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Hydrology and Hydraulics Report for the Johnson Wetland Site

IDALS ID No. **FLO971523B**
BMI Project No. **0T7130786**
Site Location: **Floyd County, Iowa NW 1/4 of Section 23, T-97N, R-15W**

Design Parameters and Procedures:

Design hydrology and hydraulic study of this site was completed. The drainage area was determined and a stage-area-storage curve was developed based on the topographic survey, Lidar data available from the Iowa Department of Natural Resources, and grading design for the wetland. 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.

Rainfall events used for this site were MSE 3 distribution, 24-hour, 5-, 10-, 25-, and 100-year events. The primary spillway is a sheet pile weir. The secondary (auxiliary) spillway is a grass waterway. The pool and outlets are designed such that the 10-year outflow passes only through the primary spillway, and the 100-year storm passes through the primary and auxiliary spillways with greater than one foot of freeboard to the top of the embankment.

Hydrology Analysis Summary

25-year Event: **5.60''** **100-year Event:** **7.5''**

* Hydrologic Soil Groups: B, C
* Runoff Curve Number: 85.0 (based on Land use shown in this report)
* Primary Spillway Weir Coefficent = 3.1
* Design life: 150 years for accumulated sediment
* Tc = 4.0 hours determined by the sum of sheet, shallow concentrated and channel flow times.

Additional Site Analysis Data

* Sediment delivery is 10%, with a trap efficency of 60%.
* The normal pool will contain 80% of the trapped sediment for the 150-year design life.
* Aerated sediment deposited will reduce flood storage by 0.23 acre-feet
* Normal Pool area is 5.42 ac; surface watershed area is approx. 766 ac or 1.2 square miles

Summary Table:
Aux Spillway Elevation: 1174.50

	Q_{max} In (cfs)	Q_{max} Out (cfs)	Max Elev (ft)	Duration - Hours at elevation		
				1173.40	1173.00	1172.50
5-year	364.19	357.78	1173.47	1.2	3.5	7.2
10-year	466.40	458.61	1173.72	2.5	4.3	8.1
25-year	630.33	620.45	1174.10	3.6	5.3	9.4
100-year	917.63	904.33	1174.67	4.8	6.6	11.3

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Reviewed By: JPR Date: 5/20/24

Rainfall Data

Surface-Drained DA = 766 ac
= 1.2 sq mi

The following rainfall data was used for the hydrology analysis of the site. Rainfall depths from three sources were compared, and the greatest depth was used to provide a conservative estimate of flood depths.

Frequency	24-hr		
yr	in [1]	in [3]	in [4]
2	3.06	3.06	3.10
5	3.82	3.83	3.80
10	4.52	4.55	4.50
25	5.56	5.67	5.60
50	6.45	6.63	6.50
100	7.40	7.68	7.50

References

[ ] Box indicates value used as required by NRCS design standards

[1] NOAA Atlas 14, Volume 8, Version 2

[3] SUDAS Design 2022 Edition

[4] 24-hour rainfall depths by county from NEH Title 210 (Figure IA2-25)

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Tributary Watershed Data

Watershed	Area (ac)	Area (sq. mi.)	Tile/Surface Drained
Main Watershed	766	1.20	Surface & Tile

Surface Total	766	1.20	(includes pothole trapped)
Tile Total	766	1.20	(pumped and gravity)

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Runoff Curve Number

Surface-Drained DA = 766 ac
= 1.2 sq mi

Soil Name[1]	HSG[1]	Cover Type and Hyd. Condition	Portion of W/S percent	CN[2]	Product
Tripoli Clay Loam, Readlyn Silt Loam, Maxfield Silt Loam, et al	C/D	Straight Row Crops, Good	95.0%	85	80.75
Basset Loam, et al	B	Straight Row Crops, Good	5.0%	78	3.9
		Total	100.0%		84.7

References

[1] USDA - NRCS Soil Survey of Floyd County, Iowa.

[2] USDA - NRCS Technical Release 55, Chapter 2, June 1986.

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Sediment Calculations

Surface-Drained DA = 766 ac
= 1.2 sq mi

DA[1]		766	acres	1.197	sqmi
Trap efficiency, very short storage time[2]				60	percent
Average annual sheet and rill erosion[3]				1.0	tons/ac/yr
Area of depressions not subject to sediment delivery				0	acres
Area subject to sheet and rill erosion				766	acres
Average annual sheet and rill erosion				741	tons
Delivery ratio[5]				10.0	percent
Sheet and rill erosion delivered to site				74.1	tons/yr
Adjustment for LRA 103[2]				0.3	factor
Adjusted sheet and rill erosion delivered				22.2	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				22.2	t/yr
Weight of sediment retained in resevoir at		60.0	percent trapped[2]	13	t/yr
Sediment accumulation during		150	-year period	2,000	tons
Estimate	80	percent of delivered sediment will not be submerged[2]		1,600	tons
Volume of submerged sediment at		1,307	t/acft[2]	1.22	acft
Normal pool volume		5.3	acft, will not be full		
Estimate	20	percent of delivered sediment will be aerated[2]		400	tons
Volume of aerated sediment at		1,742	t/acft[2]	0.23	acft

References

[1] Determined by Engineer

[2] USDA-NRCS, Engr. Field Man., Chap. 11, Amend. IA 27, Fig.2, May 1986,. Adjusted. See notes.

[3] Estimated by preparer.

[4] Estimated by preparer.

[5] Delivery curve for Des Moines lobe. Source: Iowa Geological Survey.

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Stage-Storage

Surface-Drained DA = 766 ac
= 1.2 sq mi

Contour Elev.	Area (sq ft)	Area (Acres)	Average Area (Arces)	Incremental Volume (Ac-ft)	Cumulative Volume (Ac-ft)	Volume Above Weir (Ac-ft)	Allow for Aerated Seditment (Ac-ft)	Temporary Flood Storage (Ac-ft)
1166.00	331	0.01	0.01	0.00	0.00			
1167.00	711	0.02	0.01	0.01	0.01			
1168.00	4142	0.10	0.06	0.06	0.07			
1169.00	24171	0.55	0.32	0.32	0.39			
1170.00	83379	1.91	1.23	1.23	1.63			
1171.00	**236030**	**5.42**	**3.67**	**3.67**	**5.29**	**0.00**	**0.00**	**0.00**
1172.00	245478	5.64	5.53	5.53	10.82	5.53	0.23	5.30
1173.00	291555	6.69	6.16	6.16	16.98	11.69	0.23	11.46
1174.00	357974	8.22	7.46	7.46	24.44	19.15	0.23	18.92
1175.00	477389	10.96	9.59	9.59	34.03	28.74	0.23	28.51
1175.50	**546969**	**12.56**	**11.76**	**5.88**	**39.91**	**34.61**	**0.23**	**34.38**

Storage at Normal Pool	**5.29**	**Acre-feet**
Elevation of weir =		**1171.00**
Storage at top of Dike	**39.91**	**Acre-feet**
Elevation =		**1175.50**

Average Depth = storage at normal pool / area at normal pool

Average Depth = 0.98 feet

Notes:

Storage areas include final earthwork borrow in pool area. Contour data is compiled from LiDAR, topographic survey, and proposed grading.

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Weir Flow Hydraulics

DA = 766 ac
= 1.2 sq mi

Input

$Q = CLH^{1.5}$ Use C = 3.1

100-year inflow = 918 cfs

Output

Pool El. = 1171.00

Weir Length (ft)	40	**45**	50	55	60
W.S. Elev.	Q - cfs	Q - cfs	Q - cfs	Q - cfs	Q - cfs
1171.00	0.0	0.0	0.0	0.0	0.0
1171.28	18.5	20.8	23.1	25.4	27.7
1171.56	52.3	58.9	65.4	71.9	78.5
1171.84	96.1	108.1	120.1	132.1	144.2
1172.13	148.0	166.5	185.0	203.4	221.9
1172.41	206.8	232.6	258.5	284.3	310.2
1172.69	271.8	305.8	339.8	373.8	407.7
1172.97	342.5	385.4	428.2	471.0	513.8
1173.25	418.5	470.8	523.1	575.4	627.8
1173.53	499.4	561.8	624.2	686.6	749.1
1173.81	584.9	658.0	731.1	804.2	877.3
1174.09	674.8	759.1	843.5	927.8	1012.1
1174.38	768.8	864.9	961.0	1057.1	1153.3
1174.66	866.9	975.3	1083.6	1192.0	1300.4
1174.94	968.8	1089.9	1211.1	1332.2	1453.3
1175.22	1074.5	1208.8	1343.1	1477.4	1611.7
MAX POOL 1175.50	1183.7	1331.7	1479.6	1627.6	1775.5
		USED			

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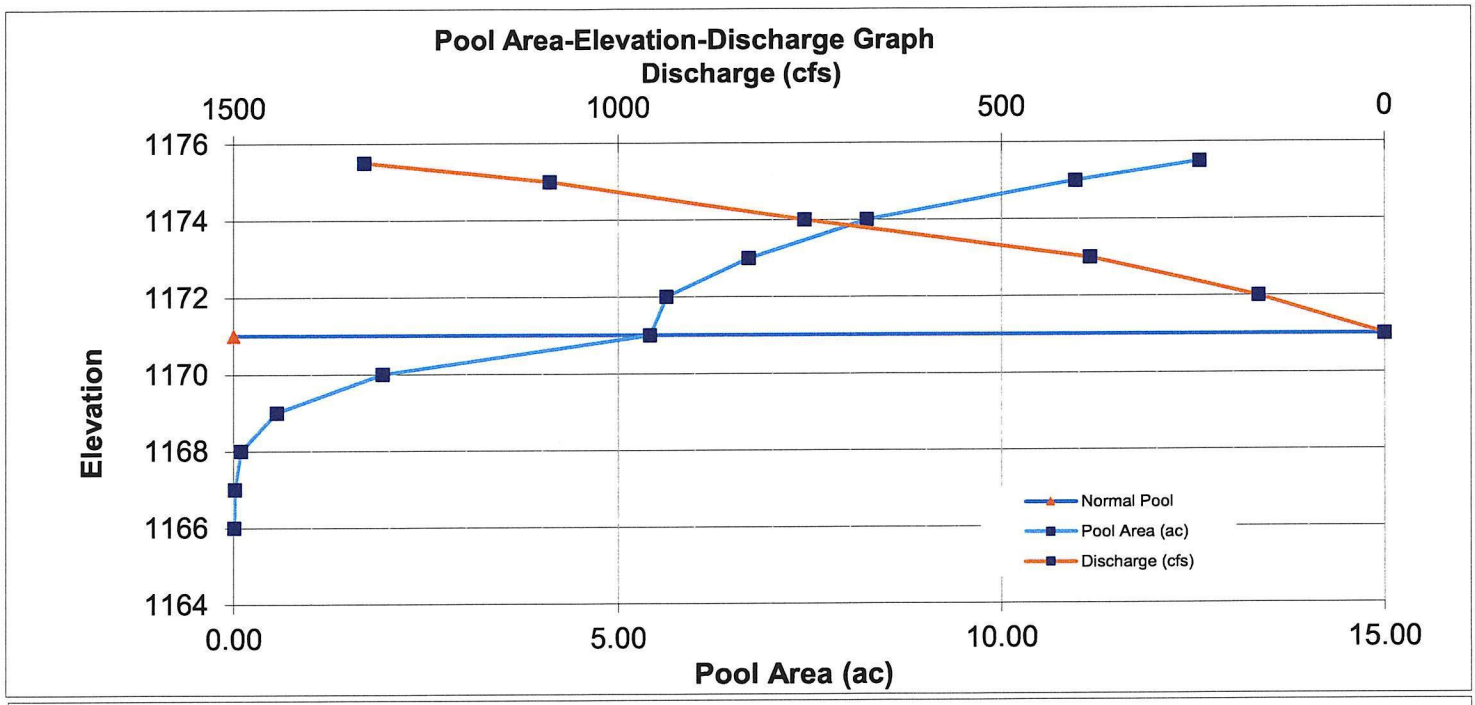
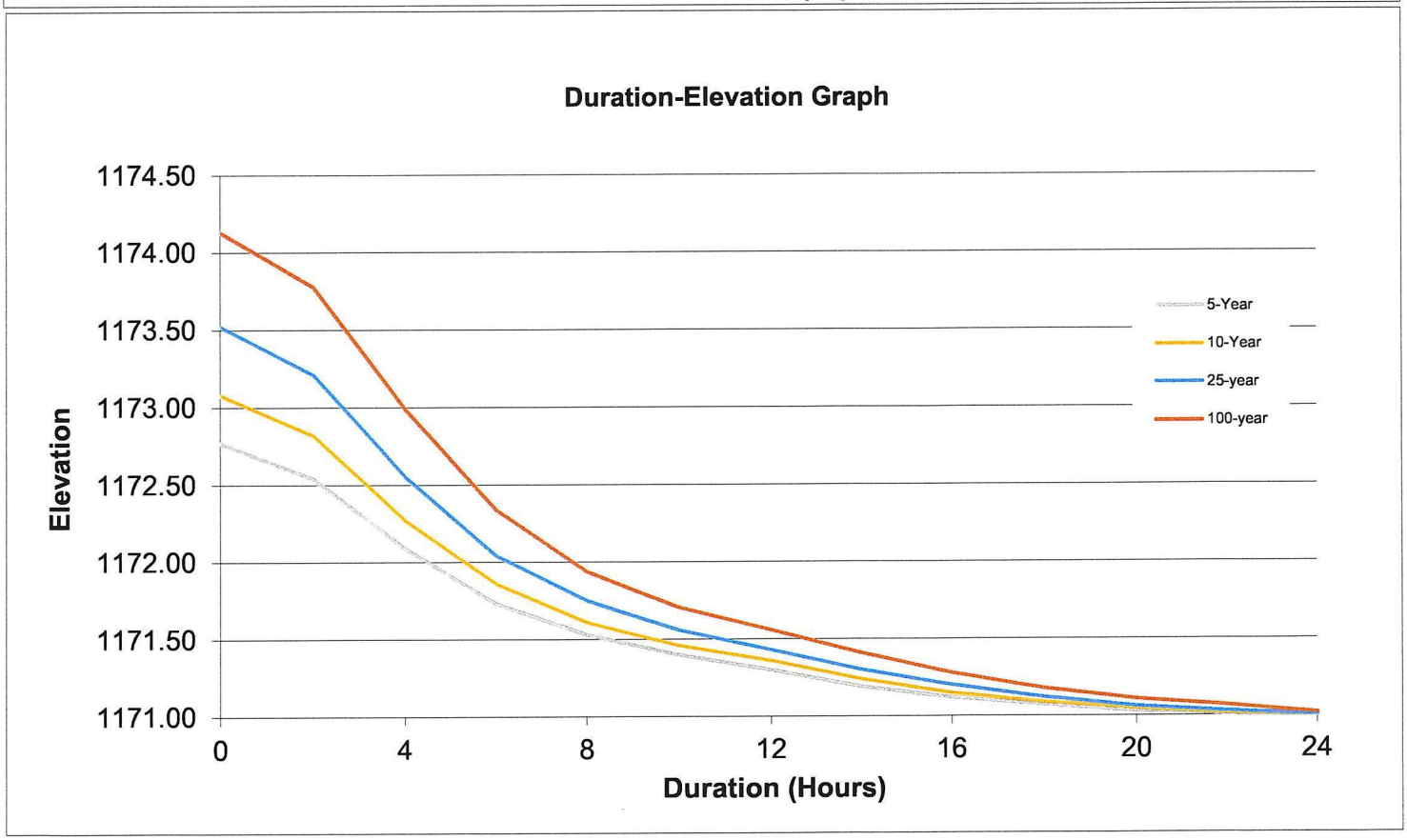
Results

Surface-Drained DA = 766 ac = 1.2 sq mi

The following are based on surface flows and storm response. Discharge includes tile flow and overland flow.





Results

Surface-Drained DA = 766 ac
= 1.2 sq mi

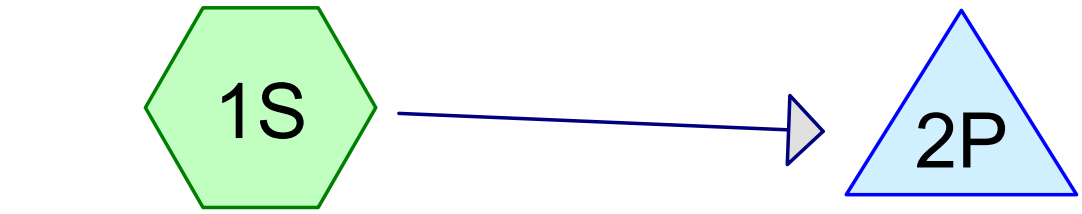
The Elevation-Discharge table below shows tile and surface outflows from the wetland for various elevations. The tile discharge is very small compared to the surface discharge at higher elevations.

Elevation	Pool Area (ac)	Total Discharge (cfs)
1166.00	0.01	0
1167.00	0.02	0
1168.00	0.10	0
1169.00	0.55	0
1170.00	1.91	0
1171.00	5.42	0
1172.00	5.64	166
1173.00	6.69	385
1174.00	8.22	759
1175.00	10.96	1090
1175.50	12.56	1332

The Duration-Elevation table below shows the duration that the pool is at each listed elevation during the design storms. This is based on surface inflows during the design storms listed. The design for the wetland is based on tile flows, but the entire watershed is analyzed, including surface flows, to show that the proposed wetland does not have adverse impacts on surrounding properties during rainfall events.

Duration-Elevation Table

5-year		10-year		25-year		100-year	
Duration	Elevation	Duration	Elevation	Duration	Elevation	Duration	Elevation
0	1172.77	0	1173.08	0	1173.52	0	1174.13
2	1172.54	2	1172.82	2	1173.21	2	1173.78
4	1172.09	4	1172.27	4	1172.55	4	1172.99
6	1171.73	6	1171.86	6	1172.04	6	1172.34
8	1171.53	8	1171.61	8	1171.75	8	1171.94
10	1171.40	10	1171.46	10	1171.56	10	1171.71
12	1171.30	12	1171.36	12	1171.43	12	1171.56
14	1171.19	14	1171.24	14	1171.30	14	1171.41
16	1171.12	16	1171.15	16	1171.20	16	1171.28
18	1171.07	18	1171.09	18	1171.12	18	1171.18
20	1171.03	20	1171.05	20	1171.06	20	1171.11
22	1171.01	22	1171.02	22	1171.03	22	1171.07
24	1171.00	24	1171.01	24	1171.01	24	1171.02



Johnson Watershed

Johnson Wetland

Subcat Reach Pond Link

Routing Diagram for 130786_Final_FutureConditions
Prepared by Bolton & Menk, Inc, Printed 5/8/2024

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	5-YR	MSE 24-hr	3	Default	24.00	1	3.80	2
2	10-YR	MSE 24-hr	3	Default	24.00	1	4.50	2
3	25-YR	MSE 24-hr	3	Default	24.00	1	5.60	2
4	100-YR	MSE 24-hr	3	Default	24.00	1	7.50	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
766.000	85	(1S)
766.000	**85**	**TOTAL AREA**

Time span=5.00-100.00 hrs, dt=0.05 hrs, 1901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Johnson Watershed Runoff Area=766.000 ac 0.00% Impervious Runoff Depth=2.28"
Flow Length=8,042' Tc=238.2 min CN=85 Runoff=364.19 cfs 145.533 af

Pond 2P: Johnson Wetland Peak Elev=1,172.77' Storage=15.417 af Inflow=364.19 cfs 145.533 af
Primary=357.29 cfs 145.533 af Secondary=0.00 cfs 0.000 af Tertiary=0.00 cfs 0.000 af Outflow=357.29 cfs 145.533 af

Total Runoff Area = 766.000 ac Runoff Volume = 145.533 af Average Runoff Depth = 2.28"
100.00% Pervious = 766.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Johnson Watershed

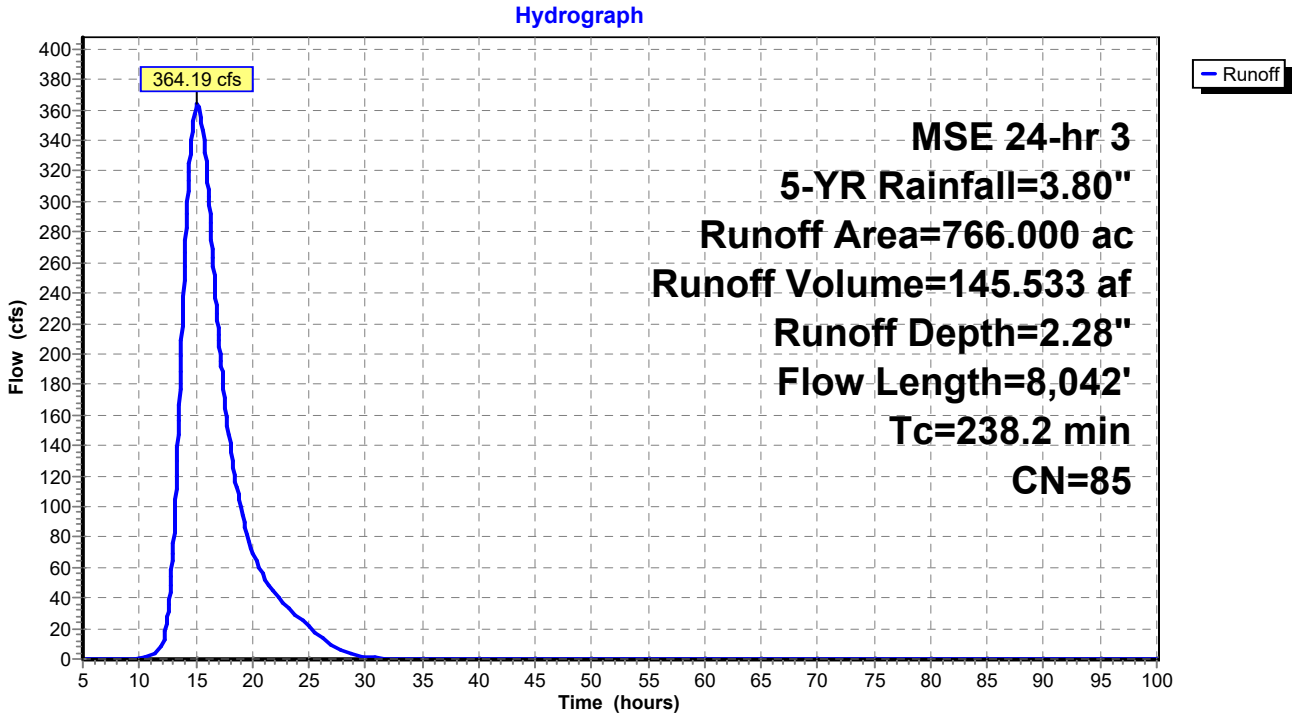
Runoff = 364.19 cfs @ 15.10 hrs, Volume= 145.533 af, Depth= 2.28"
Routed to Pond 2P : Johnson Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 5-YR Rainfall=3.80"

	Area (ac)	CN	Description
*	766.000	85	
	766.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	42	0.0050	0.07		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 3.06"
228.6	8,000	0.0042	0.58		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
238.2	8,042	Total			

Subcatchment 1S: Johnson Watershed



Summary for Pond 2P: Johnson Wetland

Inflow Area = 766.000 ac, 0.00% Impervious, Inflow Depth = 2.28" for 5-YR event
Inflow = 364.19 cfs @ 15.10 hrs, Volume= 145.533 af
Outflow = 357.29 cfs @ 15.38 hrs, Volume= 145.533 af, Atten= 2%, Lag= 17.1 min
Primary = 357.29 cfs @ 15.38 hrs, Volume= 145.533 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Tertiary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Starting Elev= 1,171.00' Surf.Area= 5.400 ac Storage= 5.245 af
Peak Elev= 1,172.77' @ 15.38 hrs Surf.Area= 6.448 ac Storage= 15.417 af (10.172 af above start)

Plug-Flow detention time= 58.3 min calculated for 140.288 af (96% of inflow)
Center-of-Mass det. time= 27.5 min (1,038.7 - 1,011.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,166.00'	39.655 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,166.00	0.010	0.000	0.000
1,167.00	0.020	0.015	0.015
1,168.00	0.060	0.040	0.055
1,169.00	0.550	0.305	0.360
1,170.00	1.910	1.230	1.590
1,171.00	5.400	3.655	5.245
1,172.00	5.640	5.520	10.765
1,173.00	6.690	6.165	16.930
1,174.00	8.220	7.455	24.385
1,175.00	10.960	9.590	33.975
1,175.50	11.760	5.680	39.655

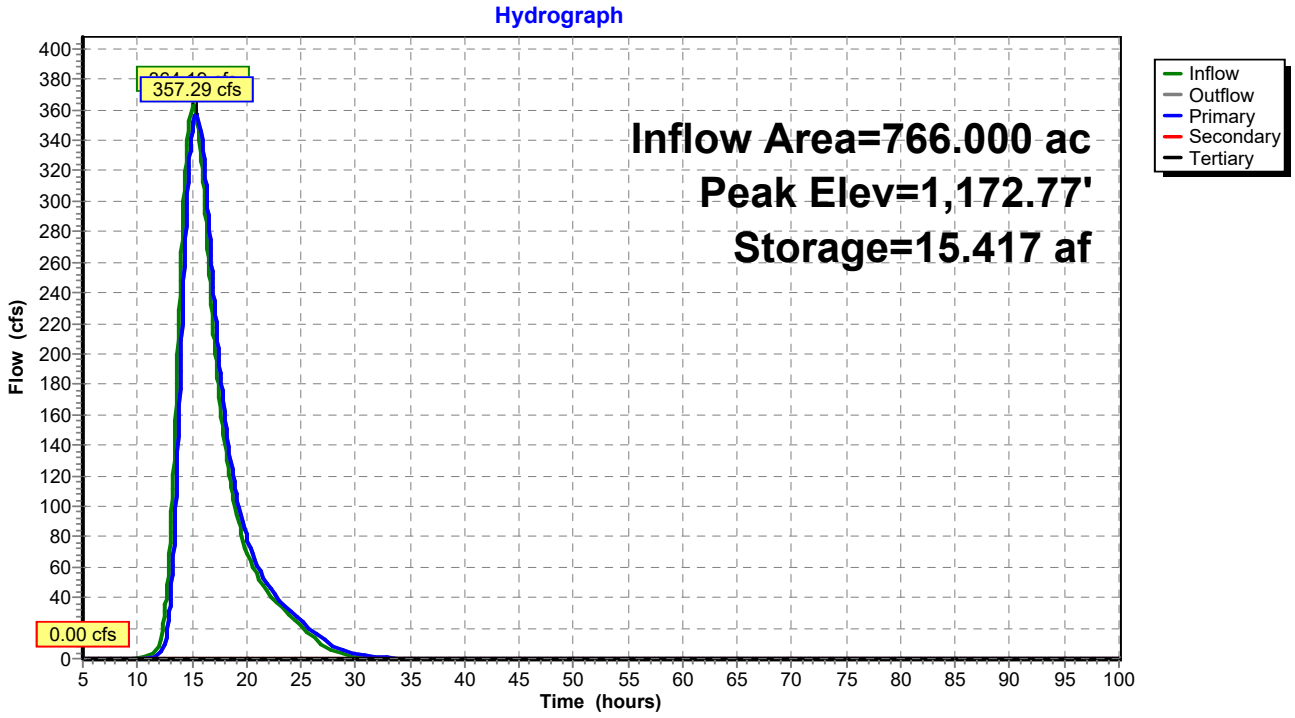
Device	Routing	Invert	Outlet Devices
#1	Primary	1,171.00'	**45.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 5.5' Crest Height
#2	Secondary	1,173.25'	**20.0' long + 3.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#3	Device 4	1,166.50'	**15.0" Round RCP_Round 15"** L= 20.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,166.50' / 1,166.50' S= 0.0000 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#4	Device 5	1,175.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 10.0' Crest Height
#5	Tertiary	1,166.50'	**15.0" Round RCP_Round 15"** L= 20.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,166.50' / 1,166.00' S= 0.0250 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf

Primary OutFlow Max=357.16 cfs @ 15.38 hrs HW=1,172.77' (Free Discharge)
└─**1=Sharp-Crested Rectangular Weir** (Weir Controls 357.16 cfs @ 4.52 fps)

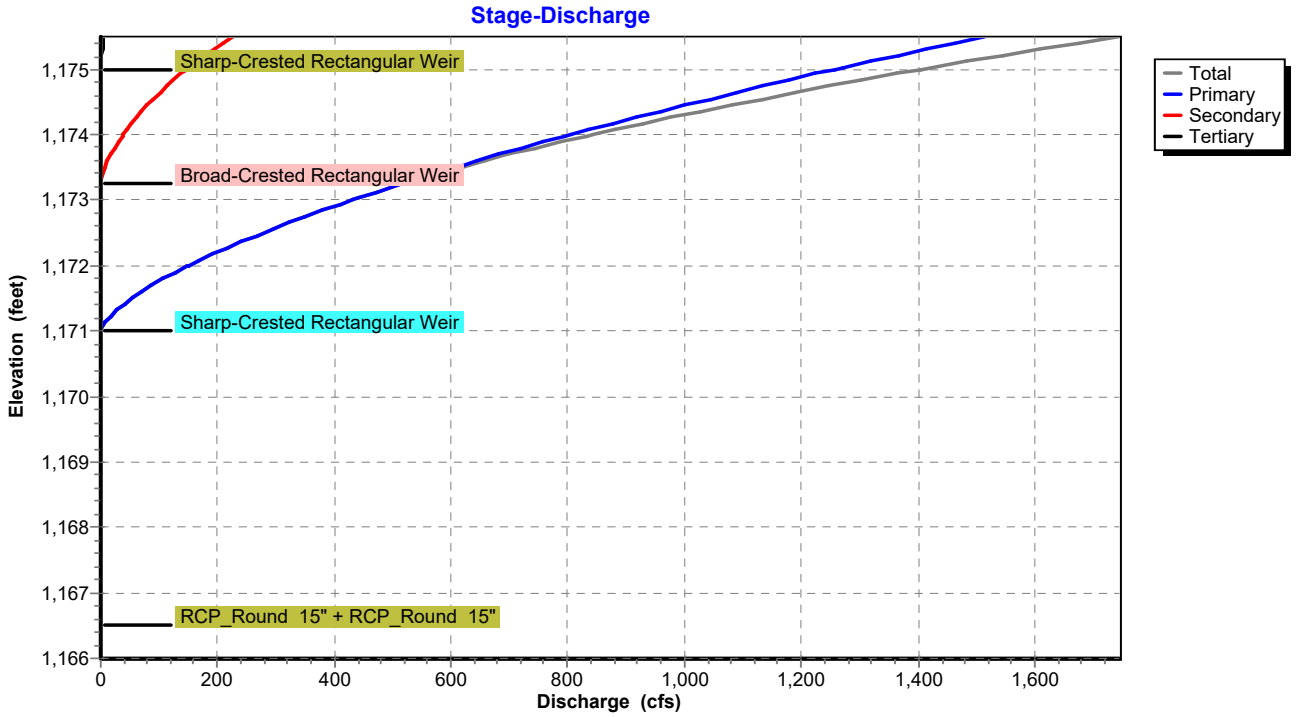
Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,171.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Tertiary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,171.00' (Free Discharge)
└─**5=RCP_Round 15"** (Passes 0.00 cfs of 14.54 cfs potential flow)
└─**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└─**3=RCP_Round 15"** (Controls 0.00 cfs)

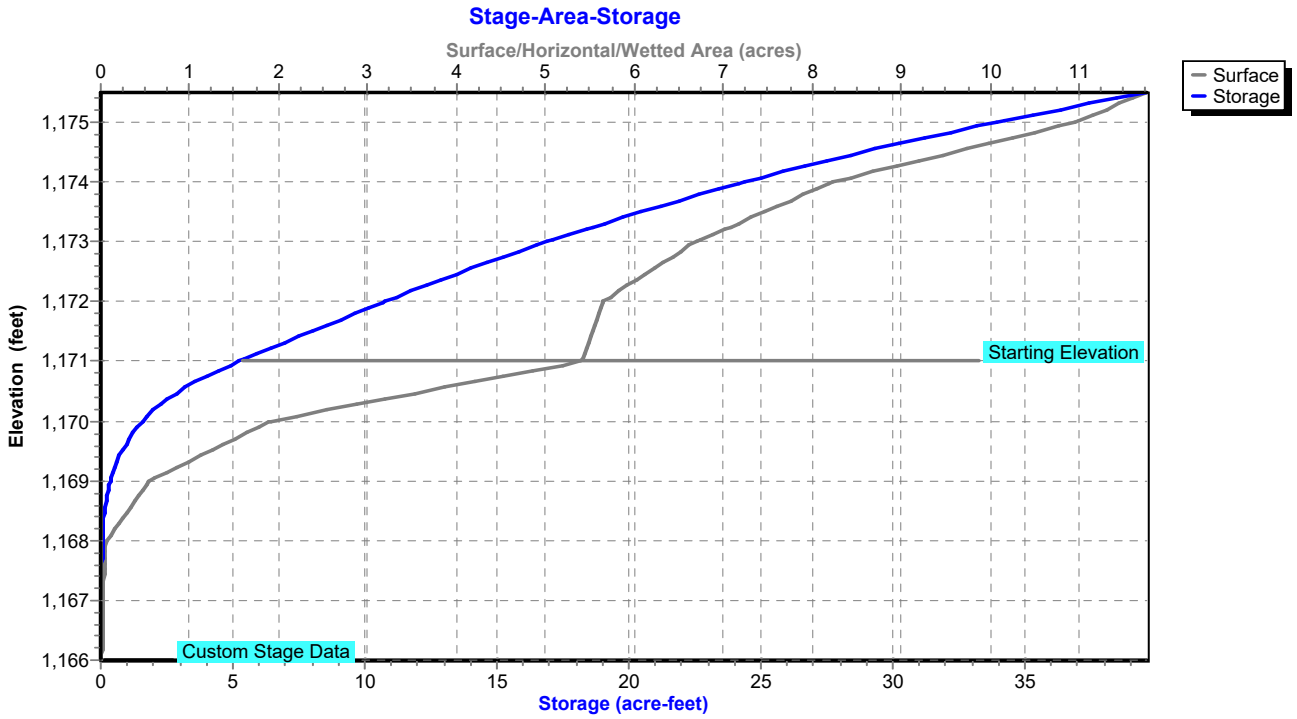
Pond 2P: Johnson Wetland



Pond 2P: Johnson Wetland



Pond 2P: Johnson Wetland



Time span=5.00-100.00 hrs, dt=0.05 hrs, 1901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Johnson Watershed Runoff Area=766.000 ac 0.00% Impervious Runoff Depth=2.91"
Flow Length=8,042' Tc=238.2 min CN=85 Runoff=466.40 cfs 185.700 af

Pond 2P: Johnson Wetland Peak Elev=1,173.08' Storage=17.478 af Inflow=466.40 cfs 185.700 af
Primary=458.07 cfs 185.700 af Secondary=0.00 cfs 0.000 af Tertiary=0.00 cfs 0.000 af Outflow=458.07 cfs 185.700 af

Total Runoff Area = 766.000 ac Runoff Volume = 185.700 af Average Runoff Depth = 2.91"
100.00% Pervious = 766.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Johnson Watershed

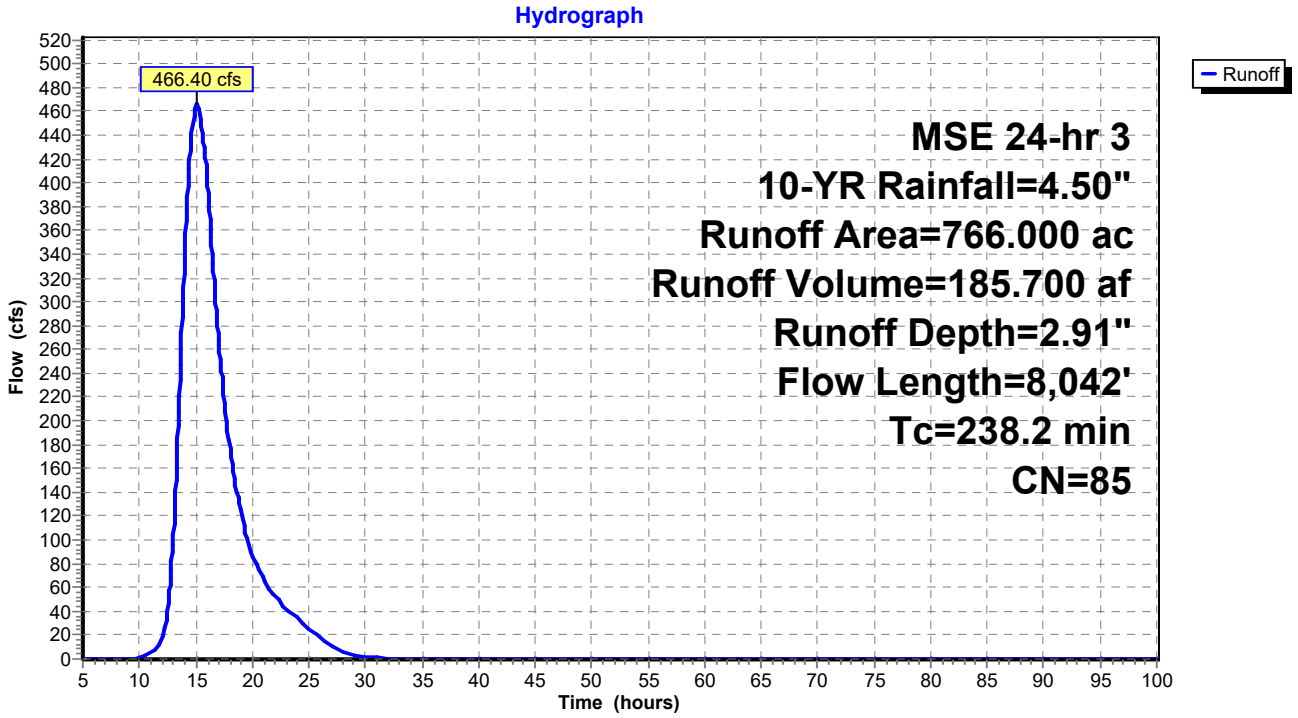
Runoff = 466.40 cfs @ 15.09 hrs, Volume= 185.700 af, Depth= 2.91"
Routed to Pond 2P : Johnson Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-YR Rainfall=4.50"

	Area (ac)	CN	Description
*	766.000	85	
	766.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	42	0.0050	0.07		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 3.06"
228.6	8,000	0.0042	0.58		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
238.2	8,042	Total			

Subcatchment 1S: Johnson Watershed



Summary for Pond 2P: Johnson Wetland

Inflow Area = 766.000 ac, 0.00% Impervious, Inflow Depth = 2.91" for 10-YR event
Inflow = 466.40 cfs @ 15.09 hrs, Volume= 185.700 af
Outflow = 458.07 cfs @ 15.34 hrs, Volume= 185.700 af, Atten= 2%, Lag= 15.0 min
Primary = 458.07 cfs @ 15.34 hrs, Volume= 185.700 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Tertiary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Starting Elev= 1,171.00' Surf.Area= 5.400 ac Storage= 5.245 af
Peak Elev= 1,173.08' @ 15.34 hrs Surf.Area= 6.814 ac Storage= 17.478 af (12.233 af above start)

Plug-Flow detention time= 49.6 min calculated for 180.360 af (97% of inflow)
Center-of-Mass det. time= 25.6 min (1,031.9 - 1,006.4)

Volume	Invert	Avail.Storage	Storage Description
#1	1,166.00'	39.655 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,166.00	0.010	0.000	0.000
1,167.00	0.020	0.015	0.015
1,168.00	0.060	0.040	0.055
1,169.00	0.550	0.305	0.360
1,170.00	1.910	1.230	1.590
1,171.00	5.400	3.655	5.245
1,172.00	5.640	5.520	10.765
1,173.00	6.690	6.165	16.930
1,174.00	8.220	7.455	24.385
1,175.00	10.960	9.590	33.975
1,175.50	11.760	5.680	39.655

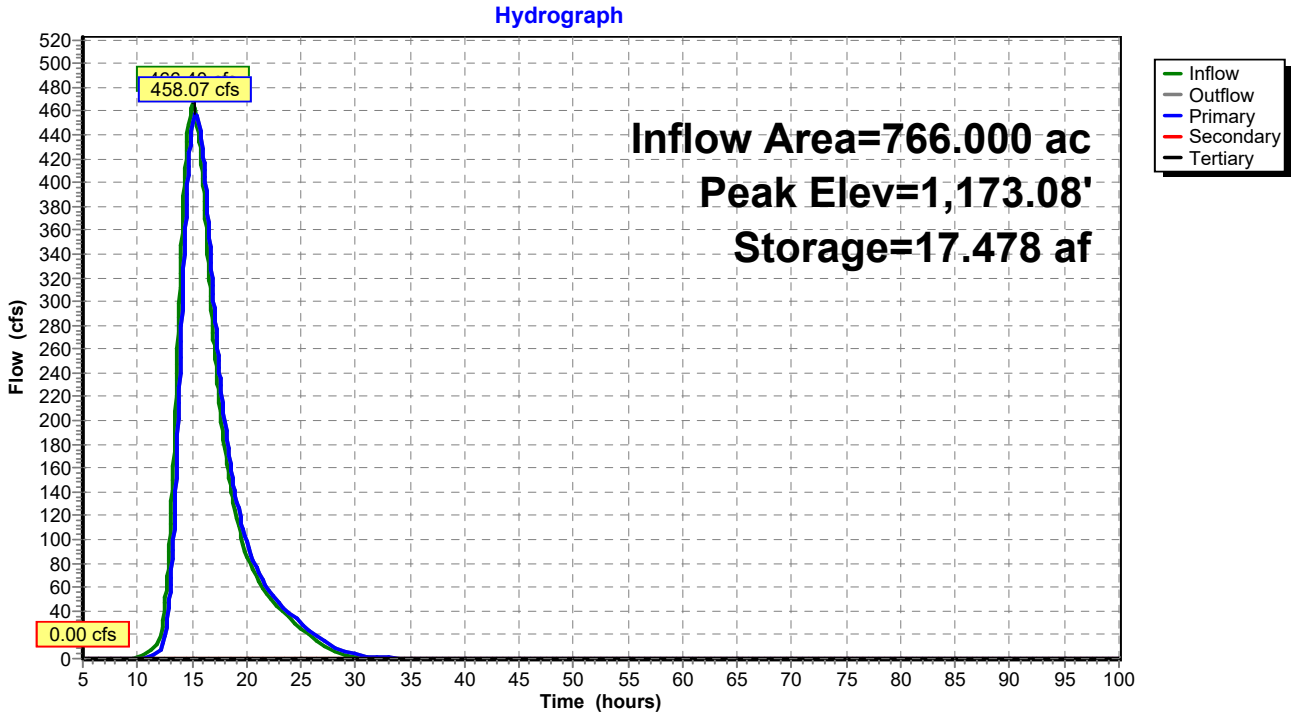
Device	Routing	Invert	Outlet Devices
#1	Primary	1,171.00'	**45.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 5.5' Crest Height
#2	Secondary	1,173.25'	**20.0' long + 3.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#3	Device 4	1,166.50'	**15.0" Round RCP_Round 15"** L= 20.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,166.50' / 1,166.50' S= 0.0000 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#4	Device 5	1,175.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 10.0' Crest Height
#5	Tertiary	1,166.50'	**15.0" Round RCP_Round 15"** L= 20.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,166.50' / 1,166.00' S= 0.0250 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf

Primary OutFlow Max=457.94 cfs @ 15.34 hrs HW=1,173.08' (Free Discharge)
└**1=Sharp-Crested Rectangular Weir** (Weir Controls 457.94 cfs @ 4.94 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,171.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Tertiary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,171.00' (Free Discharge)
└**5=RCP_Round 15"** (Passes 0.00 cfs of 14.54 cfs potential flow)
└**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└**3=RCP_Round 15"** (Controls 0.00 cfs)

Pond 2P: Johnson Wetland



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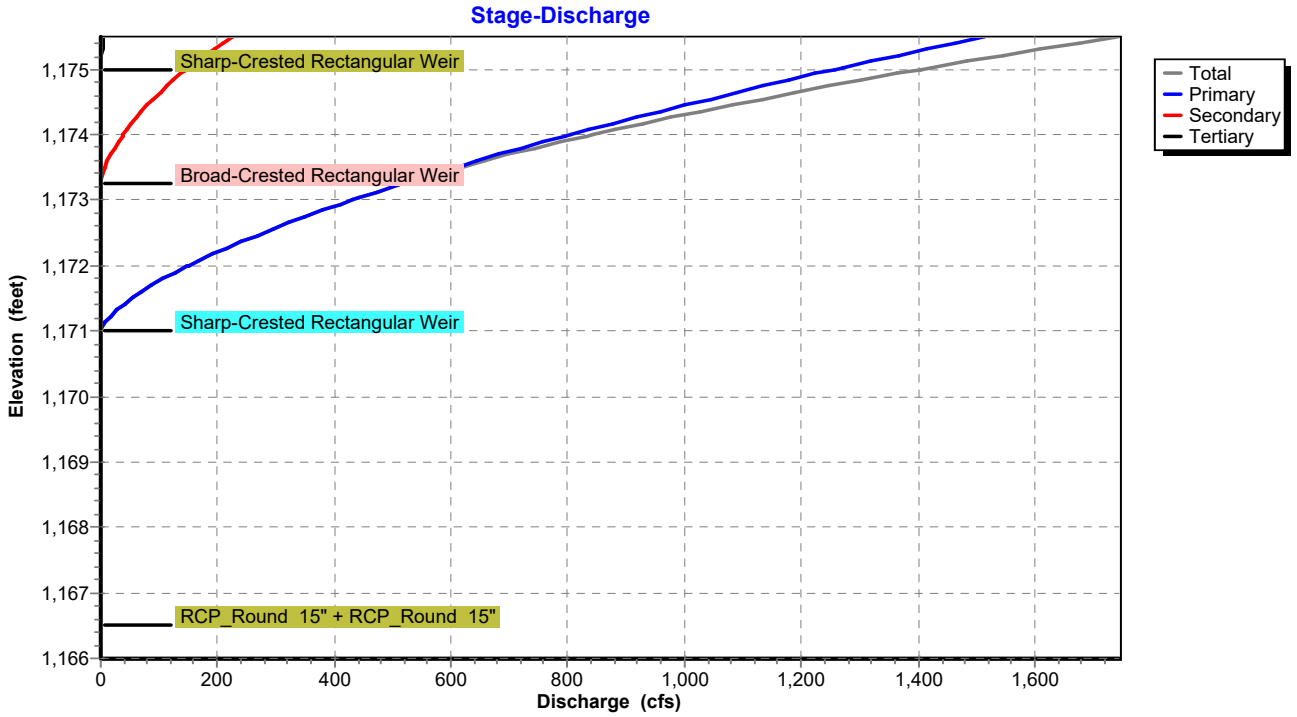

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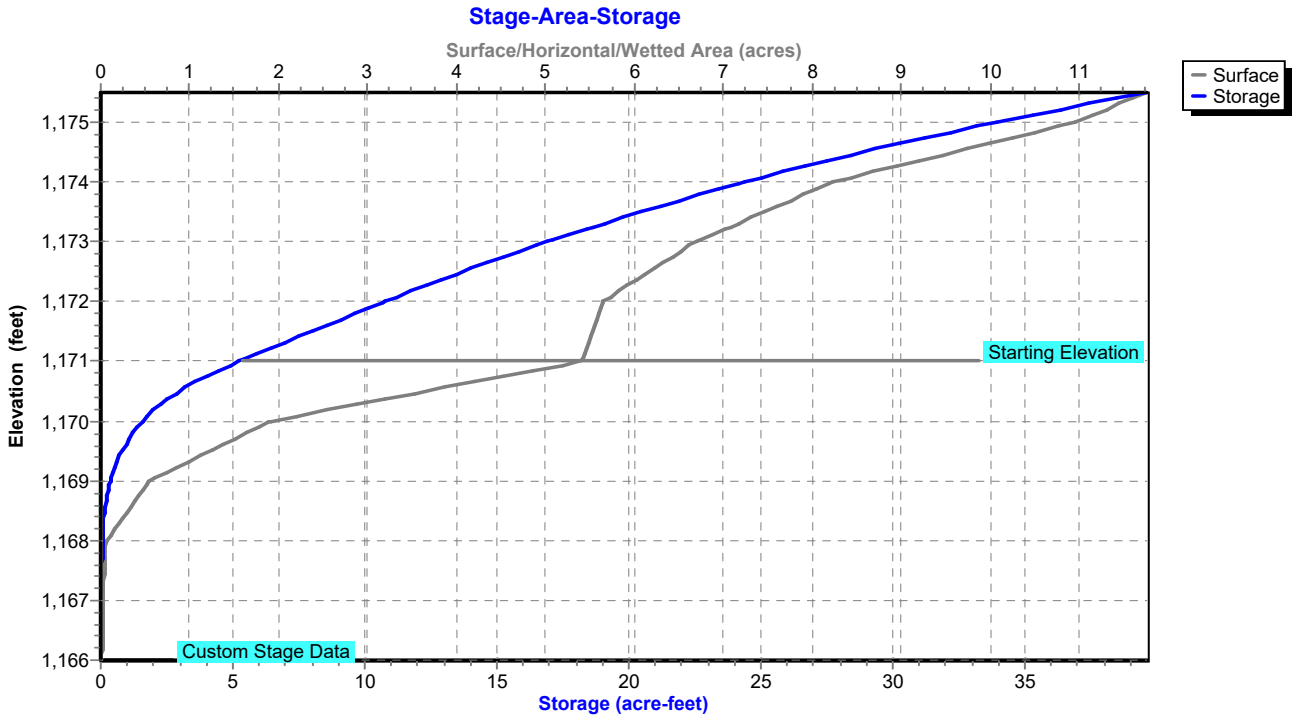


Time span=5.00-100.00 hrs, dt=0.05 hrs, 1901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Johnson Watershed Runoff Area=766.000 ac 0.00% Impervious Runoff Depth=3.93"
Flow Length=8,042' Tc=238.2 min CN=85 Runoff=630.33 cfs 250.641 af

Pond 2P: Johnson Wetland Peak Elev=1,173.52' Storage=20.587 af Inflow=630.33 cfs 250.641 af
Primary=613.27 cfs 249.943 af Secondary=7.66 cfs 0.698 af Tertiary=0.00 cfs 0.000 af Outflow=620.93 cfs 250.641 af

Total Runoff Area = 766.000 ac Runoff Volume = 250.641 af Average Runoff Depth = 3.93"
100.00% Pervious = 766.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Johnson Watershed

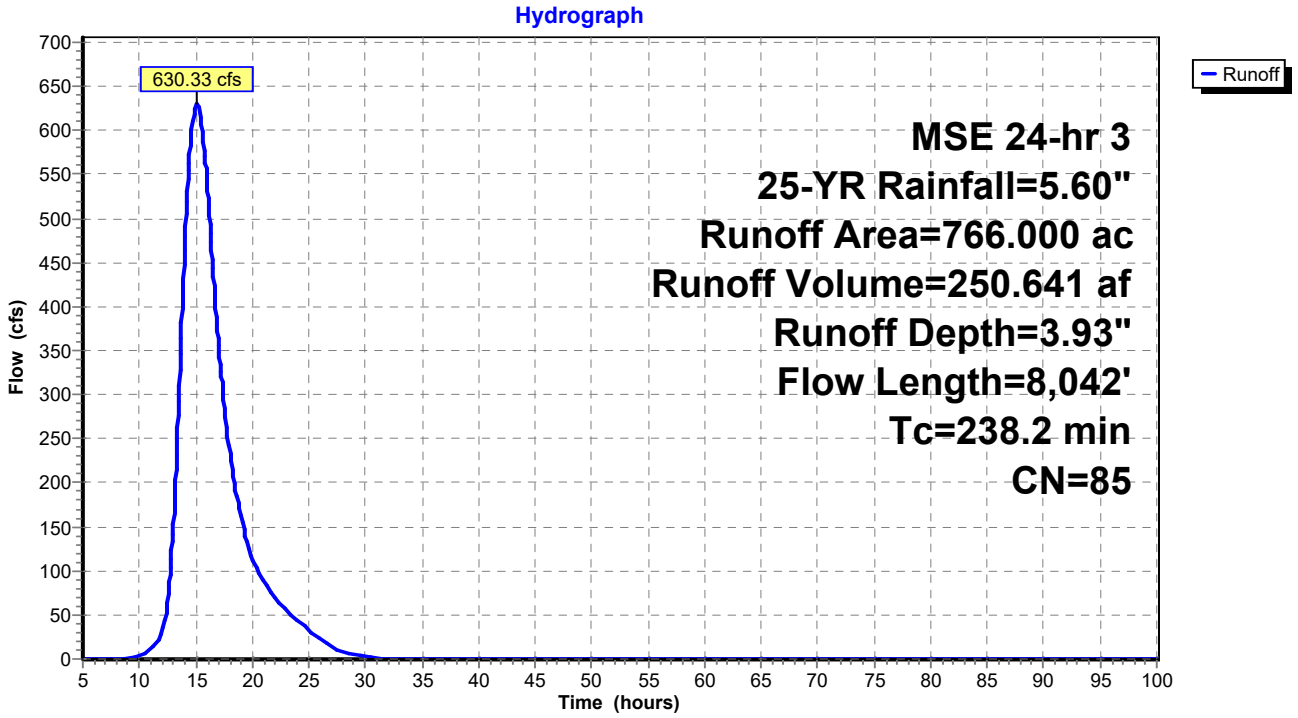
Runoff = 630.33 cfs @ 15.09 hrs, Volume= 250.641 af, Depth= 3.93"
Routed to Pond 2P : Johnson Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 25-YR Rainfall=5.60"

	Area (ac)	CN	Description
*	766.000	85	
	766.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	42	0.0050	0.07		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 3.06"
228.6	8,000	0.0042	0.58		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
238.2	8,042	Total			

Subcatchment 1S: Johnson Watershed



Summary for Pond 2P: Johnson Wetland

Inflow Area = 766.000 ac, 0.00% Impervious, Inflow Depth = 3.93" for 25-YR event
Inflow = 630.33 cfs @ 15.09 hrs, Volume= 250.641 af
Outflow = 620.93 cfs @ 15.28 hrs, Volume= 250.641 af, Atten= 1%, Lag= 11.6 min
Primary = 613.27 cfs @ 15.28 hrs, Volume= 249.943 af
Secondary = 7.66 cfs @ 15.28 hrs, Volume= 0.698 af
Tertiary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Starting Elev= 1,171.00' Surf.Area= 5.400 ac Storage= 5.245 af
Peak Elev= 1,173.52' @ 15.28 hrs Surf.Area= 7.480 ac Storage= 20.587 af (15.342 af above start)

Plug-Flow detention time= 43.5 min calculated for 245.396 af (98% of inflow)
Center-of-Mass det. time= 23.5 min (1,024.0 - 1,000.4)

Volume	Invert	Avail.Storage	Storage Description
#1	1,166.00'	39.655 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,166.00	0.010	0.000	0.000
1,167.00	0.020	0.015	0.015
1,168.00	0.060	0.040	0.055
1,169.00	0.550	0.305	0.360
1,170.00	1.910	1.230	1.590
1,171.00	5.400	3.655	5.245
1,172.00	5.640	5.520	10.765
1,173.00	6.690	6.165	16.930
1,174.00	8.220	7.455	24.385
1,175.00	10.960	9.590	33.975
1,175.50	11.760	5.680	39.655

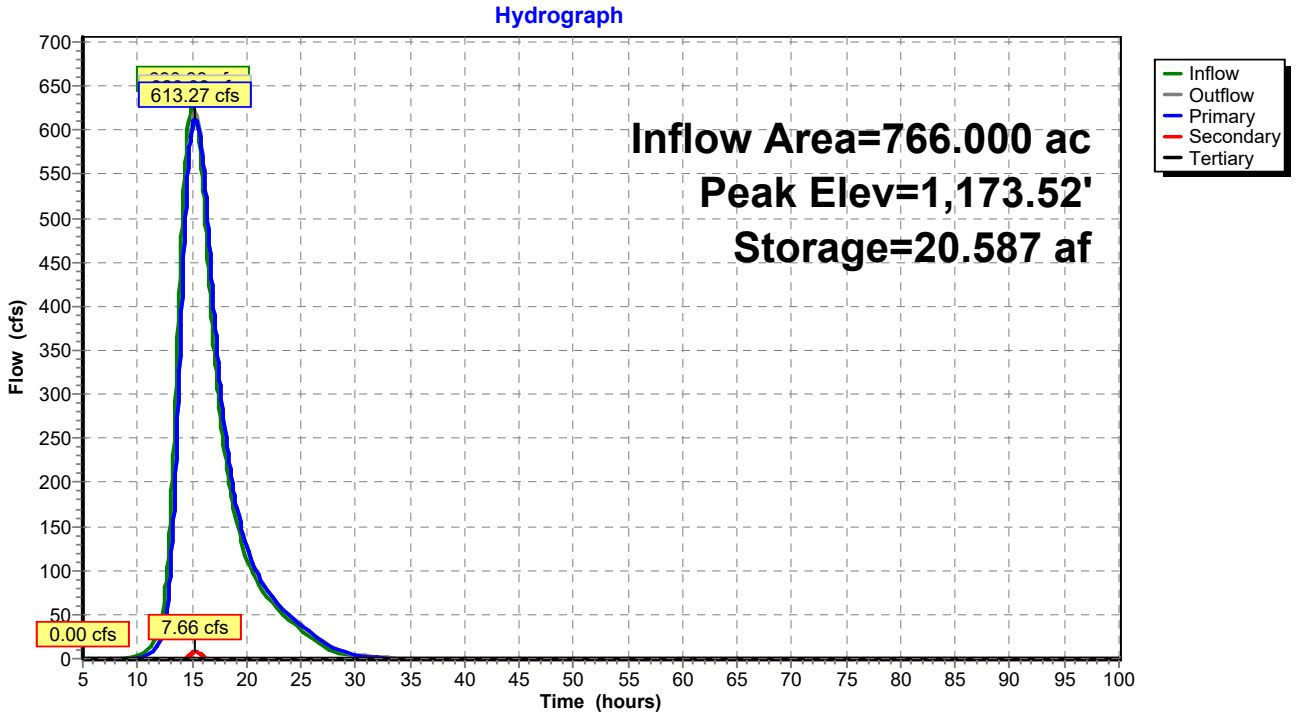
Device	Routing	Invert	Outlet Devices
#1	Primary	1,171.00'	**45.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 5.5' Crest Height
#2	Secondary	1,173.25'	**20.0' long + 3.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#3	Device 4	1,166.50'	**15.0" Round RCP_Round 15"** L= 20.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,166.50' / 1,166.50' S= 0.0000 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#4	Device 5	1,175.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 10.0' Crest Height
#5	Tertiary	1,166.50'	**15.0" Round RCP_Round 15"** L= 20.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,166.50' / 1,166.00' S= 0.0250 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf

Primary OutFlow Max=613.17 cfs @ 15.28 hrs HW=1,173.52' (Free Discharge)
└**1=Sharp-Crested Rectangular Weir** (Weir Controls 613.17 cfs @ 5.48 fps)

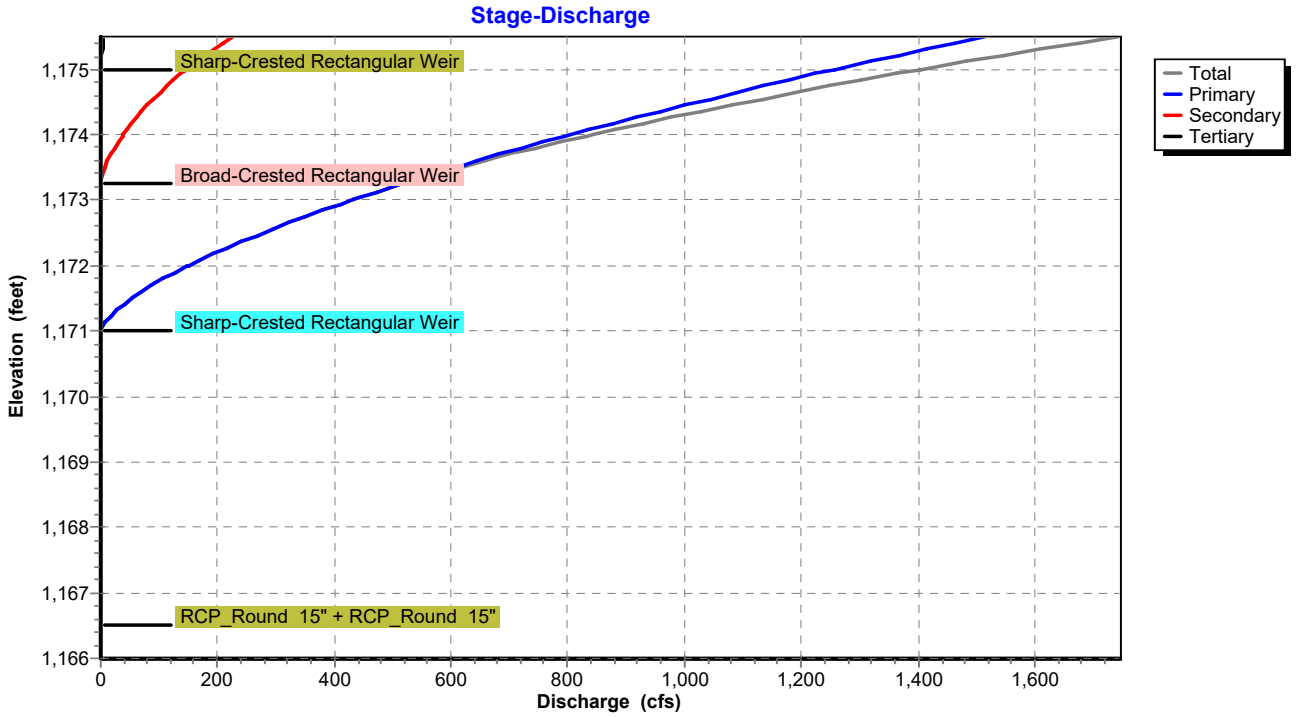
Secondary OutFlow Max=7.61 cfs @ 15.28 hrs HW=1,173.52' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 7.61 cfs @ 1.37 fps)

Tertiary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,171.00' (Free Discharge)
└**5=RCP_Round 15"** (Passes 0.00 cfs of 14.54 cfs potential flow)
└**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└**3=RCP_Round 15"** (Controls 0.00 cfs)

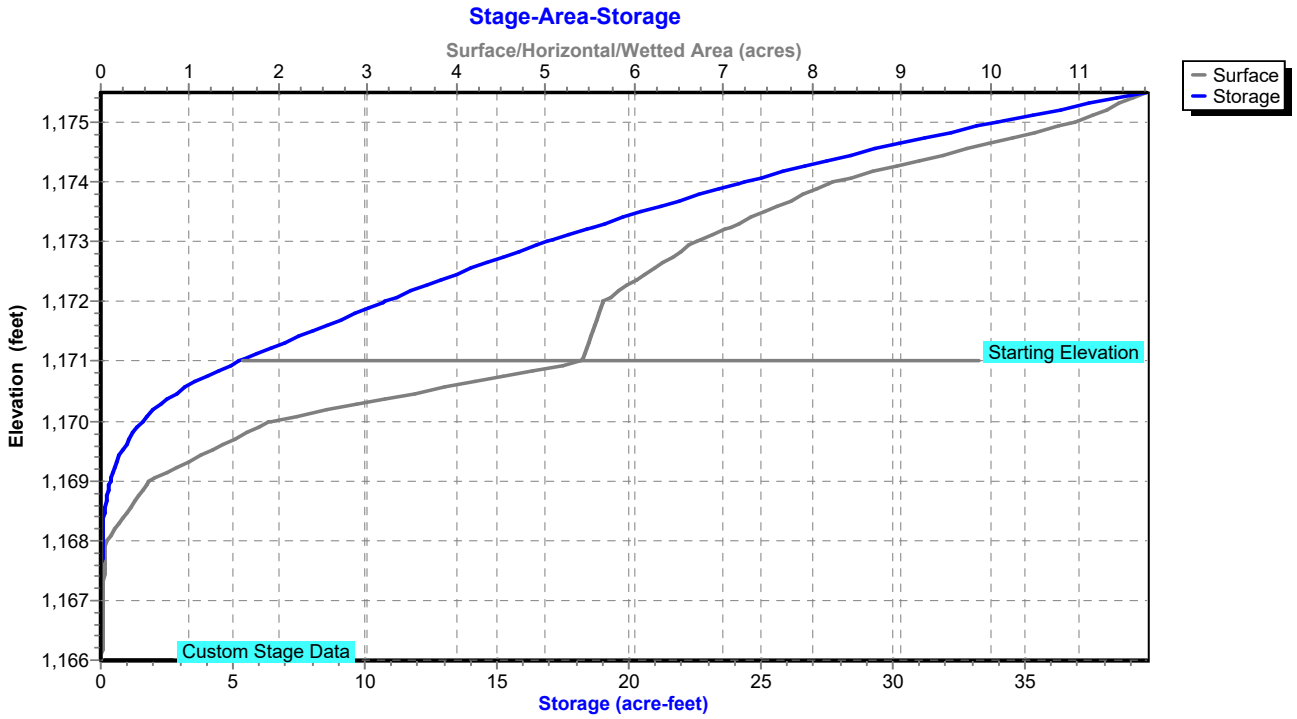
Pond 2P: Johnson Wetland



Pond 2P: Johnson Wetland



Pond 2P: Johnson Wetland



Time span=5.00-100.00 hrs, dt=0.05 hrs, 1901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Johnson Watershed Runoff Area=766.000 ac 0.00% Impervious Runoff Depth=5.73"
Flow Length=8,042' Tc=238.2 min CN=85 Runoff=917.63 cfs 365.880 af

Pond 2P: Johnson Wetland Peak Elev=1,174.13' Storage=25.454 af Inflow=917.63 cfs 365.880 af
Primary=858.41 cfs 358.515 af Secondary=47.96 cfs 7.365 af Tertiary=0.00 cfs 0.000 af Outflow=906.37 cfs 365.880 af

Total Runoff Area = 766.000 ac Runoff Volume = 365.880 af Average Runoff Depth = 5.73"
100.00% Pervious = 766.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Johnson Watershed

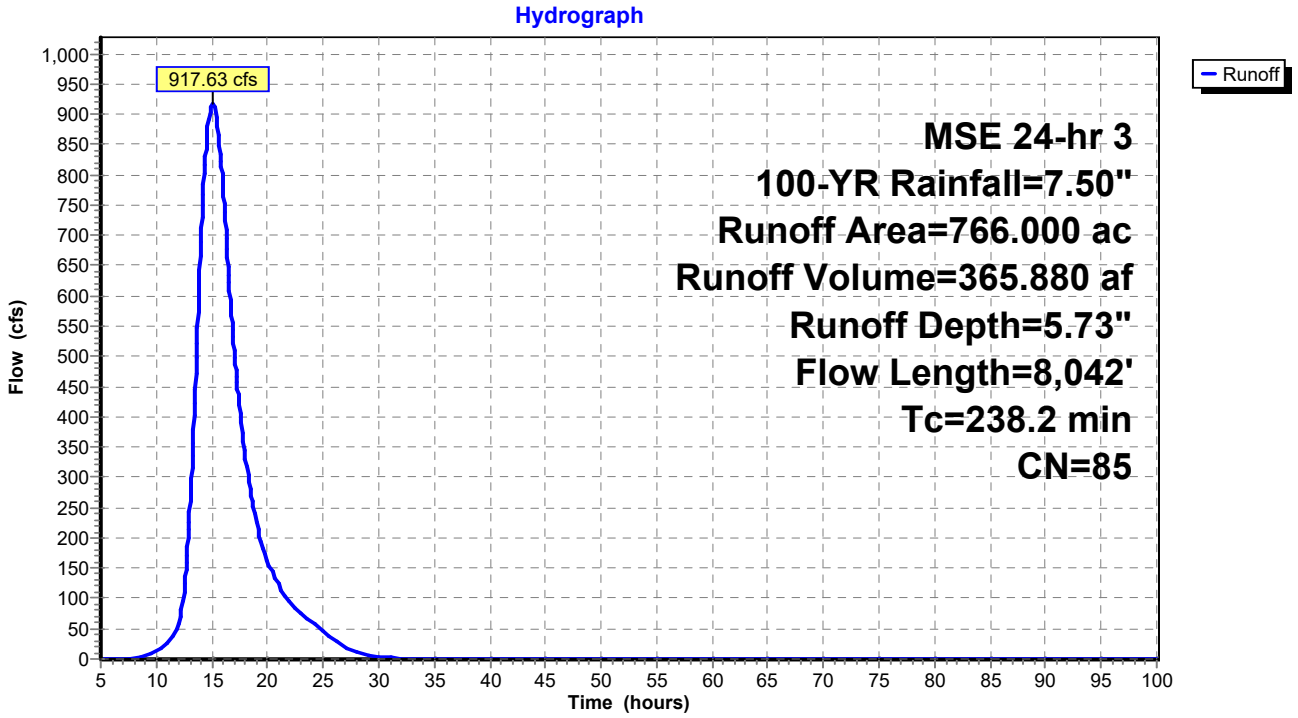
Runoff = 917.63 cfs @ 15.08 hrs, Volume= 365.880 af, Depth= 5.73"
Routed to Pond 2P : Johnson Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-YR Rainfall=7.50"

	Area (ac)	CN	Description
*	766.000	85	
	766.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	42	0.0050	0.07		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 3.06"
228.6	8,000	0.0042	0.58		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
238.2	8,042	Total			

Subcatchment 1S: Johnson Watershed



Summary for Pond 2P: Johnson Wetland

Inflow Area = 766.000 ac, 0.00% Impervious, Inflow Depth = 5.73" for 100-YR event
Inflow = 917.63 cfs @ 15.08 hrs, Volume= 365.880 af
Outflow = 906.37 cfs @ 15.23 hrs, Volume= 365.880 af, Atten= 1%, Lag= 8.8 min
Primary = 858.41 cfs @ 15.23 hrs, Volume= 358.515 af
Secondary = 47.96 cfs @ 15.23 hrs, Volume= 7.365 af
Tertiary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Starting Elev= 1,171.00' Surf.Area= 5.400 ac Storage= 5.245 af
Peak Elev= 1,174.13' @ 15.23 hrs Surf.Area= 8.569 ac Storage= 25.454 af (20.209 af above start)

Plug-Flow detention time= 36.4 min calculated for 360.635 af (99% of inflow)
Center-of-Mass det. time= 21.2 min (1,014.2 - 993.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,166.00'	39.655 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,166.00	0.010	0.000	0.000
1,167.00	0.020	0.015	0.015
1,168.00	0.060	0.040	0.055
1,169.00	0.550	0.305	0.360
1,170.00	1.910	1.230	1.590
1,171.00	5.400	3.655	5.245
1,172.00	5.640	5.520	10.765
1,173.00	6.690	6.165	16.930
1,174.00	8.220	7.455	24.385
1,175.00	10.960	9.590	33.975
1,175.50	11.760	5.680	39.655

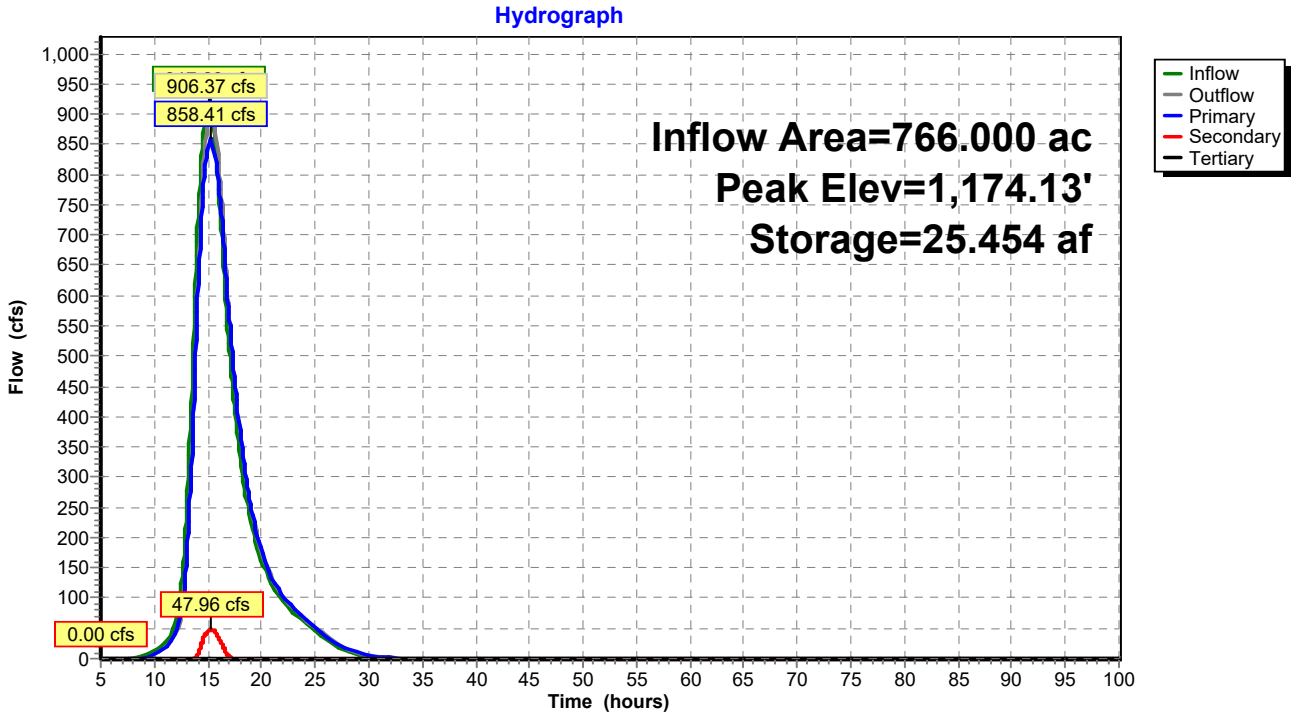
Device	Routing	Invert	Outlet Devices
#1	Primary	1,171.00'	**45.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 5.5' Crest Height
#2	Secondary	1,173.25'	**20.0' long + 3.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#3	Device 4	1,166.50'	**15.0" Round RCP_Round 15"** L= 20.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,166.50' / 1,166.50' S= 0.0000 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#4	Device 5	1,175.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 10.0' Crest Height
#5	Tertiary	1,166.50'	**15.0" Round RCP_Round 15"** L= 20.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,166.50' / 1,166.00' S= 0.0250 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf

Primary OutFlow Max=858.23 cfs @ 15.23 hrs HW=1,174.13' (Free Discharge)
└─**1=Sharp-Crested Rectangular Weir** (Weir Controls 858.23 cfs @ 6.18 fps)

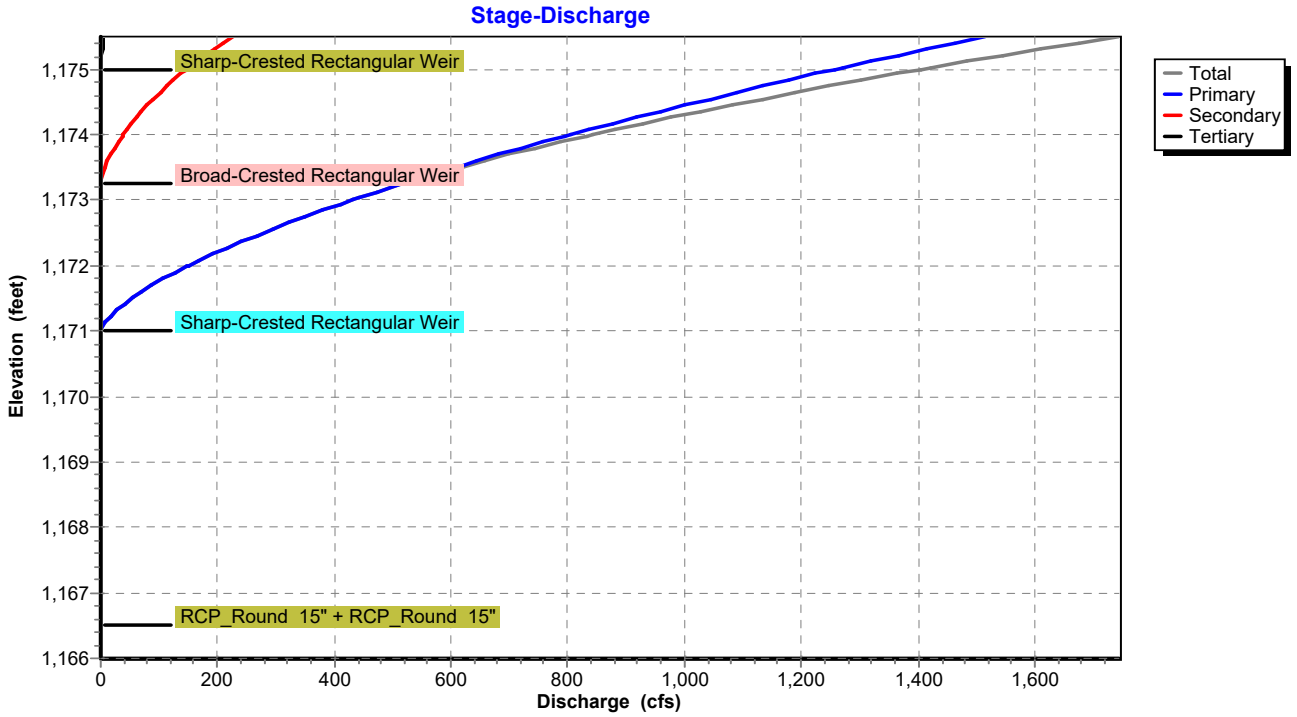
Secondary OutFlow Max=47.87 cfs @ 15.23 hrs HW=1,174.13' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 47.87 cfs @ 2.41 fps)

Tertiary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,171.00' (Free Discharge)
└─**5=RCP_Round 15"** (Passes 0.00 cfs of 14.54 cfs potential flow)
└─**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└─**3=RCP_Round 15"** (Controls 0.00 cfs)

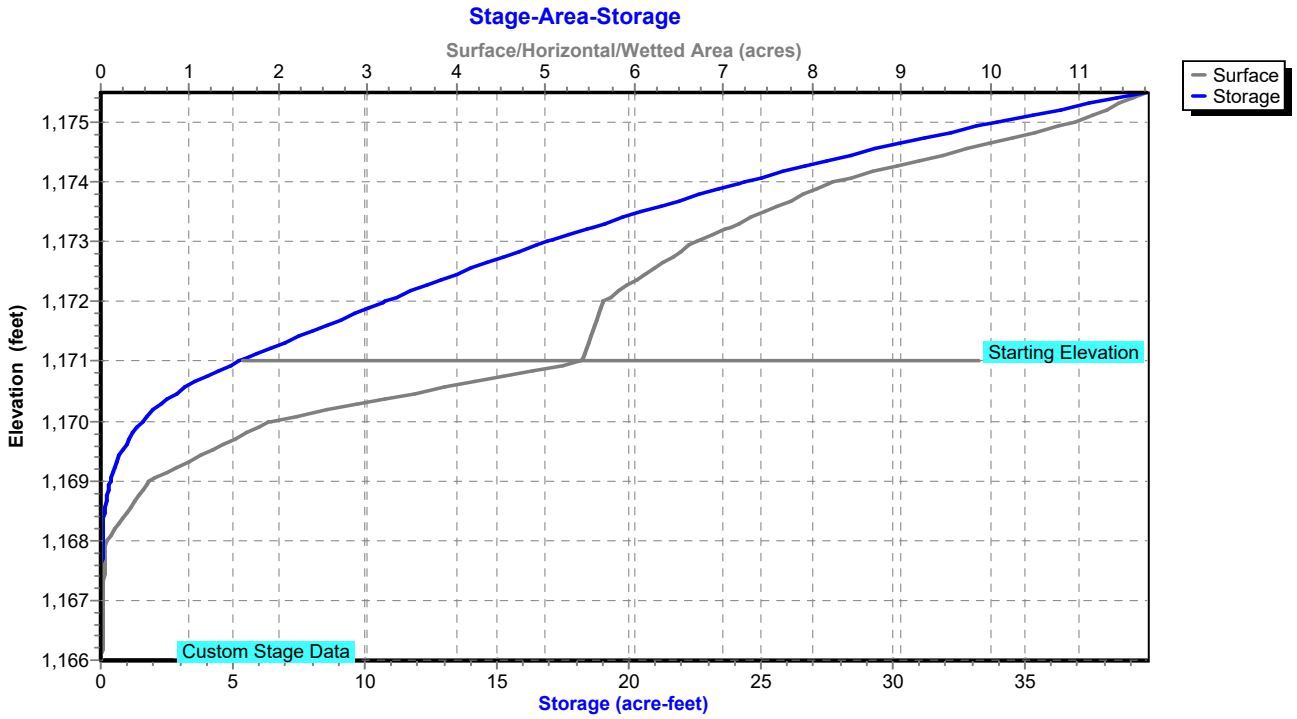
Pond 2P: Johnson Wetland



Pond 2P: Johnson Wetland



Pond 2P: Johnson Wetland



Events for Subcatchment 1S: Johnson Watershed

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
5-YR	3.80	364.19	145.533	2.28
10-YR	4.50	466.40	185.700	2.91
25-YR	5.60	630.33	250.641	3.93
100-YR	**7.50**	**917.63**	**365.880**	**5.73**

Events for Pond 2P: Johnson Wetland

Event	Inflow (cfs)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)	Tertiary (cfs)	Elevation (feet)	Storage (acre-feet)
5-YR	364.19	357.29	357.29	0.00	**0.00**	1,172.77	15.417
10-YR	466.40	458.07	458.07	0.00	0.00	1,173.08	17.478
25-YR	630.33	620.93	613.27	7.66	0.00	1,173.52	20.587
100-YR	**917.63**	**906.37**	**858.41**	**47.96**	0.00	**1,174.13**	**25.454**

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