

APPENDIX II
Wetland Inspection Plan & H&H Report



Real People. Real Solutions.

1519 Baltimore Drive
Ames, IA 50010-8783

Ph: (515) 233-6100
Fax: (515) 233-4430
Bolton-Menk.com

January 4, 2024

RE: Henderson Wetland Inspection Plan
Site No. STO852118B
Story County, Iowa

The sequence of construction will be determined with the contractor after the contract is awarded, the start date planned and whether crops have been harvested. This will be discussed at the pre-construction meeting. The easement boundary stakes and at least 3 benchmarks to be used for construction will be placed by Bolton & Menk, Inc.

Below is a list of anticipated tasks to be completed along with the amount of inspection required and the experience level of the inspector needed.

- Tile Exploration – The site likely has several tiles on site. The exact location and depth of the tiles were not determined. This work should be completed in the presence of a technician or engineer who can provide location and elevation information about where the tile is located. This information will be used by the design engineer to adjust the tile outlets as needed to provide suitable outlet based on this acquired information.
- Soil Confirmation – The contractor shall excavate test pits as needed to confirm soils for borrow before beginning stripping operations. This work should be completed with the design engineer on site. This will likely happen in concurrence with the tile exploration.
- Site stripping can occur without any site inspection being required. The contractor will need to implement storm water and sedimentation control measures.
- The embankment will be constructed to the design height with the central portion consisting of good cohesive material. This work should be inspected on an occasional part-time basis and can be completed by a technician familiar with soil placement. The location and elevation of the embankment will need to be checked with survey equipment when nearing final construction grade and before topsoil placement. No compaction testing required.
- The Engineer or a technician shall be present during the installation of the first 100 feet of R.C.P. tile. After the contractor demonstrates acceptable competence at installation of the R.C.P. tile in accordance with the specifications, the engineer or technician will only be required on a part-time basis. The contractor shall notify the engineer if unstable soils requiring bedding material are encountered. So long as joints are fit tightly, no fabric wrap is required at joints. If joints are wider than ½' when backfilled, geotextile wrap is required. If the gap exceeds 1" in width, the pipe must be removed and re-laid. If the trench is spoon shaped to fit the pipe to spring line with less than 1" gap between pipe and undisturbed soil at spring line, no compaction efforts are necessary. No testing is required for backfill of pipe trench above the pipe spring line.
- The Engineer or a technician shall be present during the installation of the first 100 feet of plastic tile. After the contractor demonstrates acceptable competence at installation of the tile in accordance with the specifications, the engineer or technician will only be required on a part-time basis. The contractor shall notify the engineer if unstable soils requiring bedding material are encountered. Corrugated plastic drainage tile may be plowed in or trenched. However, it must be laid on a properly shaped bottom conforming with the allowable ASTM 449 geometry.

Name: Henderson Wetland Inspection Plan

Date: January 4, 2024

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Joints must be watertight. The engineer or technician shall check to ensure proper rock bedding of the plastic tile in the areas where it is specified.

- The location and elevation of the sheet pile weir shall be checked prior to additional fill and grouted riprap being placed.
- The elevations of the wave berm and embankment as well as submerged berms should be checked.
- The tile inlet shall be measured with surveying equipment. The joint connections should be observed prior to backfilling. A technician with surveying equipment should check this.
- Seed bed preparation should be checked prior to seeding. The thickness of the topsoil and seed tags shall be verified. A technician familiar with seeding should observe the start of this.
- There is no testing that needs to be completed for this project.

The as-built drawings shall include the following information:

- Location and elevation of tile intercept and outlet, along with pipe sizes
- Location, elevation, and buried dimensions of the sheet pile weir
- Location and elevation of top of the stoplog structure
- Cross section east west near the center of the wetland to verify elevations

Quality control is the responsibility of the contractor, but any work deemed to not be in accordance with the plans and specifications based on inspections completed shall be reworked.

Quality assurance is the responsibility of contractor but will be verified by design engineer. This will be accomplished by material certifications provided for all pipe/tile, geotextile, granular material, and riprap. Shop drawings will be submitted and approved for the water control structure. The grout mix and seed mix designs will be submitted and approved prior to placement.

Sincerely,

Bolton & Menk, Inc.



Jonathan P Rosengren, P.E.

Project Manager



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Ph: (515) 233-6100
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Bolton-Menk.com

January 17, 2024

RE: Henderson Wetland Design Report
Site No. STO852118B
Story County, Iowa

This wetland enhancement is planned to provide nutrient reduction benefits to a watershed in Story County, Iowa. Nitrates will be converted to nitrogen gas through natural processes as the water passes through the wetland. Sediment with phosphorus will also be captured but will need to be removed from time to time. This project was designed to meet the requirements of NRCS Statement Constructed Wetland (656).

The site was initially located and evaluated by IDALS. Information was presented to the landowner who expressed interest in participating in this project.

Bolton & Menk (BMI) reviewed the soil survey data for the location and found primarily Coland-Terril Complex and Clarion loam. After this review, it was determined soil borings were unnecessary unless deep excavation work was determined to be needed. The watershed contributing to the proposed wetland was then analyzed. The watershed is agricultural crop and grass. A map of the watershed is included with this report. For conservancy of the design, all land was assumed as cultivated to develop an average RCN for the project of 81 used in the hydraulic analysis. The initial modeling of the site was done prior to the new MSE3 rainfall distribution curves being made available. Due to the new MSE3 curve being slightly flatter than the previous Type 2 distribution resulting in a reduced peak flow, as well as no change in rainfall depth except for the 2-year event, the model was left unaltered from the preliminary design.

The site is located entirely within the Henderson property several miles northeast of McCallsburg. It contains one larger tile running south down the waterway towards the creek. This tile will be intercepted and daylighted to feed the wetland pool. The new line will be larger than the old one to ensure adequate drainage despite the flatter grade. Other private tiles may drain into the site and will be located, and the design altered as needed during construction. The surface water in the waterway and the tile water will empty into a sediment basin before flowing into the pool. Once there, it will meander through the pool, directed in a serpentine pattern by submerged earthen berms to provide a longer retention time and hence, better nutrient reduction. It will then outlet over a rectangular weir within the earthen embankment into the stilling basin before running down the hill to the creek.

Important to note is the larger size of the steel sheet pile weir and the addition of wing dikes. Due to the uniquely steep gradient downstream of the embankment and small watershed size, there was insufficient tailwater to keep the weir within design standards. This necessitated the addition of wing dikes and the narrowing of the outlet channel to contain the flow for longer. Due to this, the total width of the weir had to be increased to reduce the unit flow over the edge. This will keep forces on the stilling basin within the acceptable range during high flows.

Name: Henderson Wetland Design Report

Date: January 17, 2024

Page: 2

The site has a watershed of 182 acres of which 126 is a direct surface contribution and the remaining 56 is pothole trapped but will eventually overflow to the wetland. This reduced watershed area is only accounted for in the sediment calculation to provide conservancy in the total flow calculation.

The permanent easement for this project will be on the Henderson property. IDALS-DSWQ is currently in the process of updating the abstracts and will have a signed easement recorded for the area as shown on the attached landowner drawing.

A Section 401/404 permit application and a floodplain permit application are being addressed by IDALS-DSWQ for this project.

The list of materials and engineer's estimate is attached to this report.

Sincerely,

Bolton & Menk, Inc.

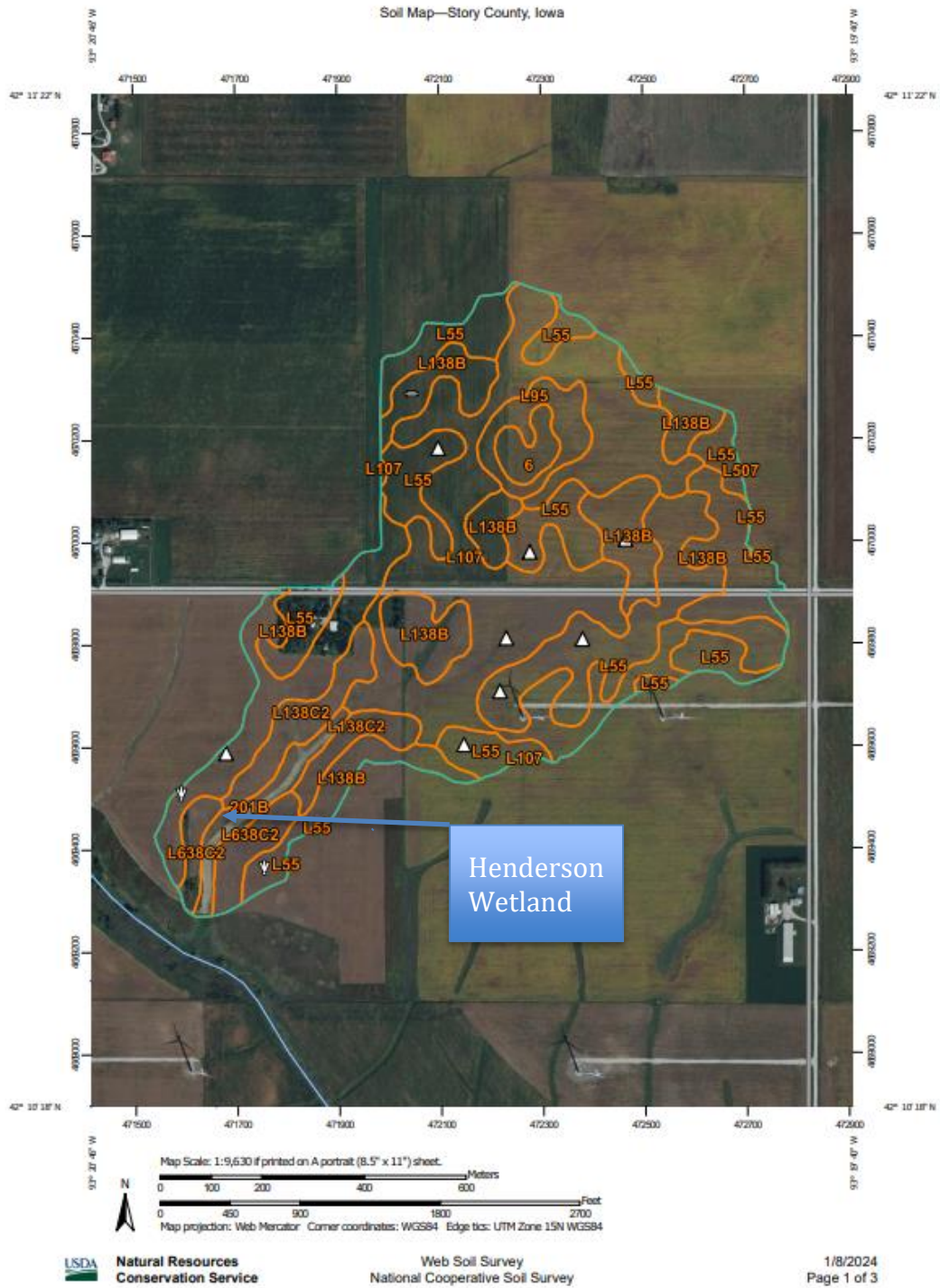


Jonathan P. Rosengren, P.E.

Project Manager

Encl: Web Soil Survey Map
Watersheds and Land Use Map
Plan Overview
Cost Estimate

Web Soil Survey Map



Watersheds and Land Use

Henderson Wetland

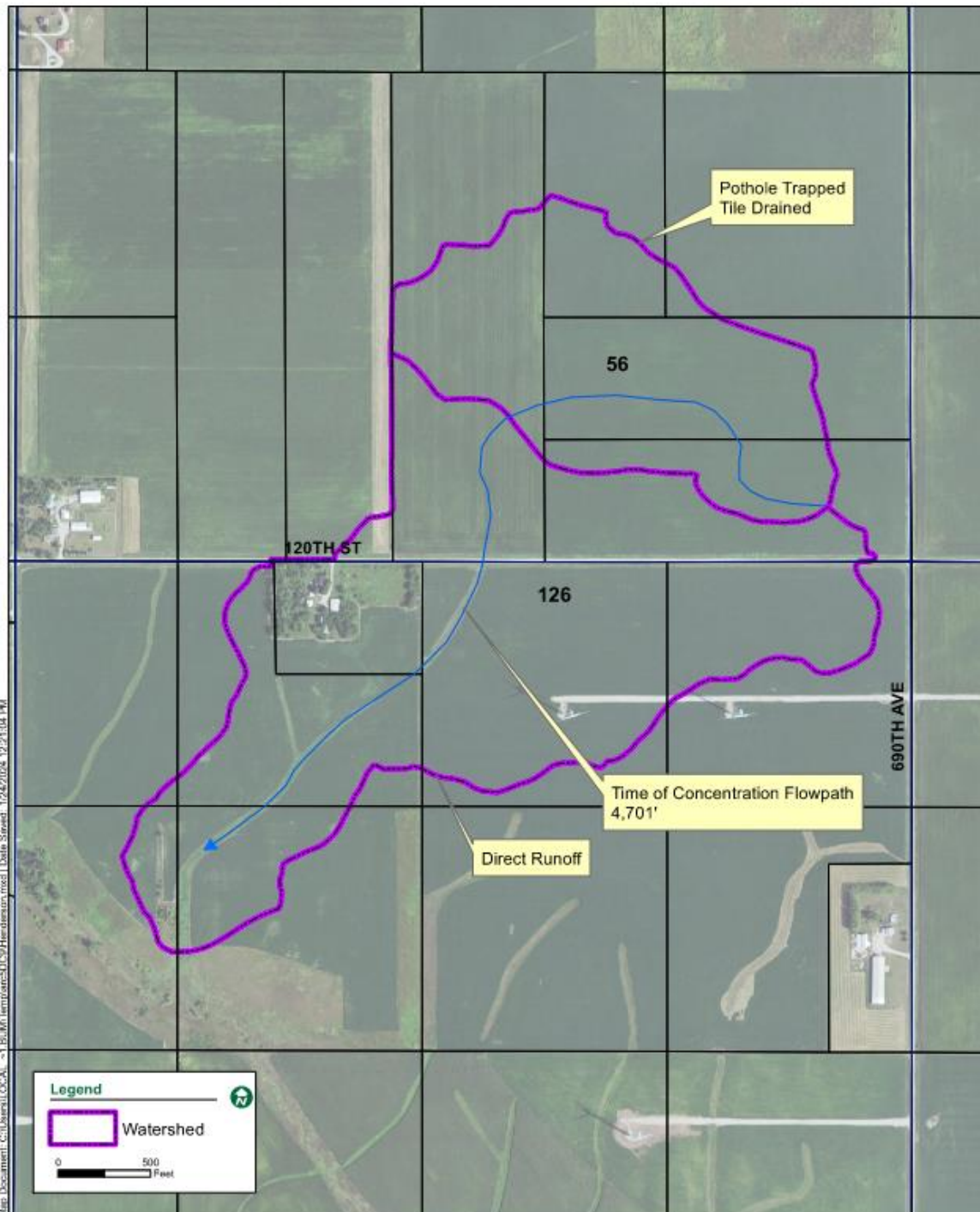
IDALS STO852118B

Watershed

January 2024



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Hydrology and Hydraulics Report for the Henderson Wetland Site

IDALS ID No.: STO 825118B

BMI Project No.: 0T7.131410

Site Location: Story County, Iowa SE 1/4 of the NW 1/4 of Section 18, T-85N, R-21W

Design Parameters and Procedures:

Design hydrology and hydraulic study of this site was completed. The drainage area was reviewed and a stage-area-storage curve was developed based on the topographic survey and Lidar data available from the Iowa Department of Natural Resources. Land use and treatment were determined through a site visit and aerial photo review and depression areas were found. Hydrologic data was compiled, sediment calculations were made, the structure was flood routed using the SCS method in HydroCAD Software, and all the output was reviewed.

Rainstorm events used for this site were Type 2 distribution, 24-hour, 5- and 10-year event for the principal spillway hydrograph and the 25- and 100-year event for the hydrograph to determine resiliency. These parameters led to satisfactory hydrographs with a designed weir length of 44 feet.

Weir Structure Design

- | | | | | |
|--|-----------------------|-------------|------------------------|-------------|
| | 25-year Event: | 5.4" | 100-year Event: | 7.1" |
|--|-----------------------|-------------|------------------------|-------------|
- * Hydraulics Soils Group: C/D
 - * Runoff Curve Number: 81 (based on Land use shown in this report)
 - * Primary Spillway Weir Coefficient = 3.1
 - * Effects on discharge from sloping weir ends was considered to balance based on end contraction loss and gain from the increase in sectional area.
 - * Design life: 150 years for accumulated sediment

Additional Structure Data

- * $T_c = 1.5$ hours determined by the sum of sheet, shallow channel and channel flow times.
- * Sediment delivery is 8%, with a trap efficiency of 93%.
- * The normal pool will contain 80% of the trapped sediment for the 150-year design life.
- * Aerated sediment deposited will reduce flood storage by .15 acre-feet
- * Normal Pool area is 2.03 acres; watershed area is approx. 182 acres or 0.28 square miles

Summary Table:

Weir Crest Elevation = 1091.50

Weir Length = 44 ft

	Q _{max} In (cfs)	Q _{max} Out (cfs)	Max Elev (ft)	Tail Water Elev (ft)	Duration - Hours at elevation		
					1093.00	1092.50	1092.00
5-year	155.99	151.57	1092.54	1086.91	0.0	0.0	2.5
10-year	199.37	194.39	1092.73	1087.05	0.0	1.0	3.0
25-year	263.49	257.74	1092.98	1087.41	0.0	2.0	3.5
100-year	374.72	368.42	1093.37	1087.98	1.0	3.0	4.0

Top of berm elevation is 1094.5; freeboard is 1.13'. See following pages for design calculations



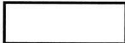
RAINFALL DATA

DA = 182 ac

= .28 sq mi

Frequency	6-hr		24-hr			
	in ¹	in ²	in ¹	in ²	in ³	in ²
2	-	-	3.1	2.9	3.1	-
5	-	-	3.9	3.6	3.8	-
10	-	-	4.5	4.3	4.5	-
25	-	-	5.4	5.2	5.4	-
50	-	-	6.2	5.9	6.3	-
100	-	-	7.0	6.6	7.1	-

References



Box indicates greater value and was selected.

¹ NOAA Atlas 14, Volume 8, Version 2 ³ SUDAS Design 2023 Edition

² Autodesk Storm and Sanitary Analysis Rainfall Designer



RUNOFF CURVE NUMBER

DA = 182 ac

= .28 sq mi

Map Unit ¹	Soil Name ¹	Hydro. Group ¹	Cover and Treatment	Hydro. Cond.	Portion of W/S percent	CN ²	Product
-----------------------	------------------------	---------------------------	---------------------	--------------	------------------------	-----------------	---------

PROPOSED CONDITION

L107	Webster Clay Loam	C/D		POOR	33.00	83	27.4
L138C2	Clarion Loam	B		POOR	61.00	78	47.6
		C	Paved parking & roofs		4.00	98	3.9
			Ponds (Wetland Pool and Potholes)		2.00	100	2.0
				Sum	100.00		80.9
				Use CN =		81	1-day

References

- ¹ USDA - NRCS Soil Survey of Story Co., Iowa.
- ² USDA - NRCS Technical Release 55, Chapter 2, June 1986.



SEDIMENT

DA = 182 ac

= .28 sq mi

DA ¹	182 acres	0.284	sqmi
Trap efficiency, very short storage time ²		93.0	percent
Average annual sheet and rill erosion ³		3.1	tons/ac/yr
Area of depressions not subject to sediment delivery		56	acres
Area subject to sheet and rill erosion		126	acres
Average annual sheet and rill erosion		386	tons
Delivery ratio ⁵		8.0	percent
Sheet and rill erosion delivered to site		30.86	tons/yr
Adjustment for LRA 103 ²		0.3	factor
Adjusted sheet and rill erosion delivered		9.26	tons/yr
Average annual gully erosion rate ⁴		0.2	cuft/ft
Length of gully erosion		0	ft
In place density of gully material		80	lb/cuft
Average annual gully erosion (100% delivered)		0.0	t/yr
Total sediment delivered		9.3	t/yr
Weight of sediment retained in resevoir at 93.0 percent trapped ²		8.6	t/yr
Sediment accumulation during 150 -year period		1,291.6	tons
Estimate 80 percent of delivered sediment will not be submerged ²		1,033.3	tons
Volume of submerged sediment at 1,307 t/acft ²		0.8	acft
Normal pool volume 0.5 acft, will be full			
Estimate 20 percent of delivered sediment will be aerated ²		258.3	tons
Volume of aerated sediment at 1,742 t/acft ²		0.15	acft

References

- ¹ Determined by Engineer
- ² USDA-NRCS, Engr. Field Man., Chap. 11, Amend. IA 27, May 1986,. Adjusted. See notes.
- ³ Estimated by preparer.
- ⁴ Estimated by preparer.
- ⁵ Delivery curve for Des Moines lobe. Source: Iowa Geological Survey.



STAGE STORAGE

DA = 182 ac

= .28 sq mi

Contour Elev.	Area (sq ft)	Area (Acres)	Average Area (Arces)	Intermediate Volume (Ac-ft)	Cumulative Volume (Ac-ft)	Volume Above Weir (Ac-ft)	Allow for Aerated Sediment (Ac-ft)	Temporary Flood Storage (Ac-ft)
1087.00	1557	0.04	0.04	0.00				
1087.50	3142	0.07	0.06	0.03	0.03			
1088.00	5544	0.13	0.10	0.05	0.08			
1088.50	8962	0.21	0.17	0.09	0.16			
1089.00	13841	0.32	0.27	0.13	0.30			
1089.50	22509	0.52	0.42	0.21	0.51			
1090.00	30382	0.70	0.61	0.31	0.81			
1090.50	78967	1.81	1.26	0.63	1.44			
1091.00	84543	1.94	1.88	0.94	2.38			
1091.50	88548	2.03	1.99	0.99	3.37	2.86	0.00	2.86
1092.00	95610	2.19	2.11	1.06	4.42	3.92	0.07	3.84
1092.50	101670	2.33	2.26	1.13	5.55	5.05	0.15	4.90
1093.00	109601	2.52	2.43	1.21	6.77	6.26	0.15	6.11
1093.50	119482	2.74	2.63	1.32	8.08	7.58	0.15	7.43
1094.00	129294	2.97	2.86	1.43	9.51	9.00	0.15	8.85
1094.50	140541	3.23	3.10	1.55	11.06	10.55	0.15	10.40

Storage at Normal Pool	3.37 Acre-feet
Elevation of weir =	1091.50
Storage at Top of Dike	11.06 Acre-feet
Elevation =	1094.50

Average Depth =	$\frac{\text{storage at normal pool}}{\text{area at normal pool}}$
Average Depth =	1.66 feet

Notes: Storage areas include final earthwork borrow in pool area.



WEIR FLOW HYDRAULICS

DA = 182 ac
= .28 sq mi

Input

$$Q = CLH^{1.5}$$

Use C = 3.1

Output

Pool El. = 1091.50

Weir Length (ft)	20	30	44	50	60
W.S. Elev.	Q - cfs	Q - cfs	Q - cfs	Q - cfs	Q - cfs
1091.50	0.0	0.0	0.0	0.0	0.0
1091.69	5.0	7.6	11.1	12.6	15.1
1091.88	14.2	21.4	31.3	35.6	42.7
1092.06	26.2	39.2	57.5	65.4	78.5
1092.25	40.3	60.4	88.6	100.7	120.8
1092.44	56.3	84.4	123.8	140.7	168.8
1092.63	74.0	111.0	162.8	185.0	221.9
1092.81	93.2	139.8	205.1	233.1	279.7
1093.00	113.9	170.9	250.6	284.8	341.7
1093.19	135.9	203.9	299.0	339.8	407.7
1093.38	159.2	238.8	350.2	398.0	477.5
1093.56	183.6	275.5	404.0	459.1	550.9
1093.75	209.3	313.9	460.4	523.1	627.8
1093.94	235.9	353.9	519.1	589.9	707.8
1094.13	263.7	395.5	580.1	659.2	791.1
1094.31	292.4	438.7	643.4	731.1	877.3
MAX POOL 1094.50	322.2	483.2	708.8	805.4	966.5

USED

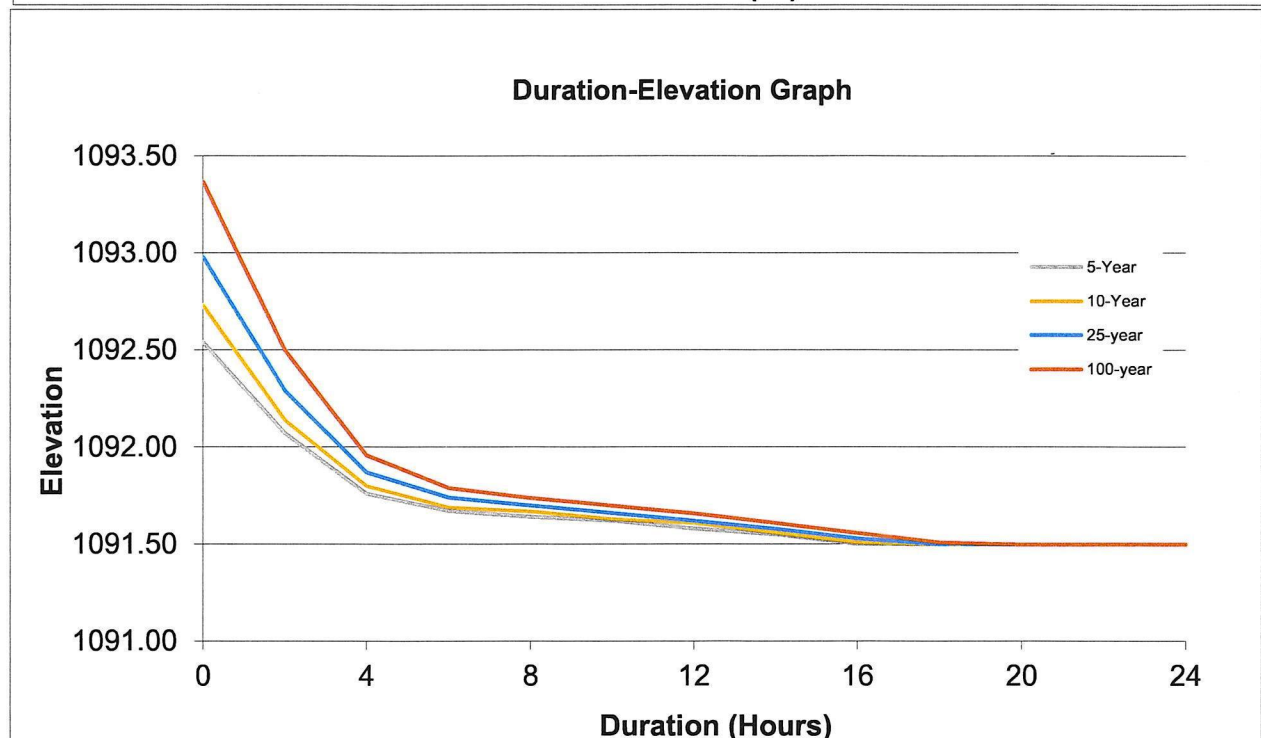
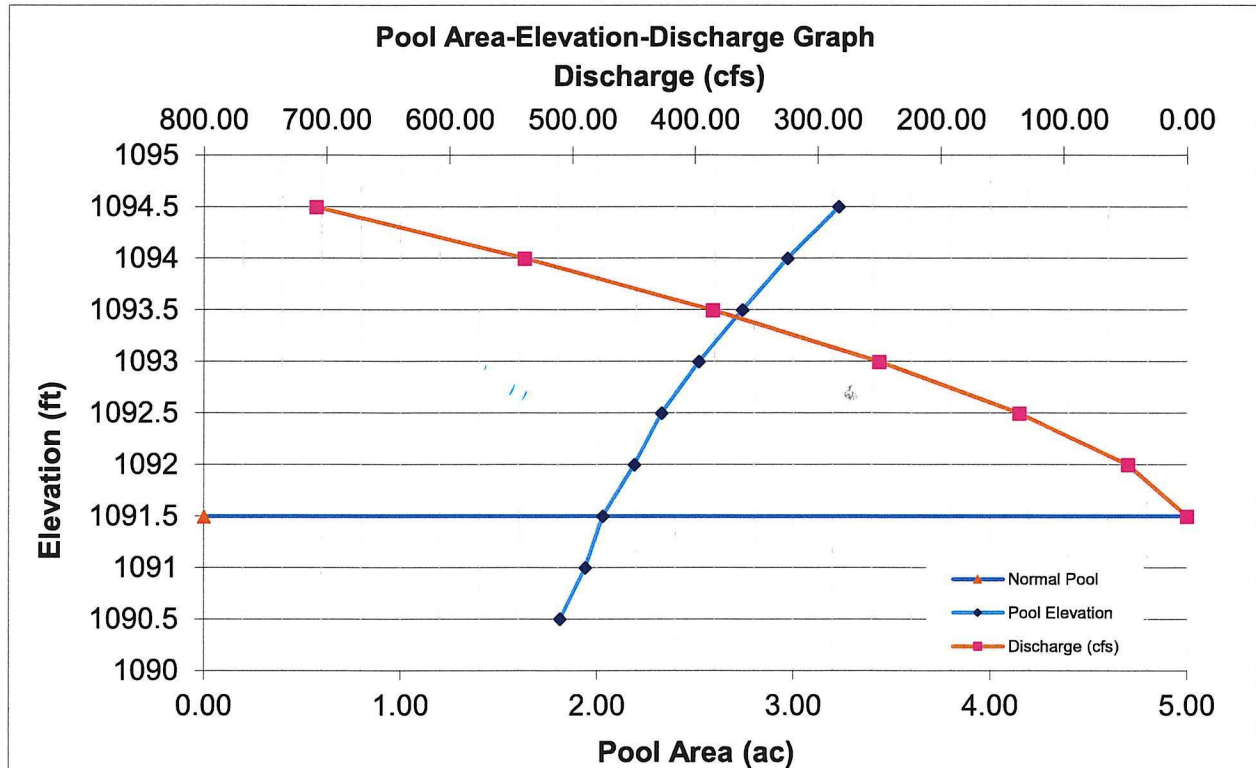
Note: Table of theoretical flows outletting from multiple wier lengths/water surface elevation combinations given the target pool elevation of 1091.5



RESULTS

DA = 182 ac

= .28 sq mi





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IDALS ID Number: STO852118B

Job: Henderson

BMI Project Number: OT7.131410

Designed By: TJB Date: 01/17/2024

Reviewed By: JPR Date: 1/24/24

RESULTS

DA = 182 ac

= .28 sq mi

Pool Area-Elevation-Discharge Table

Pool Area (ac)	Elevation (ft)	Discharge (cfs)
1.81	1090.50	
1.94	1091.00	
2.03	1091.50	0.00
2.19	1092.00	48.22
2.33	1092.50	136.40
2.52	1093.00	250.58
2.74	1093.50	385.80
2.97	1094.00	539.17
3.23	1094.50	708.76

Note: Table referencing the pool area in relation to the pool elevation and the discharge through the primary weir in relation to the pool elevation.

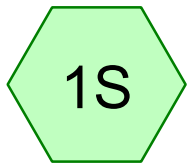
Reference: Pool Area-Elevation-Discharge Graph

Duration-Elevation Table

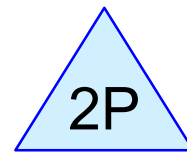
5-year		10-year		25-year		100-year	
Duration	Elevation	Duration	Elevation	Duration	Elevation	Duration	Elevation
0	1092.54	0	1092.73	0	1092.98	0	1093.37
2	1092.07	2	1092.14	2	1092.29	2	1092.5
4	1091.76	4	1091.8	4	1091.87	4	1091.96
6	1091.67	6	1091.69	6	1091.74	6	1091.79
8	1091.64	8	1091.67	8	1091.70	8	1091.74
10	1091.62	10	1091.63	10	1091.66	10	1091.7
12	1091.58	12	1091.61	12	1091.62	12	1091.66
14	1091.55	14	1091.56	14	1091.58	14	1091.61
16	1091.50	16	1091.51	16	1091.53	16	1091.56
18	1091.50	18	1091.5	18	1091.50	18	1091.51
20	1091.50	20	1091.5	20	1091.50	20	1091.5
22	1091.50	22	1091.5	22	1091.50	22	1091.5
24	1091.50	24	1091.5	24	1091.50	24	1091.5

Note: Tables denoting the length of time the pool stays at a specific elevation given the storm return period.

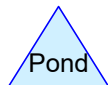
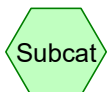
Reference: Duration-Elevation Graph



Henderson Watershed



Henderson Pond



Project Notes

Rainfall events imported from "NRCS-Rain.txt" for 1484 IA Story

Henderson_final

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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-Year	MSE 24-hr	3	Default	24.00	1	2.73	2
2	10-Year	MSE 24-hr	3	Default	24.00	1	4.50	2
3	25-Year	MSE 24-hr	3	Default	24.00	1	5.42	2
4	100-Year	MSE 24-hr	3	Default	24.00	1	6.98	2

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
182.000	81	Row Crop (1S)
182.000	81	TOTAL AREA

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	182.000	182.000	Row Crop	1S
0.000	0.000	0.000	0.000	182.000	182.000	TOTAL AREA	

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MSE 24-hr 3 1-Year Rainfall=2.73"

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Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Henderson Watershed Runoff Area=182.000 ac 0.00% Impervious Runoff Depth=1.11"
Flow Length=4,701' Tc=92.4 min CN=81 Runoff=83.95 cfs 16.829 af

Pond 2P: Henderson Pond Peak Elev=1,092.18' Storage=4.834 af Inflow=83.95 cfs 16.829 af
Primary=81.01 cfs 16.829 af Secondary=0.00 cfs 0.000 af Outflow=81.01 cfs 16.829 af

Total Runoff Area = 182.000 ac Runoff Volume = 16.829 af Average Runoff Depth = 1.11"
100.00% Pervious = 182.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Henderson Watershed

Runoff = 83.95 cfs @ 13.27 hrs, Volume= 16.829 af, Depth= 1.11"
 Routed to Pond 2P : Henderson Pond

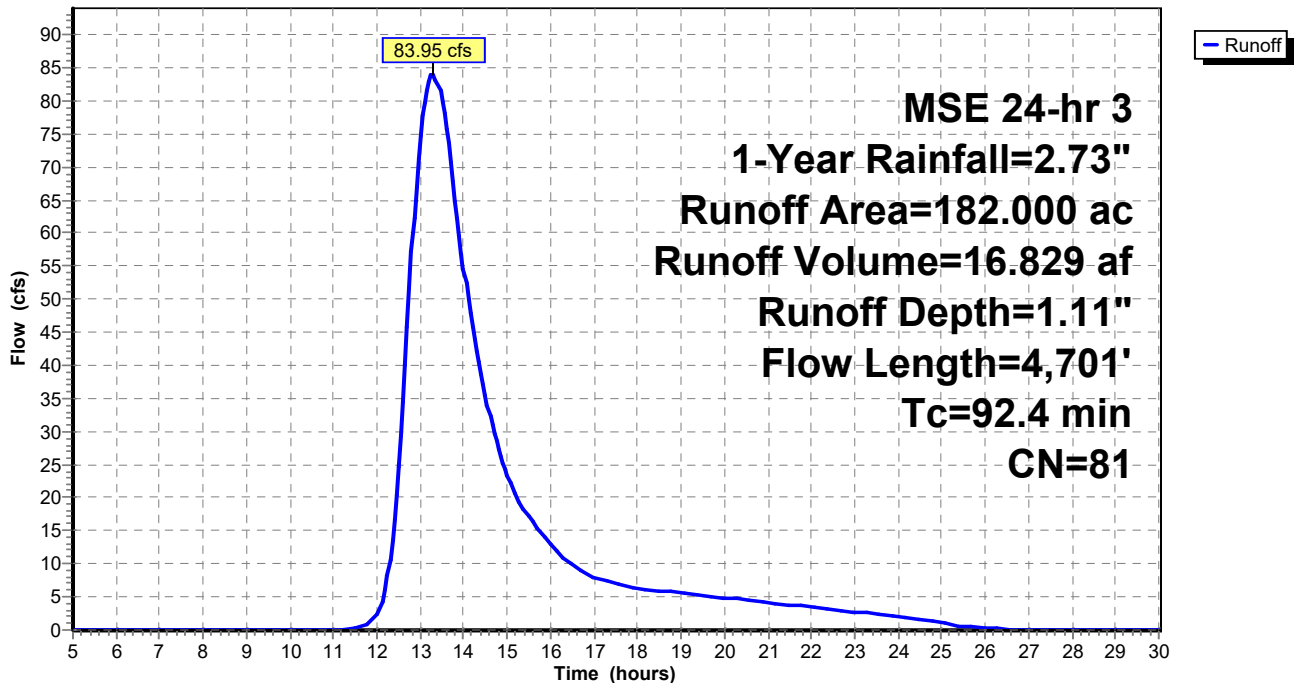
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
 MSE 24-hr 3 1-Year Rainfall=2.73"

Area (ac)	CN	Description
* 182.000	81	Row Crop
182.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.1	100	0.0050	0.09		Sheet Flow, Cultivated: Residue>20% n= 0.170 P2= 3.12"
73.3	4,601	0.0135	1.05		Shallow Concentrated Flow, Cultivated Straight Rows Kv= 9.0 fps
92.4	4,701	Total			

Subcatchment 1S: Henderson Watershed

Hydrograph



Summary for Pond 2P: Henderson Pond

Inflow Area = 182.000 ac, 0.00% Impervious, Inflow Depth = 1.11" for 1-Year event
 Inflow = 83.95 cfs @ 13.27 hrs, Volume= 16.829 af
 Outflow = 81.01 cfs @ 13.46 hrs, Volume= 16.829 af, Atten= 3%, Lag= 11.9 min
 Primary = 81.01 cfs @ 13.46 hrs, Volume= 16.829 af
 Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
 Starting Elev= 1,091.50' Storage= 3.360 af
 Peak Elev= 1,092.18' @ 13.46 hrs Storage= 4.834 af (1.474 af above start)

Plug-Flow detention time= 122.0 min calculated for 13.442 af (80% of inflow)
 Center-of-Mass det. time= 19.4 min (917.2 - 897.8)

Volume	Invert	Avail.Storage	Storage Description
#1	1,087.00'	11.060 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
1,087.00	0.000
1,087.50	0.030
1,088.00	0.080
1,088.50	0.160
1,089.00	0.290
1,089.50	0.500
1,090.00	0.800
1,090.50	1.430
1,091.00	2.370
1,091.50	3.360
1,092.00	4.420
1,092.50	5.550
1,093.00	6.760
1,093.50	8.080
1,094.00	9.510
1,094.50	11.060

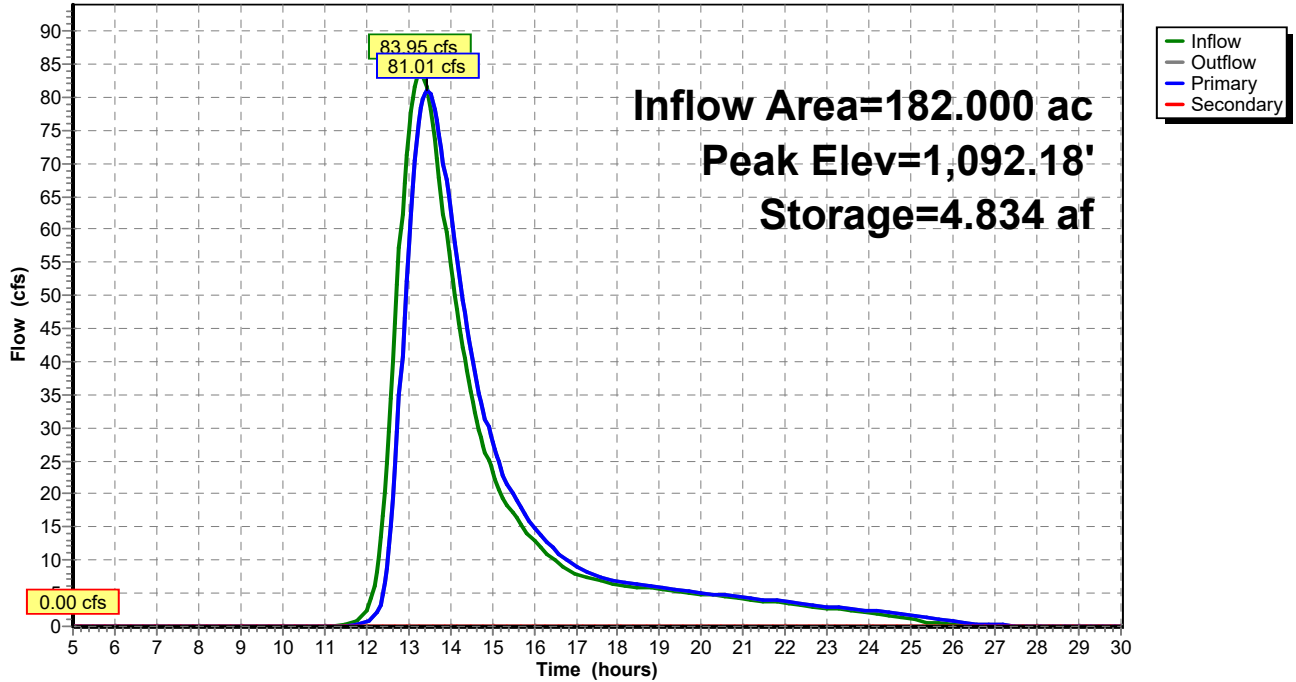
Device	Routing	Invert	Outlet Devices
#1	Primary	1,091.50'	44.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Secondary	1,094.00'	20.0' long + 3.0 ' SideZ x 30.0' breadth Broad-Crested Rectangular Weir (aux.)
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=80.93 cfs @ 13.46 hrs HW=1,092.18' (Free Discharge)
 ↑1=Sharp-Crested Rectangular Weir (Weir Controls 80.93 cfs @ 2.70 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,091.50' (Free Discharge)
 ↑2=Broad-Crested Rectangular Weir (aux. spillway) Controls 0.00 cfs)

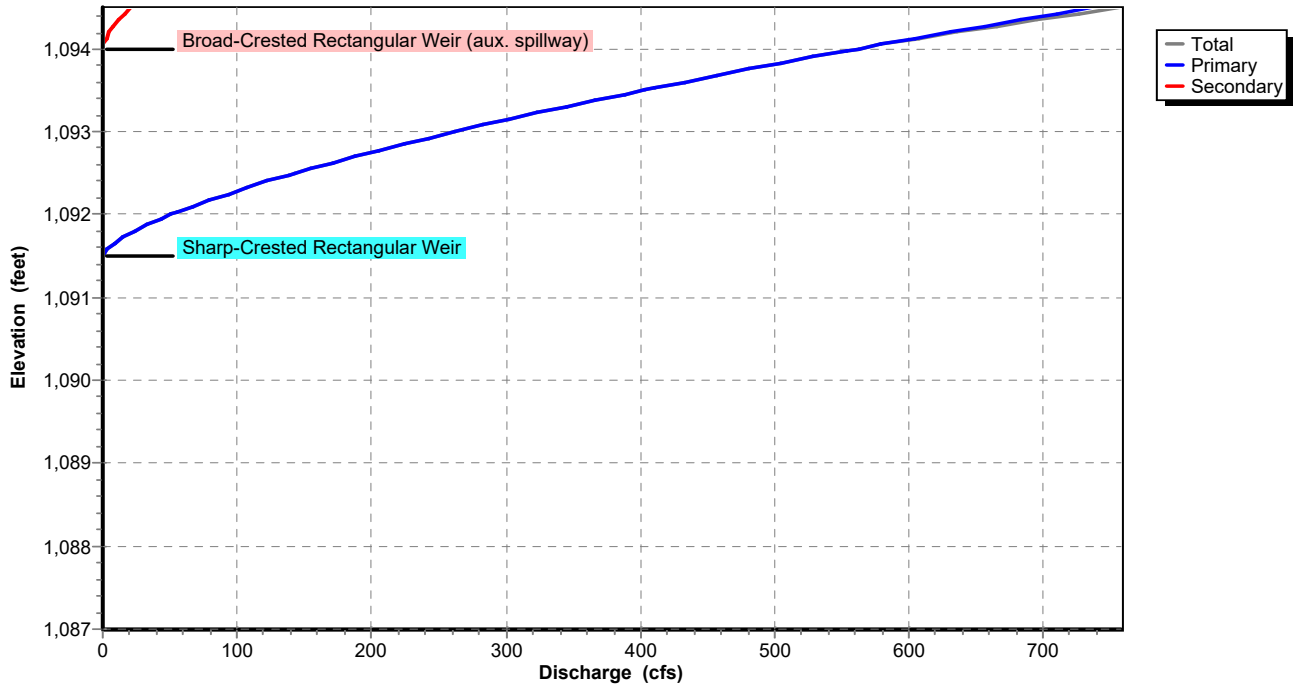
Pond 2P: Henderson Pond

Hydrograph

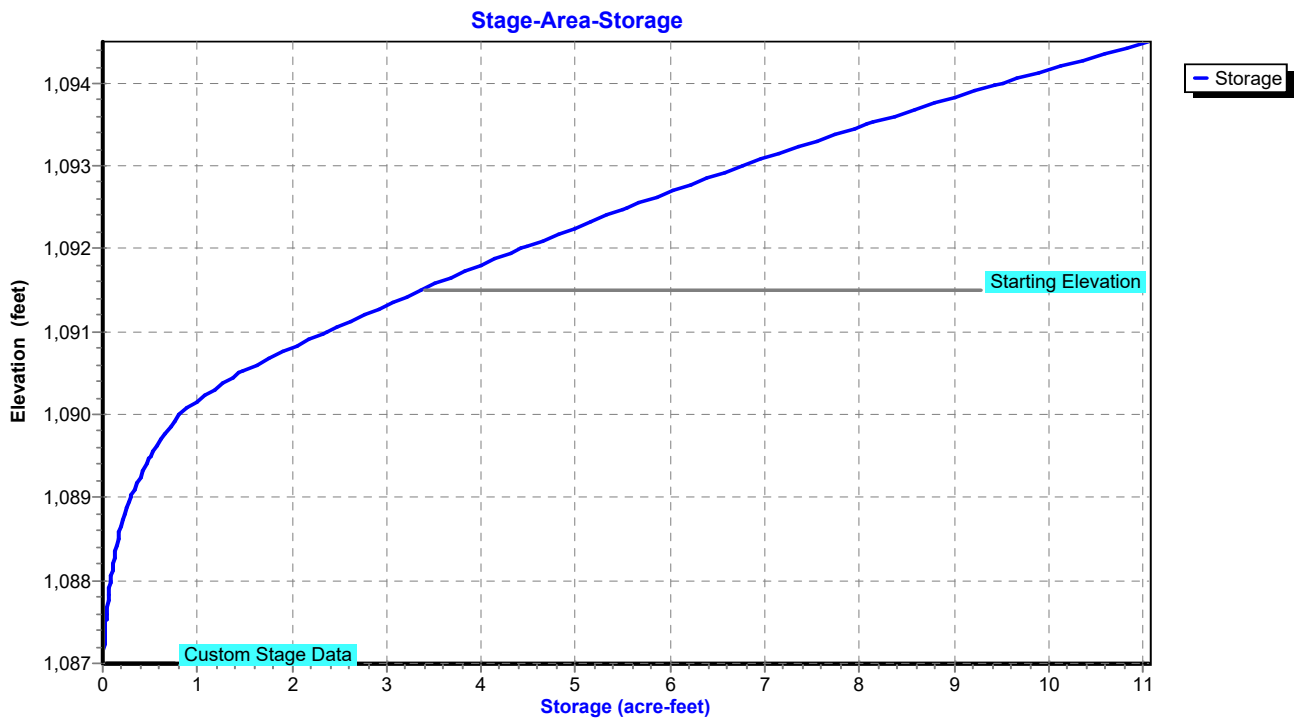


Pond 2P: Henderson Pond

Stage-Discharge



Pond 2P: Henderson Pond



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MSE 24-hr 3 10-Year Rainfall=4.50"

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Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Henderson Watershed Runoff Area=182.000 ac 0.00% Impervious Runoff Depth=2.55"
Flow Length=4,701' Tc=92.4 min CN=81 Runoff=199.37 cfs 38.646 af

Pond 2P: Henderson Pond Peak Elev=1,092.73' Storage=6.101 af Inflow=199.37 cfs 38.646 af
Primary=194.66 cfs 38.645 af Secondary=0.00 cfs 0.000 af Outflow=194.66 cfs 38.645 af

Total Runoff Area = 182.000 ac Runoff Volume = 38.646 af Average Runoff Depth = 2.55"
100.00% Pervious = 182.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Henderson Watershed

Runoff = 199.37 cfs @ 13.24 hrs, Volume= 38.646 af, Depth= 2.55"
 Routed to Pond 2P : Henderson Pond

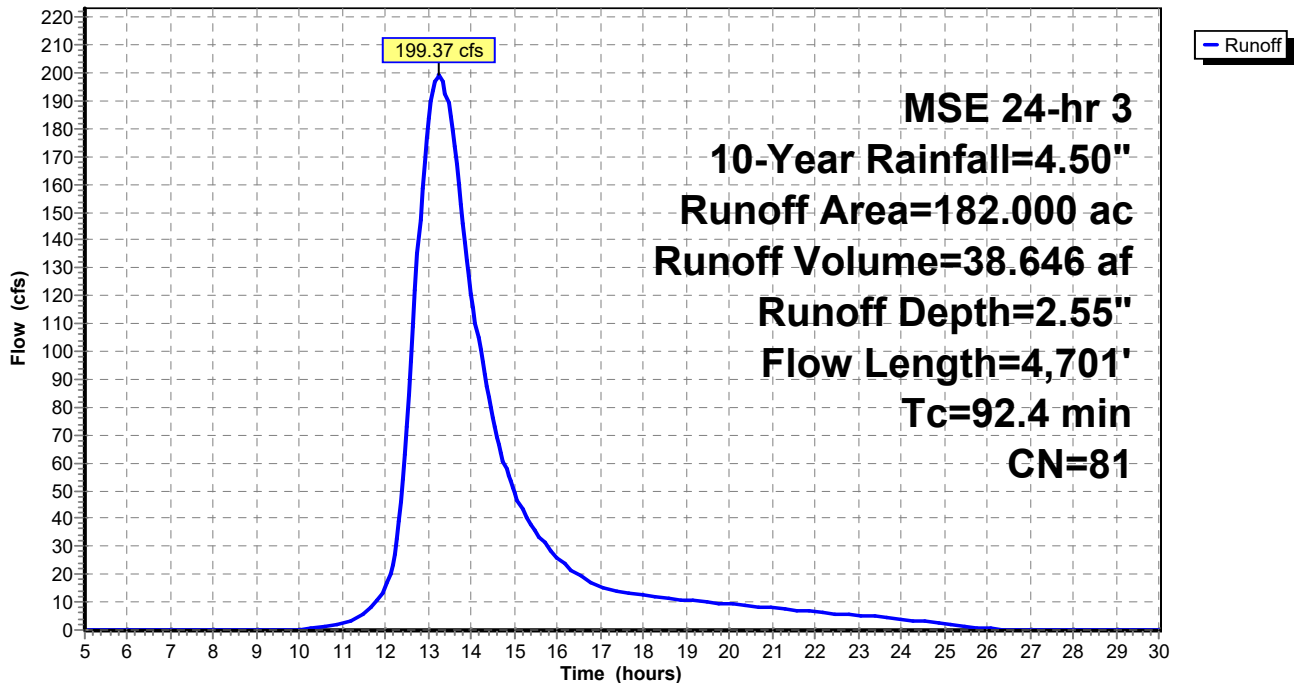
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
 MSE 24-hr 3 10-Year Rainfall=4.50"

Area (ac)	CN	Description
* 182.000	81	Row Crop
182.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.1	100	0.0050	0.09		Sheet Flow, Cultivated: Residue>20% n= 0.170 P2= 3.12"
73.3	4,601	0.0135	1.05		Shallow Concentrated Flow, Cultivated Straight Rows Kv= 9.0 fps
92.4	4,701	Total			

Subcatchment 1S: Henderson Watershed

Hydrograph



Summary for Pond 2P: Henderson Pond

Inflow Area = 182.000 ac, 0.00% Impervious, Inflow Depth = 2.55" for 10-Year event
 Inflow = 199.37 cfs @ 13.24 hrs, Volume= 38.646 af
 Outflow = 194.66 cfs @ 13.37 hrs, Volume= 38.645 af, Atten= 2%, Lag= 7.5 min
 Primary = 194.66 cfs @ 13.37 hrs, Volume= 38.645 af
 Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
 Starting Elev= 1,091.50' Storage= 3.360 af
 Peak Elev= 1,092.73' @ 13.37 hrs Storage= 6.101 af (2.741 af above start)

Plug-Flow detention time= 68.6 min calculated for 35.285 af (91% of inflow)
 Center-of-Mass det. time= 15.0 min (895.7 - 880.7)

Volume	Invert	Avail.Storage	Storage Description
#1	1,087.00'	11.060 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
1,087.00	0.000
1,087.50	0.030
1,088.00	0.080
1,088.50	0.160
1,089.00	0.290
1,089.50	0.500
1,090.00	0.800
1,090.50	1.430
1,091.00	2.370
1,091.50	3.360
1,092.00	4.420
1,092.50	5.550
1,093.00	6.760
1,093.50	8.080
1,094.00	9.510
1,094.50	11.060

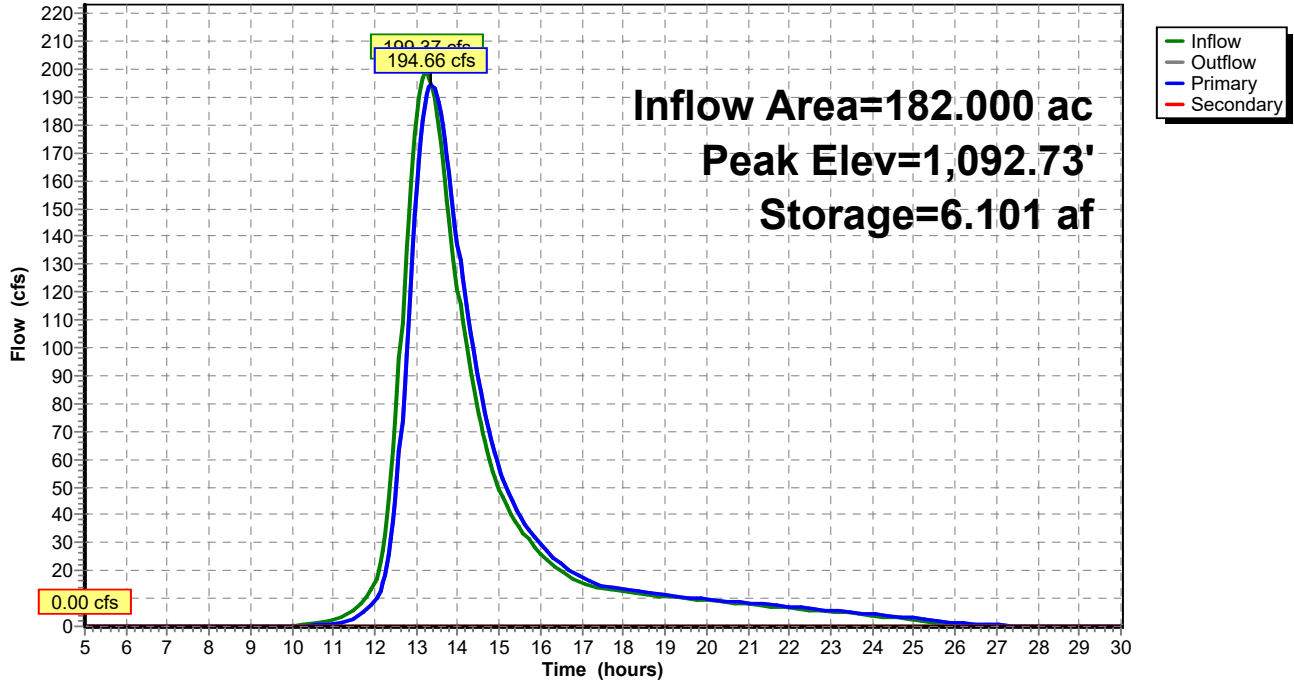
Device	Routing	Invert	Outlet Devices
#1	Primary	1,091.50'	44.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Secondary	1,094.00'	20.0' long + 3.0 ' SideZ x 30.0' breadth Broad-Crested Rectangular Weir (aux. Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=194.46 cfs @ 13.37 hrs HW=1,092.73' (Free Discharge)
 ↑1=Sharp-Crested Rectangular Weir (Weir Controls 194.46 cfs @ 3.62 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,091.50' (Free Discharge)
 ↑2=Broad-Crested Rectangular Weir (aux. spillway) Controls 0.00 cfs)

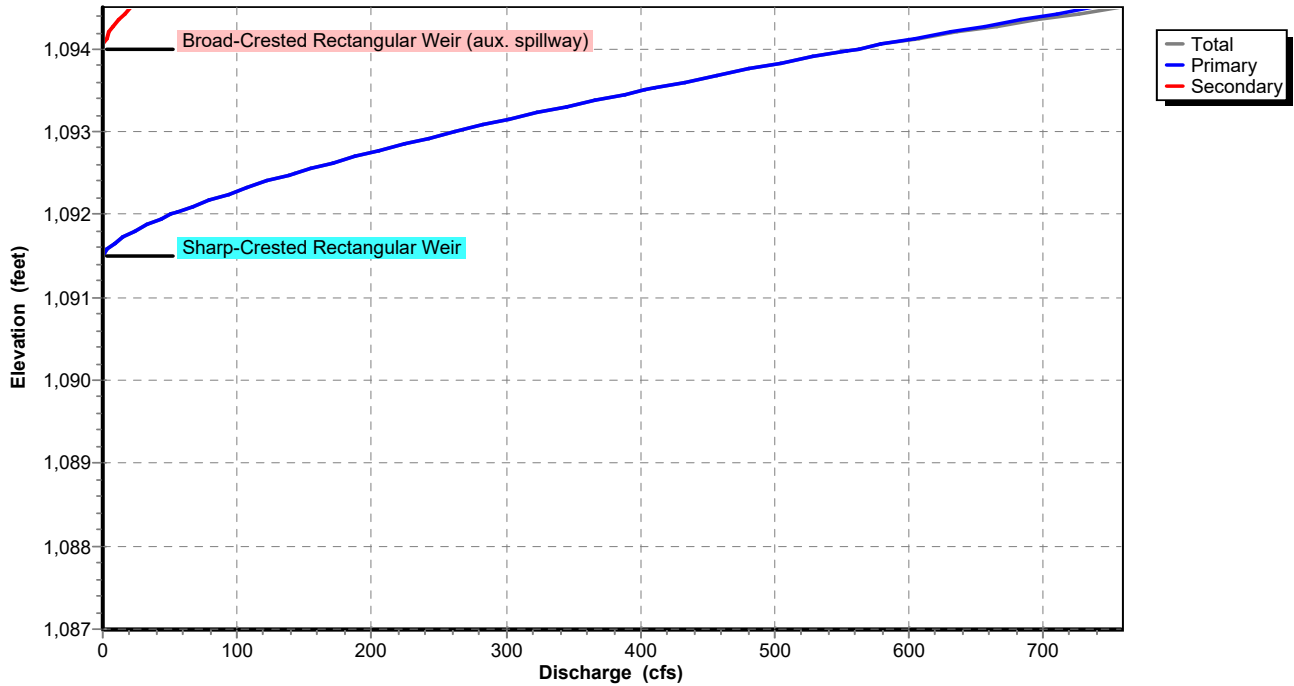
Pond 2P: Henderson Pond

Hydrograph

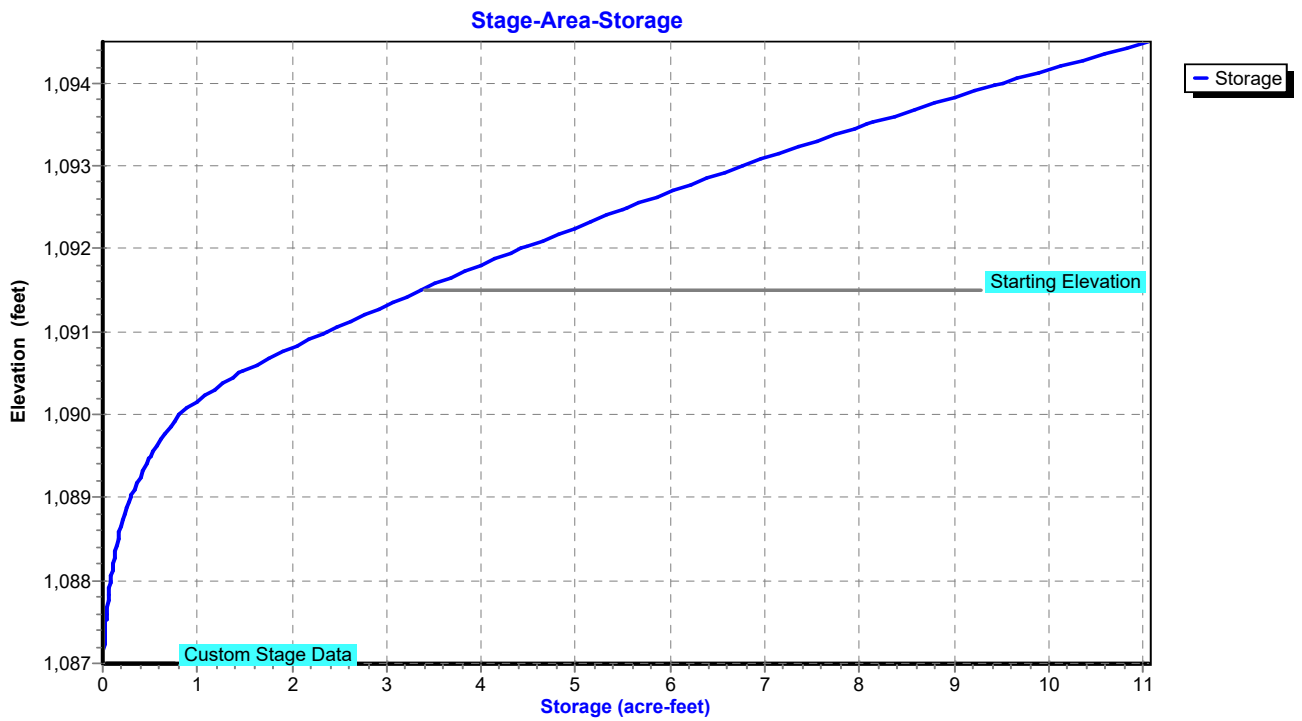


Pond 2P: Henderson Pond

Stage-Discharge



Pond 2P: Henderson Pond



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MSE 24-hr 3 25-Year Rainfall=5.42"

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Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Henderson Watershed Runoff Area=182.000 ac 0.00% Impervious Runoff Depth=3.36"
Flow Length=4,701' Tc=92.4 min CN=81 Runoff=263.49 cfs 50.949 af

Pond 2P: Henderson Pond Peak Elev=1,092.98' Storage=6.720 af Inflow=263.49 cfs 50.949 af
Primary=258.27 cfs 50.949 af Secondary=0.00 cfs 0.000 af Outflow=258.27 cfs 50.949 af

Total Runoff Area = 182.000 ac Runoff Volume = 50.949 af Average Runoff Depth = 3.36"
100.00% Pervious = 182.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Henderson Watershed

Runoff = 263.49 cfs @ 13.24 hrs, Volume= 50.949 af, Depth= 3.36"
 Routed to Pond 2P : Henderson Pond

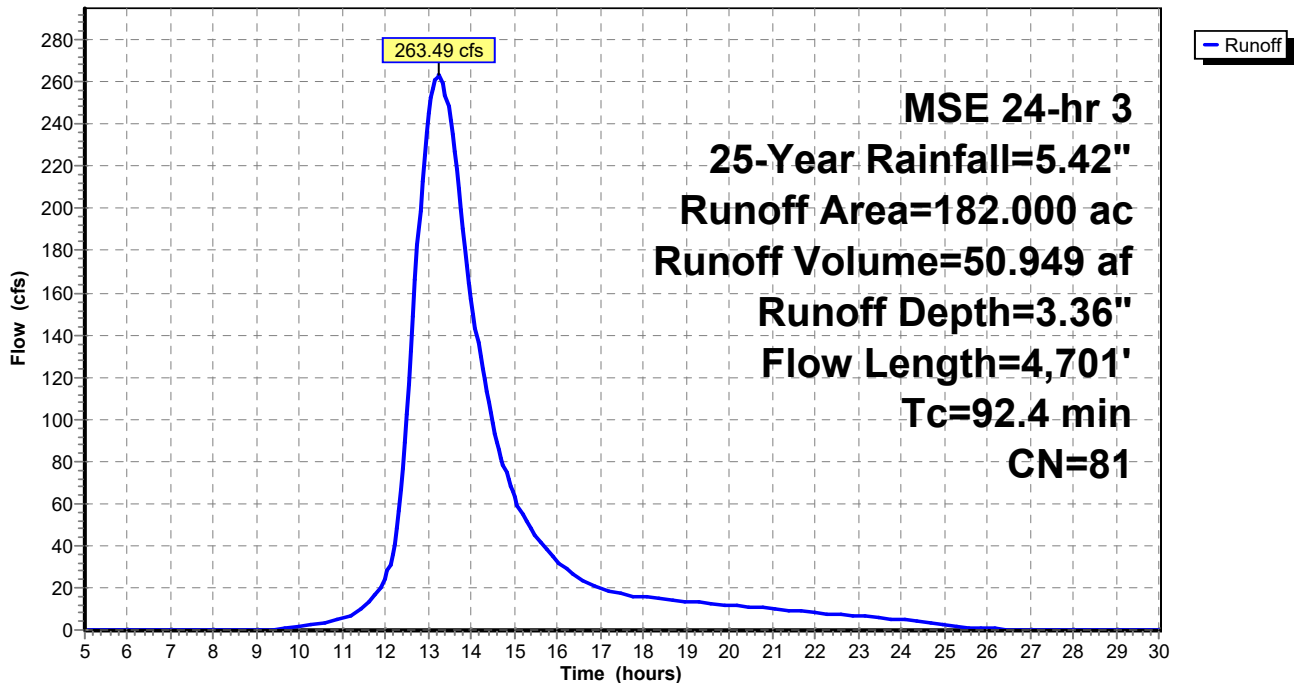
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
 MSE 24-hr 3 25-Year Rainfall=5.42"

Area (ac)	CN	Description
* 182.000	81	Row Crop
182.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.1	100	0.0050	0.09		Sheet Flow, Cultivated: Residue>20% n= 0.170 P2= 3.12"
73.3	4,601	0.0135	1.05		Shallow Concentrated Flow, Cultivated Straight Rows Kv= 9.0 fps
92.4	4,701	Total			

Subcatchment 1S: Henderson Watershed

Hydrograph



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MSE 24-hr 3 25-Year Rainfall=5.42"

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Summary for Pond 2P: Henderson Pond

Inflow Area = 182.000 ac, 0.00% Impervious, Inflow Depth = 3.36" for 25-Year event
 Inflow = 263.49 cfs @ 13.24 hrs, Volume= 50.949 af
 Outflow = 258.27 cfs @ 13.34 hrs, Volume= 50.949 af, Atten= 2%, Lag= 6.4 min
 Primary = 258.27 cfs @ 13.34 hrs, Volume= 50.949 af
 Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
 Starting Elev= 1,091.50' Storage= 3.360 af
 Peak Elev= 1,092.98' @ 13.34 hrs Storage= 6.720 af (3.360 af above start)

Plug-Flow detention time= 57.1 min calculated for 47.589 af (93% of inflow)
 Center-of-Mass det. time= 13.9 min (889.0 - 875.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,087.00'	11.060 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
1,087.00	0.000
1,087.50	0.030
1,088.00	0.080
1,088.50	0.160
1,089.00	0.290
1,089.50	0.500
1,090.00	0.800
1,090.50	1.430
1,091.00	2.370
1,091.50	3.360
1,092.00	4.420
1,092.50	5.550
1,093.00	6.760
1,093.50	8.080
1,094.00	9.510
1,094.50	11.060

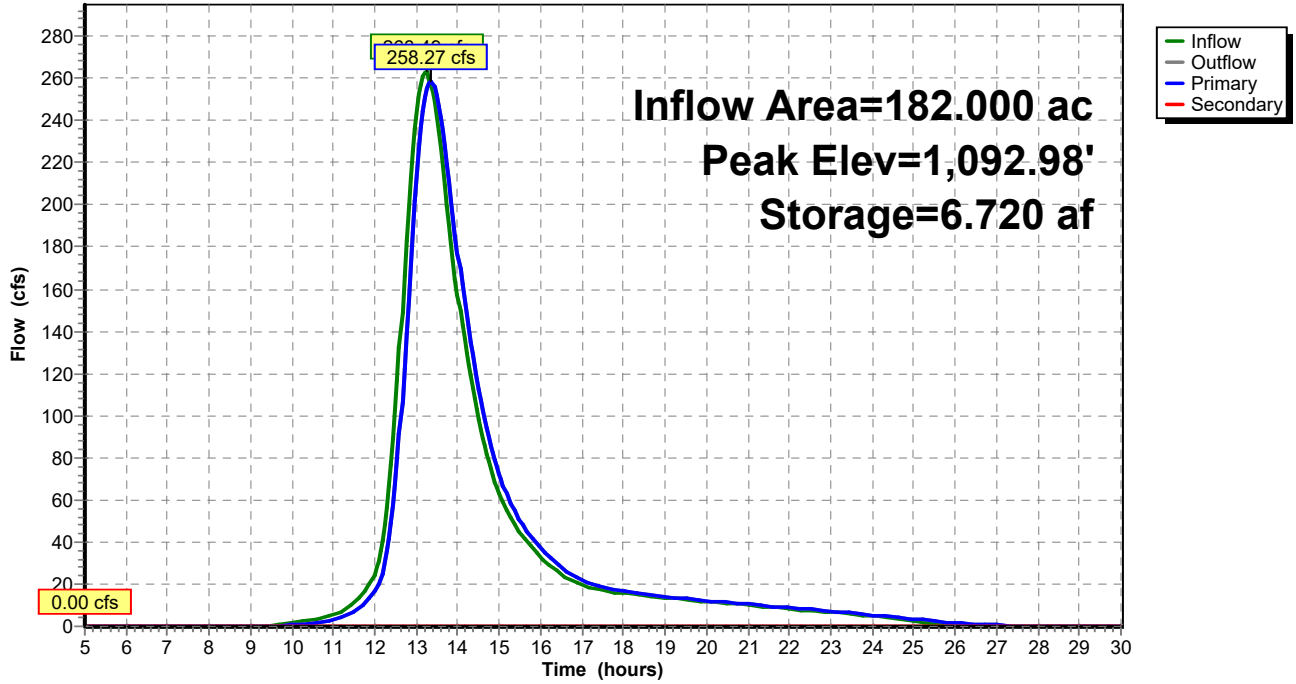
Device	Routing	Invert	Outlet Devices
#1	Primary	1,091.50'	44.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Secondary	1,094.00'	20.0' long + 3.0 ' SideZ x 30.0' breadth Broad-Crested Rectangular Weir (aux. Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=258.14 cfs @ 13.34 hrs HW=1,092.98' (Free Discharge)
 ↑1=Sharp-Crested Rectangular Weir (Weir Controls 258.14 cfs @ 3.98 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,091.50' (Free Discharge)
 ↑2=Broad-Crested Rectangular Weir (aux. spillway) Controls 0.00 cfs)

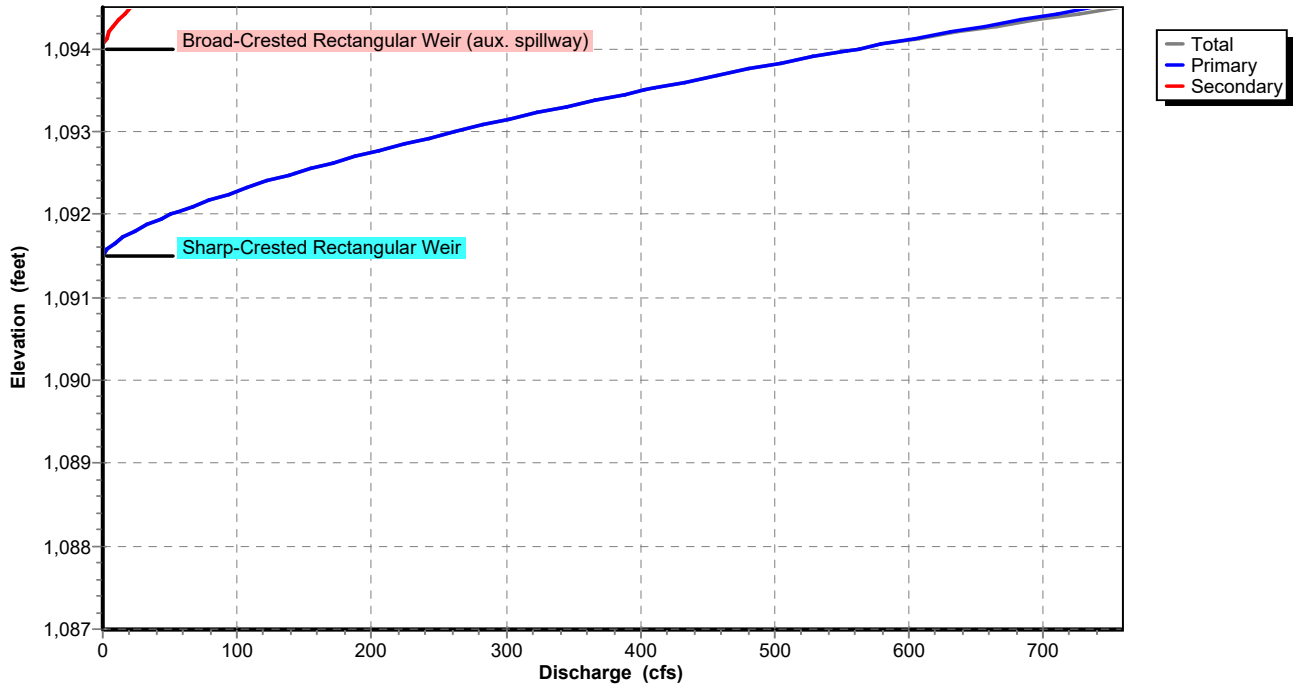
Pond 2P: Henderson Pond

Hydrograph

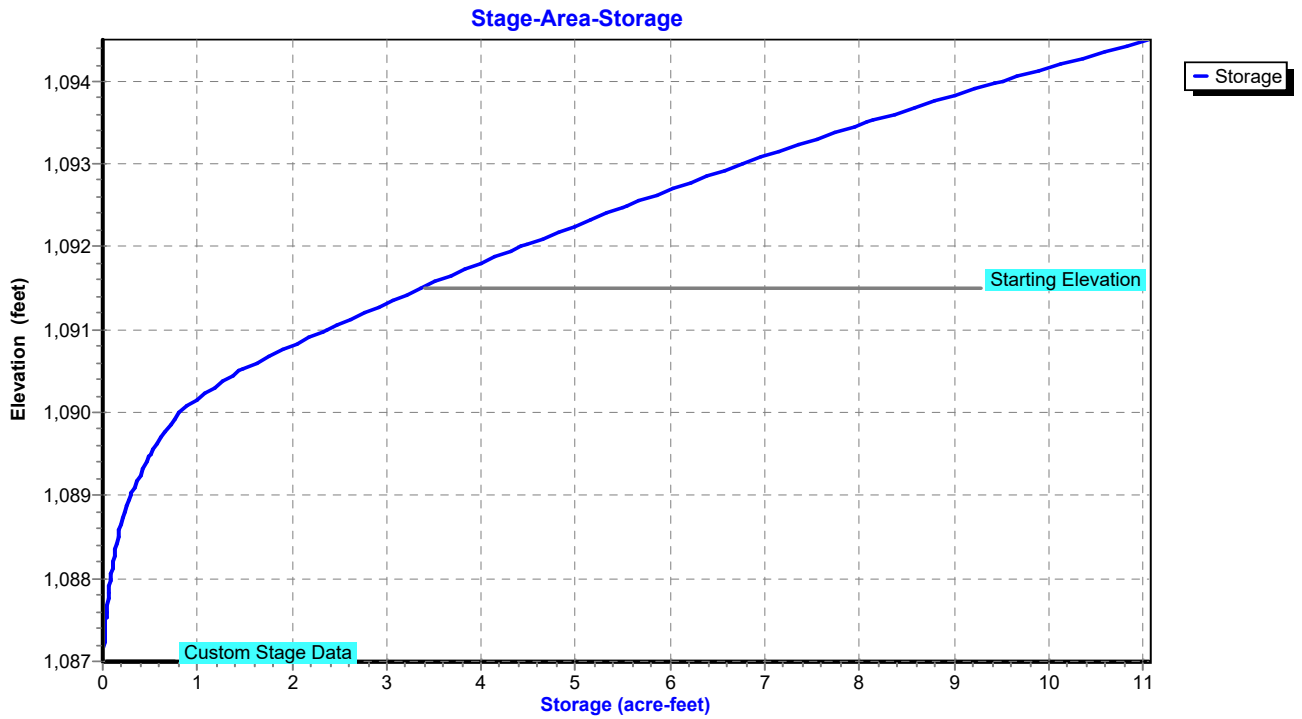


Pond 2P: Henderson Pond

Stage-Discharge



Pond 2P: Henderson Pond



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MSE 24-hr 3 100-Year Rainfall=6.98"

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Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Henderson Watershed Runoff Area=182.000 ac 0.00% Impervious Runoff Depth=4.79"
Flow Length=4,701' Tc=92.4 min CN=81 Runoff=374.72 cfs 72.594 af

Pond 2P: Henderson Pond Peak Elev=1,093.38' Storage=7.767 af Inflow=374.72 cfs 72.594 af
Primary=368.10 cfs 72.594 af Secondary=0.00 cfs 0.000 af Outflow=368.10 cfs 72.594 af

Total Runoff Area = 182.000 ac Runoff Volume = 72.594 af Average Runoff Depth = 4.79"
100.00% Pervious = 182.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Henderson Watershed

Runoff = 374.72 cfs @ 13.23 hrs, Volume= 72.594 af, Depth= 4.79"
 Routed to Pond 2P : Henderson Pond

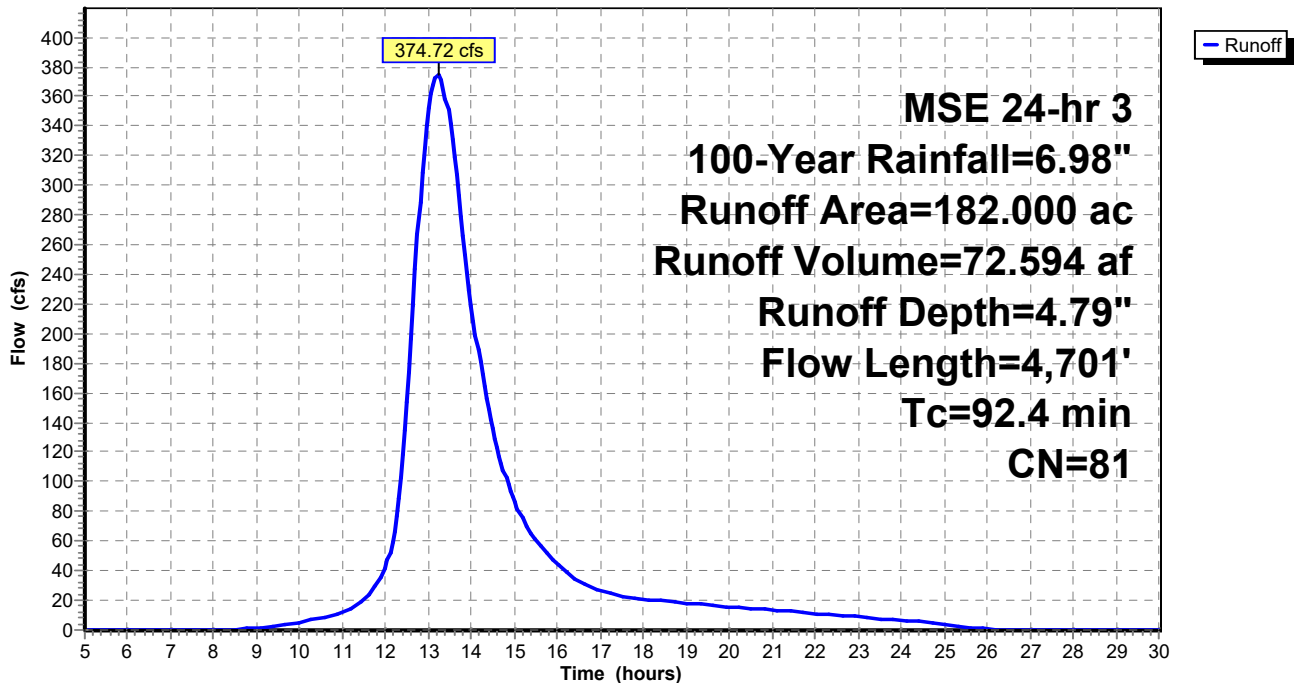
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
 MSE 24-hr 3 100-Year Rainfall=6.98"

Area (ac)	CN	Description
* 182.000	81	Row Crop
182.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.1	100	0.0050	0.09		Sheet Flow, Cultivated: Residue>20% n= 0.170 P2= 3.12"
73.3	4,601	0.0135	1.05		Shallow Concentrated Flow, Cultivated Straight Rows Kv= 9.0 fps
92.4	4,701	Total			

Subcatchment 1S: Henderson Watershed

Hydrograph



Summary for Pond 2P: Henderson Pond

Inflow Area = 182.000 ac, 0.00% Impervious, Inflow Depth = 4.79" for 100-Year event
 Inflow = 374.72 cfs @ 13.23 hrs, Volume= 72.594 af
 Outflow = 368.10 cfs @ 13.32 hrs, Volume= 72.594 af, Atten= 2%, Lag= 5.6 min
 Primary = 368.10 cfs @ 13.32 hrs, Volume= 72.594 af
 Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
 Starting Elev= 1,091.50' Storage= 3.360 af
 Peak Elev= 1,093.38' @ 13.32 hrs Storage= 7.767 af (4.407 af above start)

Plug-Flow detention time= 45.0 min calculated for 69.096 af (95% of inflow)
 Center-of-Mass det. time= 12.6 min (880.7 - 868.1)

Volume	Invert	Avail.Storage	Storage Description
#1	1,087.00'	11.060 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
1,087.00	0.000
1,087.50	0.030
1,088.00	0.080
1,088.50	0.160
1,089.00	0.290
1,089.50	0.500
1,090.00	0.800
1,090.50	1.430
1,091.00	2.370
1,091.50	3.360
1,092.00	4.420
1,092.50	5.550
1,093.00	6.760
1,093.50	8.080
1,094.00	9.510
1,094.50	11.060

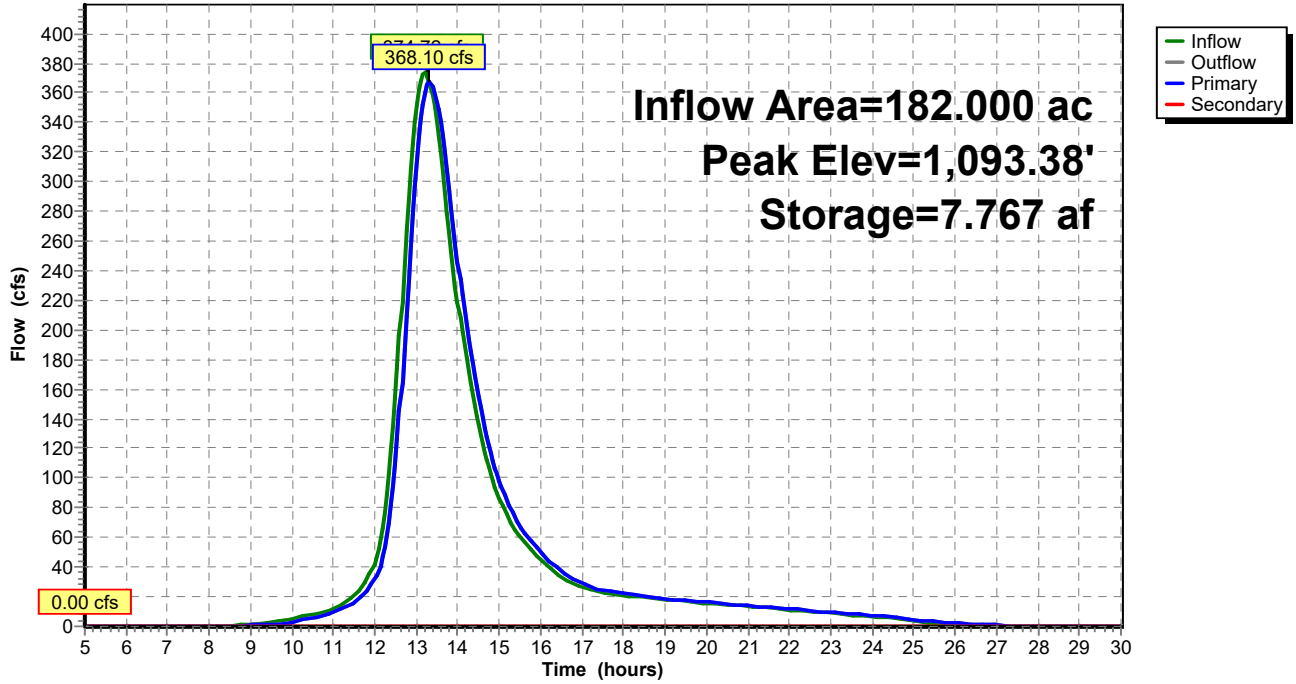
Device	Routing	Invert	Outlet Devices
#1	Primary	1,091.50'	44.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)
#2	Secondary	1,094.00'	20.0' long + 3.0 ' SideZ x 30.0' breadth Broad-Crested Rectangular Weir (aux. Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=367.75 cfs @ 13.32 hrs HW=1,093.38' (Free Discharge)
 ↑1=Sharp-Crested Rectangular Weir (Weir Controls 367.75 cfs @ 4.48 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,091.50' (Free Discharge)
 ↑2=Broad-Crested Rectangular Weir (aux. spillway) Controls 0.00 cfs)

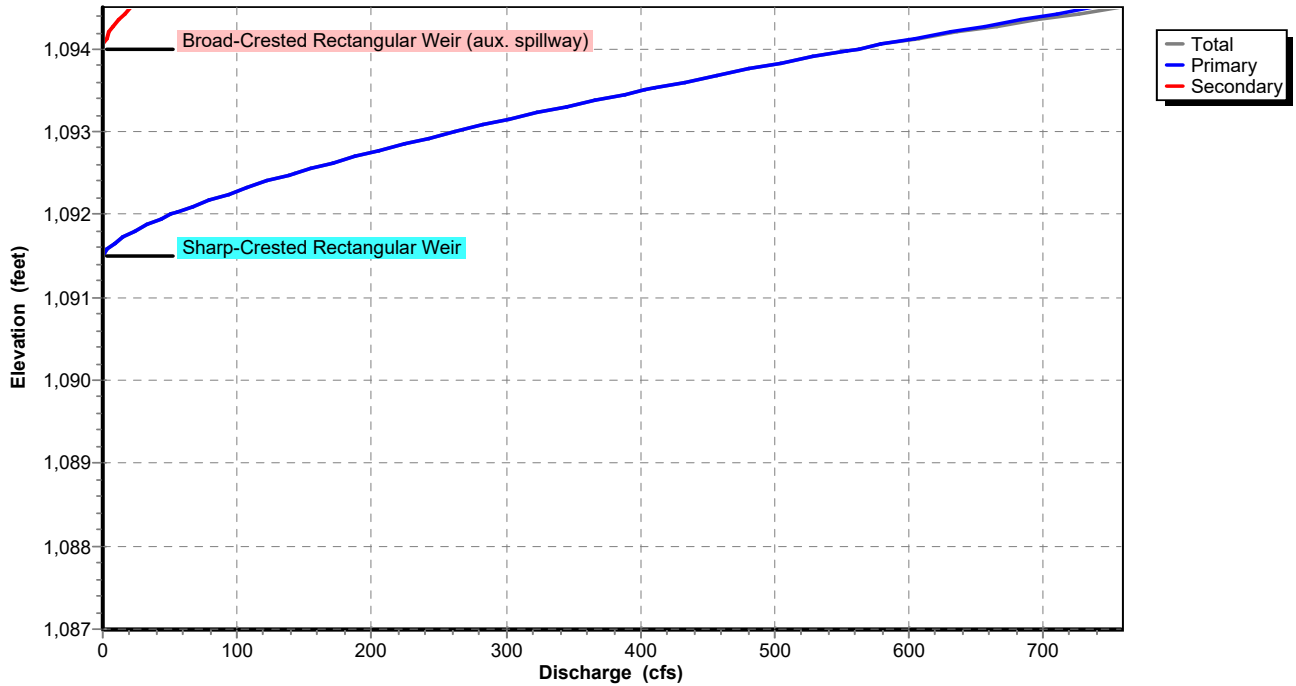
Pond 2P: Henderson Pond

Hydrograph

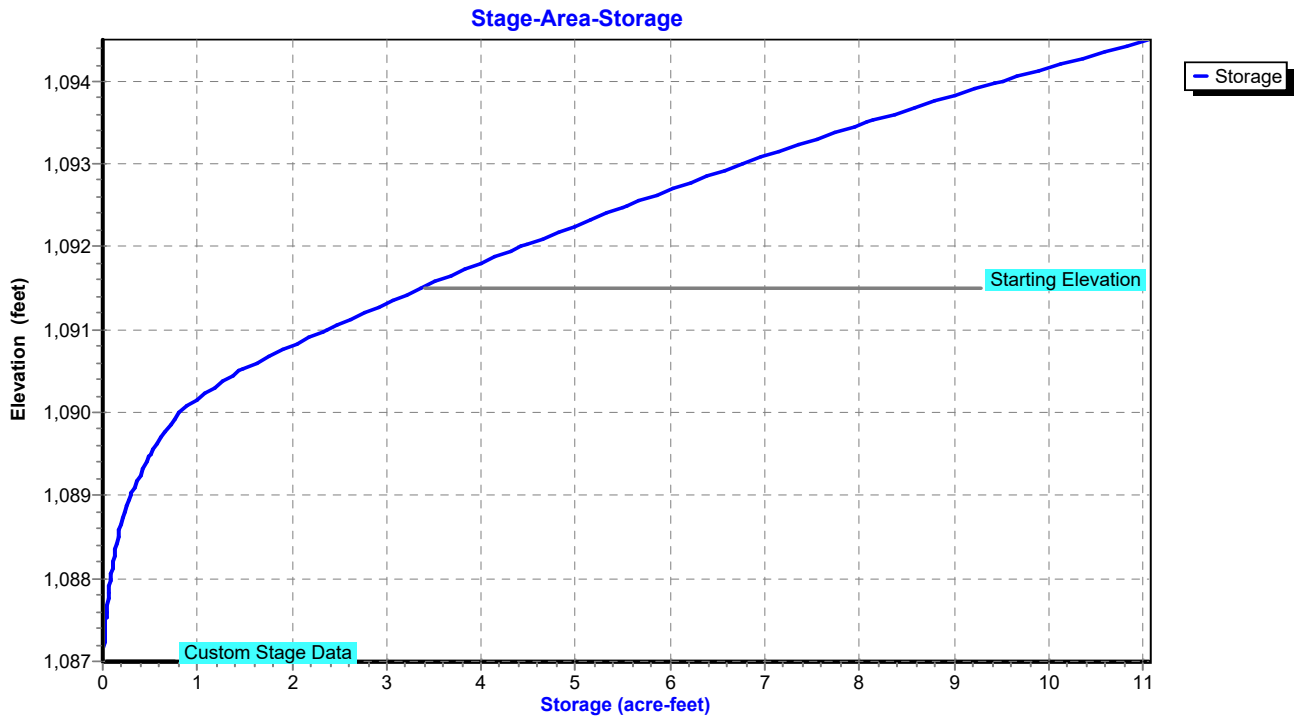


Pond 2P: Henderson Pond

Stage-Discharge



Pond 2P: Henderson Pond



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Multi-Event Tables

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Events for Subcatchment 1S: Henderson Watershed

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
1-Year	2.73	83.95	16.829	1.11
10-Year	4.50	199.37	38.646	2.55
25-Year	5.42	263.49	50.949	3.36
100-Year	6.98	374.72	72.594	4.79

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Multi-Event Tables

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Events for Pond 2P: Henderson Pond

Event	Inflow (cfs)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)	Elevation (feet)	Storage (acre-feet)
1-Year	83.95	81.01	81.01	0.00	1,092.18	4.834
10-Year	199.37	194.66	194.66	0.00	1,092.73	6.101
25-Year	263.49	258.27	258.27	0.00	1,092.98	6.720
100-Year	374.72	368.10	368.10	0.00	1,093.38	7.767

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