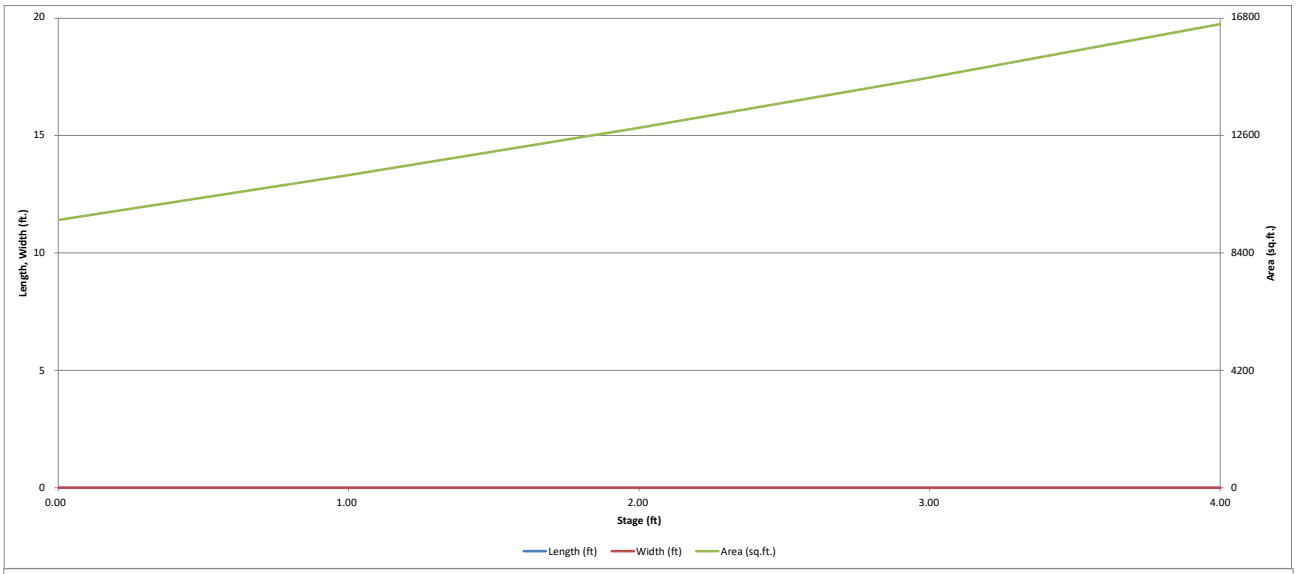
Define Zones and Basin Geometry

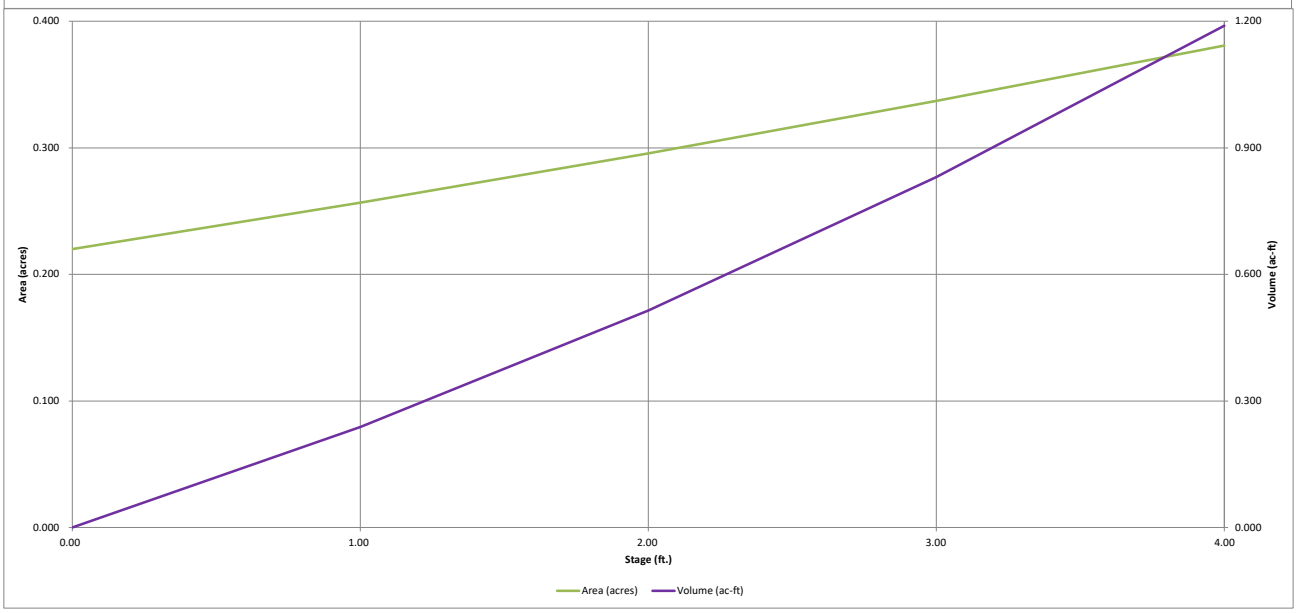
Zone 1 Volume (WQCV) =	0.017	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.017	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	9,583	0.220		
	--	1.00	--	--	--	11,181	0.257	10,382	0.238
	--	2.00	--	--	--	12,879	0.296	22,412	0.515
	--	3.00	--	--	--	14,684	0.337	36,193	0.831
	--	4.00	--	--	--	16,589	0.381	51,830	1.190


20
15
10
5
0
16800
12600
8400
4200
0
0.00
1.00
2.00
3.00
4.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

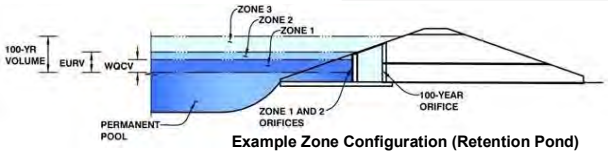

0.400
0.300
0.200
0.100
0.000
1.200
0.900
0.600
0.300
0.000
0.00
1.00
2.00
3.00
4.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Grandview - Interim**

Basin ID: **TSB-E2**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.08	0.017	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.017	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.875E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.12	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.99	sq. inches (diameter = 1-1/8 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20			
Orifice Area (sq. inches)	0.99	0.99	0.99	0.99	0.99			

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.21	feet
Spillway Crest Length =	28.00	feet	Stage at Top of Freeboard =	4.21	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.38	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.19	acre-ft

Calculated Parameters for Spillway

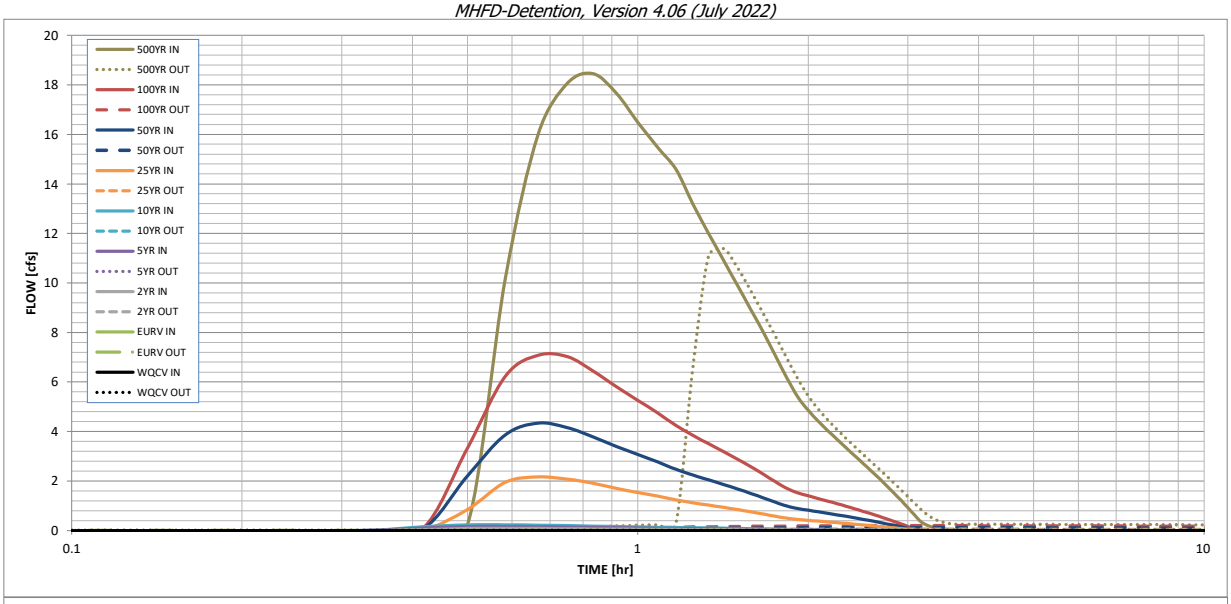
Routed Hydrograph Results

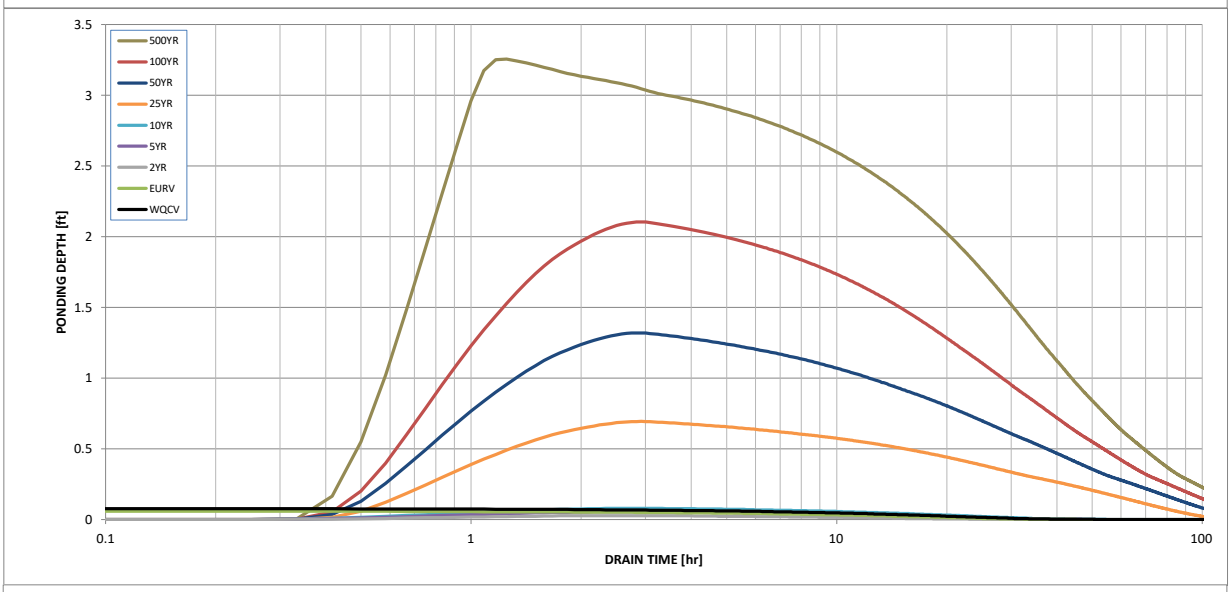
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

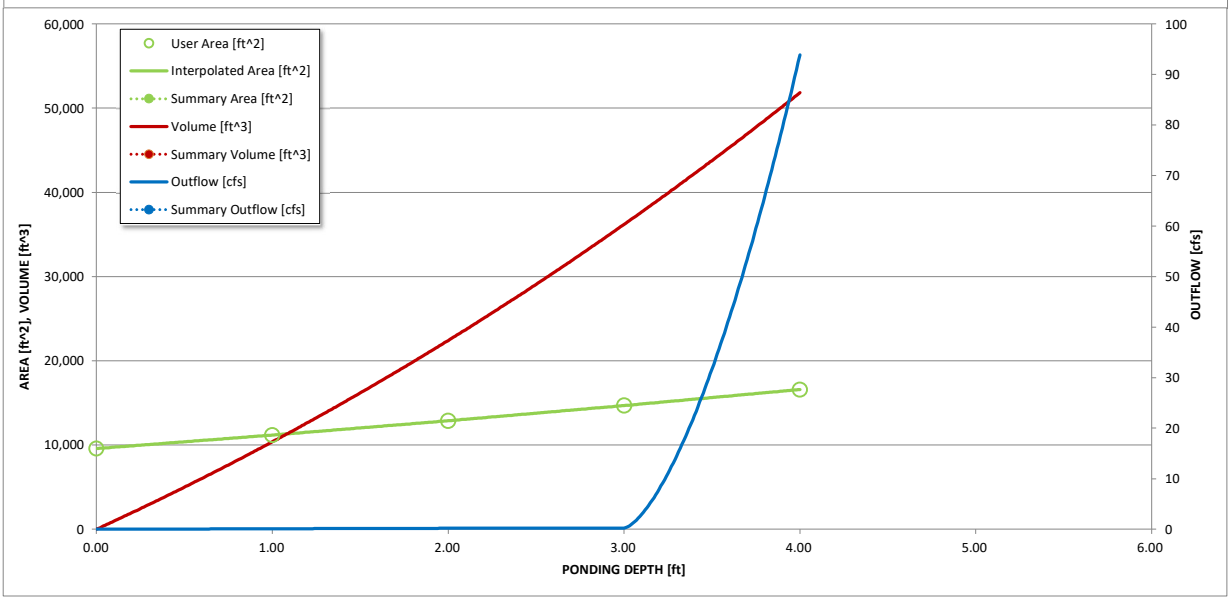
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.017	0.013	0.007	0.013	0.019	0.170	0.343	0.579	1.696
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.007	0.013	0.019	0.170	0.343	0.579	1.696
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.2	0.2	2.2	4.3	7.1	18.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.16	0.32	0.52	1.36
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.2	0.2	2.2	4.3	7.1	18.4
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	11.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	41	37	33	38	43	100	111	117	100
Time to Drain 99% of Inflow Volume (hours) =	**49**	46	41	47	52	110	>120	>120	>120
Maximum Ponding Depth (ft) =	0.08	0.06	0.03	0.05	0.08	0.69	1.32	2.10	3.25
Area at Maximum Ponding Depth (acres) =	0.22	0.22	0.22	0.22	0.22	0.25	0.27	0.30	0.35
Maximum Volume Stored (acre-ft) =	0.018	0.013	0.004	0.011	0.015	0.161	0.322	0.544	0.917

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:25:00	0.00	0.00	0.04	0.10	0.15	0.03	0.06	0.08	0.25
	0:30:00	0.00	0.00	0.08	0.17	0.23	0.85	2.21	3.34	10.16
	0:35:00	0.00	0.00	0.09	0.17	0.24	1.95	3.86	6.23	16.01
	0:40:00	0.00	0.00	0.08	0.16	0.22	2.16	4.34	7.08	18.05
	0:45:00	0.00	0.00	0.07	0.14	0.20	2.08	4.16	7.03	18.45
	0:50:00	0.00	0.00	0.07	0.13	0.18	1.91	3.78	6.45	17.66
	0:55:00	0.00	0.00	0.06	0.12	0.16	1.70	3.40	5.81	16.48
	1:00:00	0.00	0.00	0.05	0.10	0.15	1.54	3.07	5.26	15.48
	1:05:00	0.00	0.00	0.05	0.09	0.13	1.39	2.77	4.76	14.60
	1:10:00	0.00	0.00	0.04	0.09	0.12	1.24	2.47	4.25	13.20
	1:15:00	0.00	0.00	0.04	0.08	0.11	1.12	2.24	3.84	12.00
	1:20:00	0.00	0.00	0.04	0.07	0.10	1.03	2.05	3.51	10.92
	1:25:00	0.00	0.00	0.03	0.07	0.10	0.94	1.86	3.19	9.90
	1:30:00	0.00	0.00	0.03	0.06	0.09	0.85	1.68	2.88	8.93
	1:35:00	0.00	0.00	0.03	0.05	0.08	0.76	1.50	2.58	7.99
	1:40:00	0.00	0.00	0.02	0.04	0.07	0.67	1.32	2.27	7.07
	1:45:00	0.00	0.00	0.02	0.04	0.06	0.58	1.14	1.97	6.16
	1:50:00	0.00	0.00	0.02	0.04	0.05	0.50	0.99	1.70	5.39
	1:55:00	0.00	0.00	0.02	0.03	0.05	0.44	0.89	1.53	4.85
	2:00:00	0.00	0.00	0.02	0.03	0.05	0.41	0.82	1.40	4.42
	2:05:00	0.00	0.00	0.02	0.03	0.04	0.38	0.76	1.29	4.03
	2:10:00	0.00	0.00	0.01	0.03	0.04	0.35	0.70	1.19	3.68
	2:15:00	0.00	0.00	0.01	0.02	0.03	0.32	0.63	1.08	3.34
	2:20:00	0.00	0.00	0.01	0.02	0.03	0.29	0.57	0.98	3.02
	2:25:00	0.00	0.00	0.01	0.02	0.03	0.26	0.51	0.88	2.71
	2:30:00	0.00	0.00	0.01	0.02	0.02	0.23	0.45	0.78	2.41
	2:35:00	0.00	0.00	0.01	0.01	0.02	0.20	0.39	0.68	2.11
	2:40:00	0.00	0.00	0.01	0.01	0.02	0.17	0.33	0.58	1.82
	2:45:00	0.00	0.00	0.00	0.01	0.01	0.14	0.27	0.47	1.52
	2:50:00	0.00	0.00	0.00	0.01	0.01	0.11	0.21	0.37	1.22
	2:55:00	0.00	0.00	0.00	0.00	0.01	0.08	0.15	0.27	0.92
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.05	0.09	0.17	0.63
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.07	0.35
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.20
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).