

MEMORANDUM

TO: Anne Capra, AICP, Director of Planning & Conservation, South Hadley, MA
Rebekah Cornell, Conservation Administrator, South Hadley, MA

FROM: Lara Sup, PE, Fuss & O'Neill, Inc.
Julianne Busa, PhD, CSE, Fuss & O'Neill, Inc.

DATE: May 31, 2022

RE: **Queensville Dam Declassification Analysis**

Fuss & O'Neill has studied the Queensville Dam impoundment at Titus Pond in South Hadley, MA as part of the FY22 EEA Municipal Vulnerability Preparedness Program Action Grant. A 2018 Phase 1 Dam Inspection showed the Queensville Dam to be in poor condition and in need of roughly \$175K in repairs to bring it to a safe condition. The situation at Queensville Dam does not lend itself to a 'classic' dam removal because Route 116 is located on the dam embankment and cannot be relocated. Our study, therefore, looked at two primary options with respect to dam removal: 1) open up the dam embankment, replacing the existing dam outlet structure with a small bridge to facilitate passage under Route 116, re-routing and re-constructing a stream channel through the impoundment and through the wooded area south of the adjacent 7-Eleven in order to daylight the portion of the stream currently buried under the 7-Eleven parking area; or 2) removing the outlet control structure which maintains the depth of the Titus Pond impoundment to drain the impoundment during normal conditions, restore the impounded area to wetland, and utilize the existing outlet pipe to convey the stream under Route 116 and the 7-Eleven. The small bridge option was ultimately found to be infeasible due to a number of factors, but most notably the fact that site topography (driven by fill to build Route 116 and surrounding development) would not allow for daylighting of the stream without substantial retaining walls, which would, in turn, channelize the stream and negate the potential ecological value of daylighting. The preferred alternative is therefore to remove the existing outlet control structure while maintaining the existing 24" culvert underneath 116 and restoring the impoundment to a series of natural wetland habitats.

In order to be classified as a regulated dam through the Office of Dam Safety, the Queensville Dam needs to meet both of the following criteria in a 24-hour, 100-year storm event: impound more than 15 acre-ft of water and have a water depth greater than 6'. Newton Street overtopping will remain at elevation 664.5 and the 24" RCP culvert under the road will also remain at approximately 652, therefore the water depth will be greater than 6'. **The proposed impoundment must therefore be less than 15 ac-ft during a 24-hour, 100-year storm event to remove the Queensville dam's jurisdictional status.**

To analyze the 24-hour, 100-year storm event for existing and proposed conditions (years 2022 and future 2070), a HydroCAD hydrologic model was developed. The Buttery Brook watershed was delineated using the USGS StreamStats online web tool, a commonly used program developed by the United States Geological Survey (USGS). The total watershed has an area of 0.32 sq mi at the outlet of

Titus Pond at Newton Street. Curve numbers and time of concentration values were interpolated from the Hydrologic and Hydraulic Analysis completed by Fuss & O'Neill, report dated April 7, 2022. A precipitation depth value of 7.99 inches was obtained from NOAA Atlas 14 for the 24-hour, 100-year storm event. The crossing was classified as Tier 2 based on the RMA2 Climate Resilience Design Standards Tool. Per Tier 2 RMA2 methodology, present baseline precipitation depths from NOAA Atlas 14 were scaled by 27% for the 100-year design storm, therefore resulting in a precipitation depth of 10.15 inches. The existing stage-storage relationship of the dam impoundment was measured from a survey dated January 2022 and a 1-meter LiDAR-based Digital Elevation Model (DEM) downloaded from NOAA Coastal Data Viewer (2015 USGS Lidar: Maine & Massachusetts QL1 & QL2). The proposed stage-storage relationship was measured from the Conceptual Design Concept to be submitted under Task 4.5 of the FY23 MVP grant. Appendix A contains the supporting calculations for the dam classification analysis.

Table 1 summarizes the results of the HydroCAD analysis, which demonstrates that the impoundment volume of the proposed Conceptual Plan will be less than 15 ac-ft for both current and future climate conditions. The HydroCAD results are contained in Appendix B.

Table 1: Dam Classification Results

24-hour, 100-year Design Storm	Proposed Conditions (2022)	Proposed Conditions (2070)
Peak Flow (cfs)	113.21	205.26
Peak Elevation	165.19	165.54
Peak Storage (ac-ft)	12.6	13.5

Next Steps

The proposed Conceptual Plan has a storage volume less than 15 ac-ft and it is imperative that as the design of Titus Pond conservation area is moved to permitting and construction these calculations are revised to assure the storage volume remains below 15 ac-ft. Additional field investigations and analysis of the storm sewer networks and road culverts will also be completed to assess contributing drainage areas. The existing conditions hydrologic model will be revised based on the findings of the additional field investigation, and opportunities to optimize treatment of stormwater entering the restoration area will be identified for improved water quality, ease of maintenance, and capture of nutrients/sediments. During the permitting stage of this project, we will apply to the Office of Dam Safety to remove jurisdictional status from Queensville Dam.

Appendix A

Supporting Information for Hydrologic Model Development

South Hadley Queensville Dam
 20170390.V30
 25-May-22
 Existing Impoundment

elevation	area (ft ²)	average area (ft ²)	average volume (ft ³)	total volume (ft ³)	volume (ac-ft)
152	25			0	0.000
		25	25		
153	25			25	0.001
		25	25		
154	25			50	0.001
		25	25		
155	25			75	0.002
		25	25		
156	25			100	0.002
		25	25		
157	25			125	0.003
		25	25		
158	25			150	0.003
		25	25		
159	25			175	0.004
		25	29.75		
160.19	25			205	0.005
		26989	269.89		
160.2	53953			475	0.011
		59477	47581.2		
161	65000			48056	1.103
		71296	71295.5		
162	77591			119351	2.740
		82135	82134.5		
163	86678			201486	4.625
		91491	91491		
164	96304			292977	6.726
		101247	101247		
165	106190			394224	9.050
		111701	111700.5		
166	117211			505924	11.614

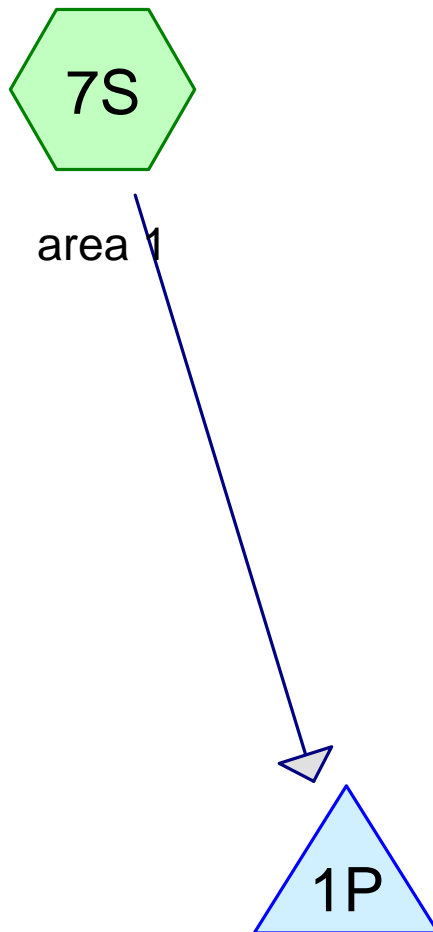
South Hadley Queensville Dam
 20170390.V30
 25-May-22
 Proposed Natural Restoration

elevation	area (ft ²)	average area (ft ²)	average volume (ft ³)	total volume (ft ³)	volume (ac-ft)
152	424.02			0	0.000
		723	723.47		
153	1022.92			723	0.017
		1440	1440.135		
154	1857.35			2164	0.050
		2452	2452.165		
155	3046.98			4616	0.106
		4799	4799.11		
156	6551.24			9415	0.216
		13042	13041.62		
157	19532			22457	0.516
		24836	24835.53		
158	30139.1			47292	1.086
		34970	34969.86		
159	39800.7			82262	1.888
		44177	44176.78		
160	48552.9			126439	2.903
		56776	56776.45		
161	65000			183215	4.206
		71296	71295.5		
162	77591			254511	5.843
		82135	82134.5		
163	86678			336645	7.728
		91491	91491		
164	96304			428136	9.829
		101247	101247		
165	106190			529383	12.153
		111701	111700.5		
166	117211			641084	14.717

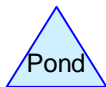
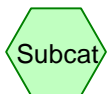
Appendix B

HydroCAD Model Summary Report

Existing Conditions -
4/5/22



Titus Pond outlet control
structure



South Hadley Titus Pond

Prepared by Fuss & O'Neill

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Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	100-yr, 2070	Type III 24-hr		Default	24.00	1	10.15	2
2	100yr (2022)	Type III 24-hr		Default	24.00	1	7.99	2

South Hadley Titus Pond

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Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
205.000	60	(7S)
205.000	60	TOTAL AREA

South Hadley Titus Pond

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Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
205.000	Other	7S
205.000		TOTAL AREA

South Hadley Titus Pond

Type III 24-hr 100-yr, 2070 Rainfall=10.15"

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Time span=5.00-36.00 hrs, dt=0.05 hrs, 621 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 7S: area 1

Runoff Area=205.000 ac 0.00% Impervious Runoff Depth=5.02"
Tc=200.0 min CN=60 Runoff=206.63 cfs 85.766 af

Pond 1P: Titus Pond outlet control structure Peak Elev=165.54' Storage=10.401 af Inflow=206.63 cfs 85.766 af
Outflow=206.42 cfs 85.626 af

Total Runoff Area = 205.000 ac Runoff Volume = 85.766 af Average Runoff Depth = 5.02"
100.00% Pervious = 205.000 ac 0.00% Impervious = 0.000 ac

South Hadley Titus Pond

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Type III 24-hr 100-yr, 2070 Rainfall=10.15"

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Summary for Subcatchment 7S: area 1

Runoff = 206.63 cfs @ 14.70 hrs, Volume= 85.766 af, Depth= 5.02"

Routed to Pond 1P : Titus Pond outlet control structure

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-36.00 hrs, dt= 0.05 hrs

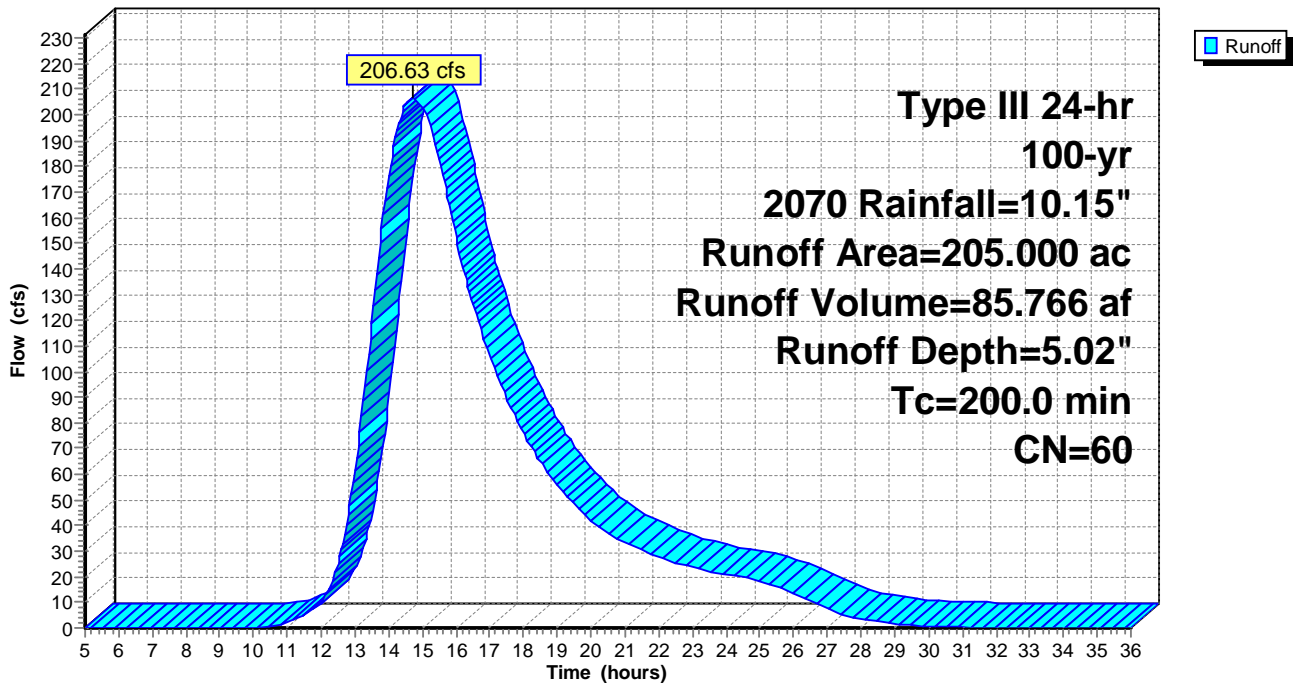
Type III 24-hr 100-yr, 2070 Rainfall=10.15"

Area (ac)	CN	Description
* 205.000	60	
205.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
200.0					Direct Entry,

Subcatchment 7S: area 1

Hydrograph



South Hadley Titus Pond

Type III 24-hr 100-yr, 2070 Rainfall=10.15"

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Summary for Pond 1P: Titus Pond outlet control structure

Inflow Area = 205.000 ac, 0.00% Impervious, Inflow Depth = 5.02" for 100-yr, 2070 event
 Inflow = 206.63 cfs @ 14.70 hrs, Volume= 85.766 af
 Outflow = 206.42 cfs @ 14.88 hrs, Volume= 85.626 af, Atten= 0%, Lag= 10.7 min
 Primary = 206.42 cfs @ 14.88 hrs, Volume= 85.626 af
 Routed to nonexistent node 8R

Routing by Stor-Ind method, Time Span= 5.00-36.00 hrs, dt= 0.05 hrs
 Peak Elev= 165.54' @ 14.88 hrs Surf.Area= 2.571 ac Storage= 10.401 af

Plug-Flow detention time= 67.1 min calculated for 85.626 af (100% of inflow)
 Center-of-Mass det. time= 65.8 min (1,080.0 - 1,014.1)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	11.606 af	Custom Stage Data (Prismatic) Listed below (Recalc)

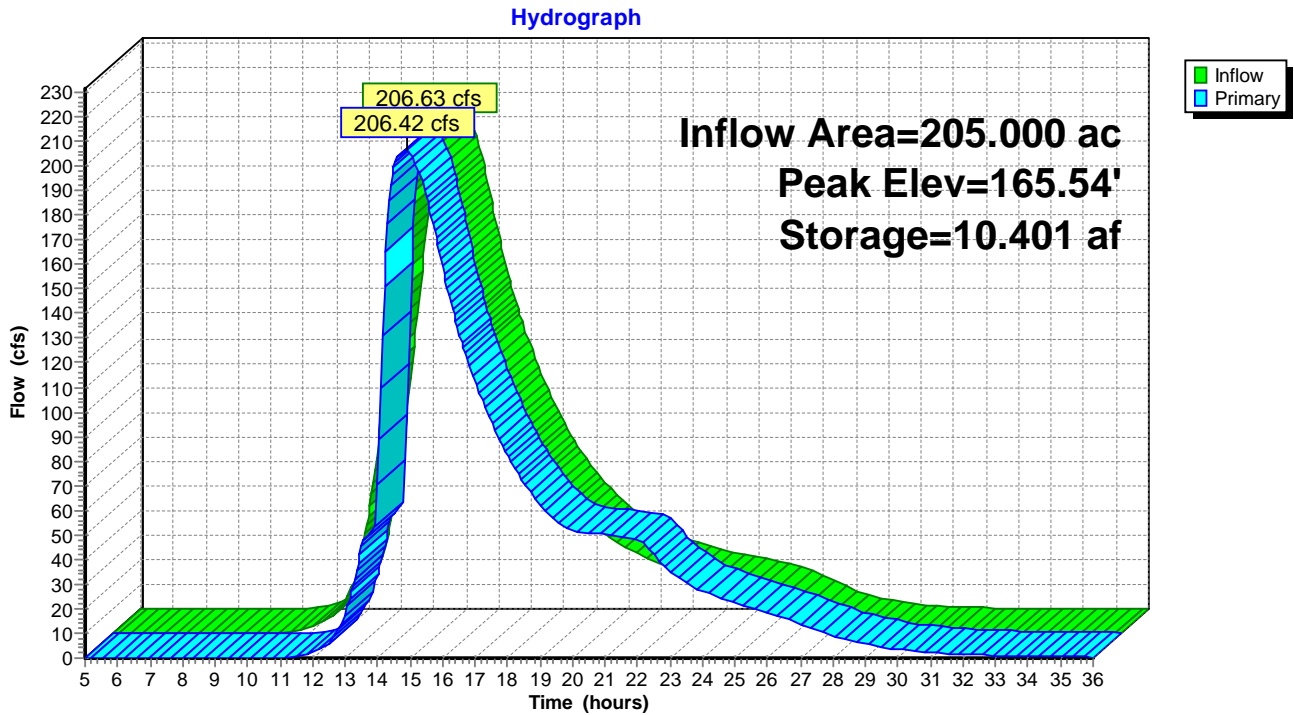
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
152.00	0.001	0.000	0.000
153.00	0.001	0.001	0.001
154.00	0.001	0.001	0.002
155.00	0.001	0.001	0.003
156.00	0.001	0.001	0.004
157.00	0.001	0.001	0.005
158.00	0.001	0.001	0.006
160.19	0.001	0.002	0.008
160.20	1.240	0.006	0.014
161.00	1.490	1.092	1.106
162.00	1.780	1.635	2.741
163.00	1.990	1.885	4.626
164.00	2.210	2.100	6.726
165.00	2.430	2.320	9.046
166.00	2.690	2.560	11.606

Device	Routing	Invert	Outlet Devices
#1	Primary	152.00'	24.0" Round Culvert L= 210.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 152.00' / 143.99' S= 0.0381 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Device 1	160.20'	36.0" W x 36.0" H Vert. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Primary	164.50'	Custom Weir/Orifice, Cv= 2.62 (C= 3.28) Head (feet) 0.00 0.50 1.50 Width (feet) 20.00 40.00 165.00

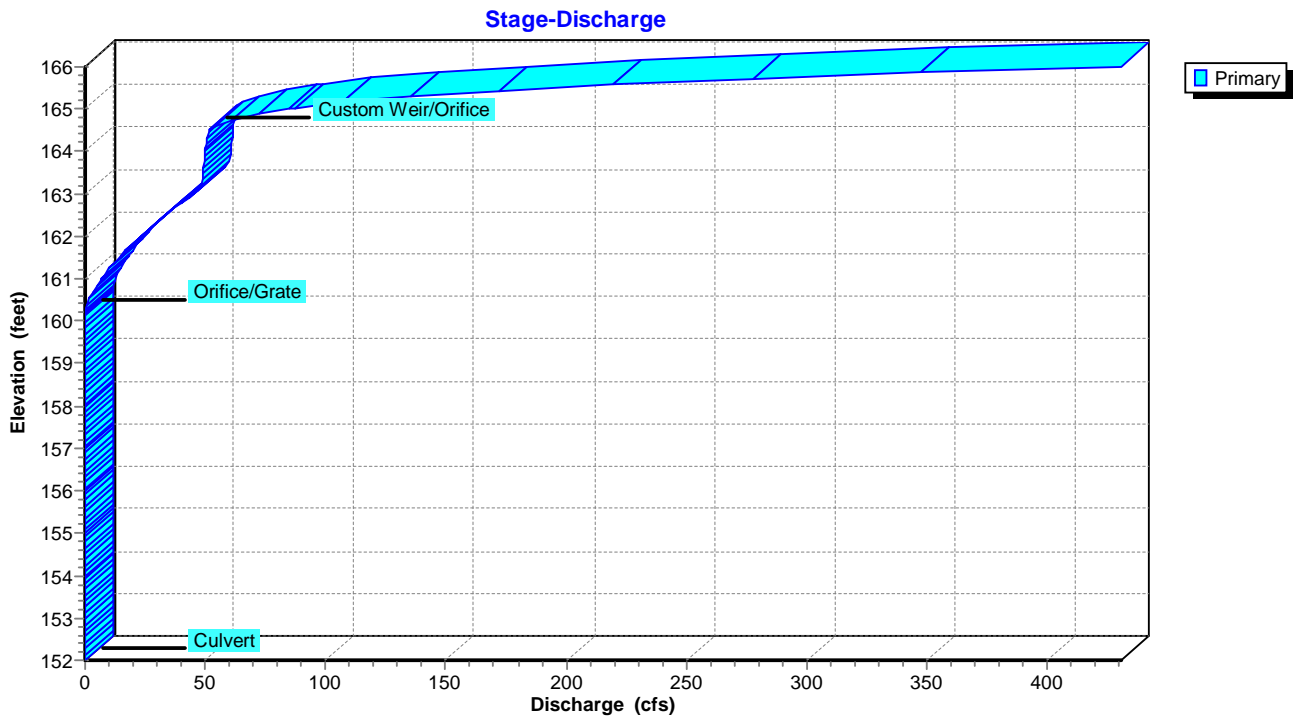
Primary OutFlow Max=205.31 cfs @ 14.88 hrs HW=165.54' (Free Discharge)

- 1=Culvert (Inlet Controls 53.57 cfs @ 17.05 fps)
- 2=Orifice/Grate (Passes 53.57 cfs of 84.38 cfs potential flow)
- 3=Custom Weir/Orifice (Weir Controls 151.74 cfs @ 2.76 fps)

Pond 1P: Titus Pond outlet control structure



Pond 1P: Titus Pond outlet control structure



South Hadley Titus Pond

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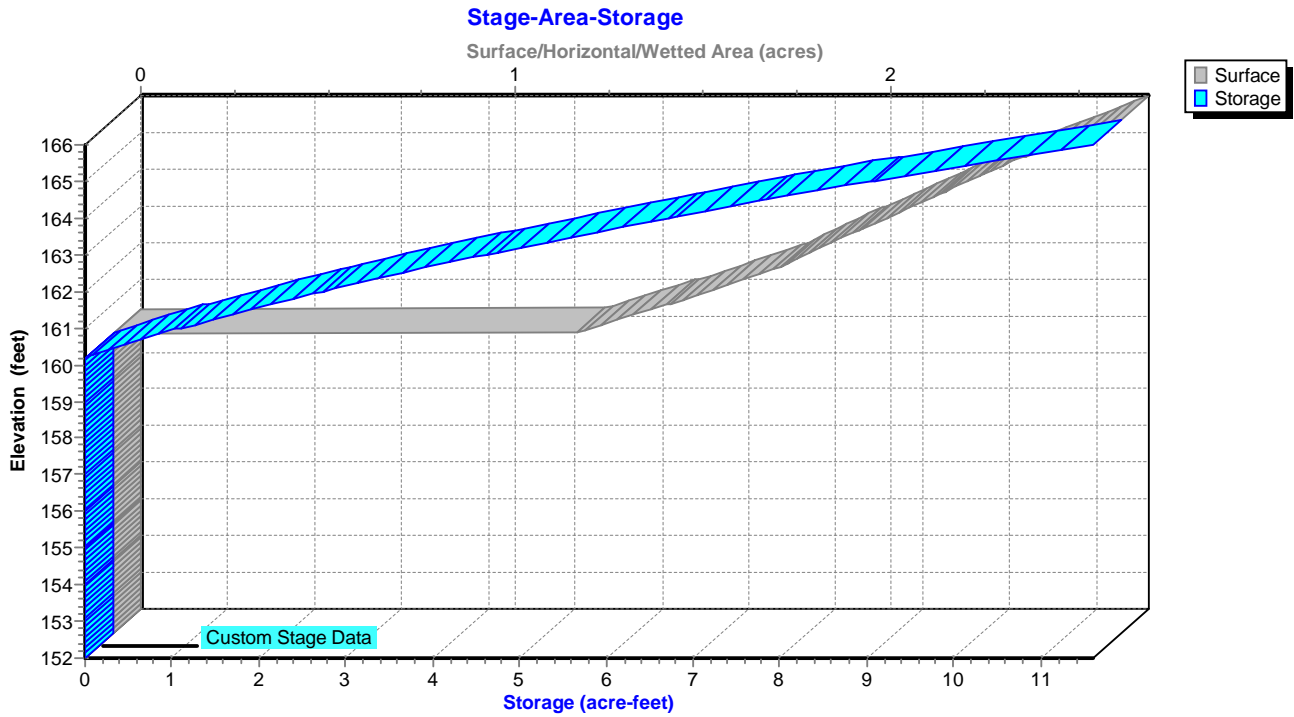
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Type III 24-hr 100-yr, 2070 Rainfall=10.15"

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Pond 1P: Titus Pond outlet control structure



South Hadley Titus Pond

Type III 24-hr 100yr (2022) Rainfall=7.99"

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Time span=5.00-36.00 hrs, dt=0.05 hrs, 621 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 7S: area 1

Runoff Area=205.000 ac 0.00% Impervious Runoff Depth=3.33"
Tc=200.0 min CN=60 Runoff=134.59 cfs 56.816 af

Pond 1P: Titus Pond outlet control structure Peak Elev=165.27' Storage=9.719 af Inflow=134.59 cfs 56.816 af
Outflow=129.99 cfs 56.689 af

Total Runoff Area = 205.000 ac Runoff Volume = 56.816 af Average Runoff Depth = 3.33"
100.00% Pervious = 205.000 ac 0.00% Impervious = 0.000 ac

South Hadley Titus Pond

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Type III 24-hr 100yr (2022) Rainfall=7.99"

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Summary for Subcatchment 7S: area 1

Runoff = 134.59 cfs @ 14.87 hrs, Volume= 56.816 af, Depth= 3.33"

Routed to Pond 1P : Titus Pond outlet control structure

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-36.00 hrs, dt= 0.05 hrs

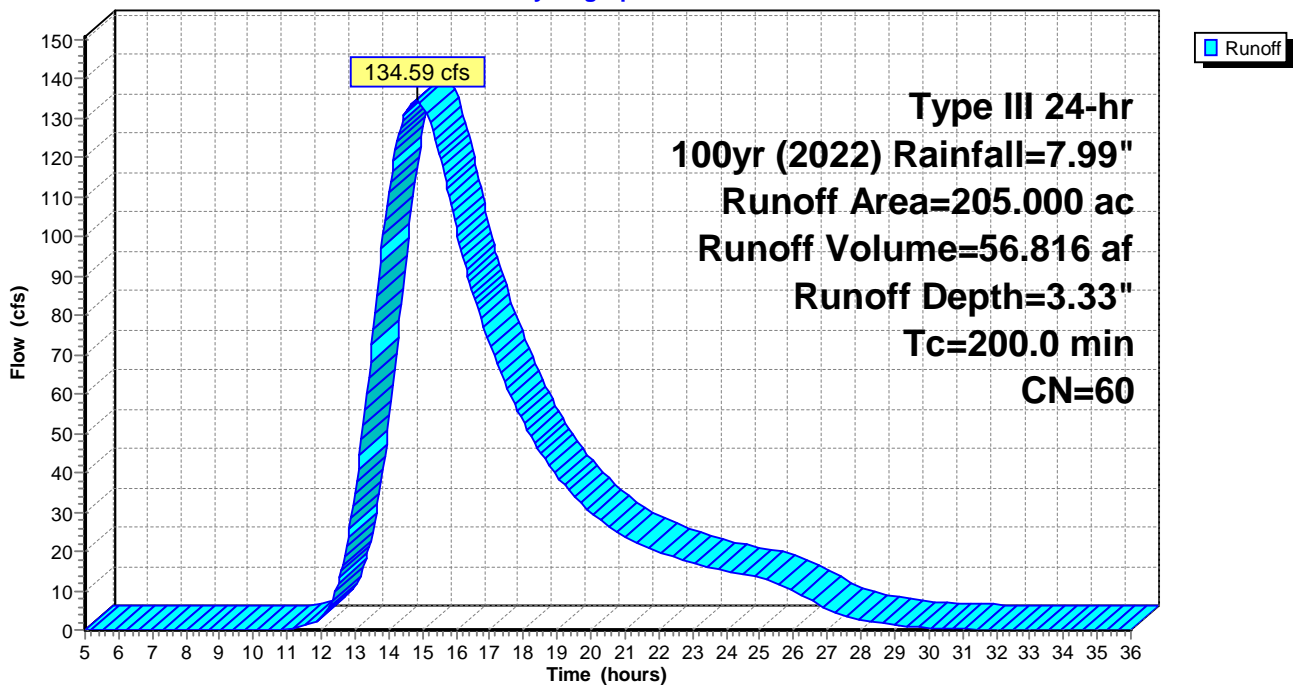
Type III 24-hr 100yr (2022) Rainfall=7.99"

Area (ac)	CN	Description
* 205.000	60	
205.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
200.0					Direct Entry,

Subcatchment 7S: area 1

Hydrograph



South Hadley Titus Pond

Type III 24-hr 100yr (2022) Rainfall=7.99"

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Summary for Pond 1P: Titus Pond outlet control structure

Inflow Area = 205.000 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100yr (2022) event
 Inflow = 134.59 cfs @ 14.87 hrs, Volume= 56.816 af
 Outflow = 129.99 cfs @ 15.19 hrs, Volume= 56.689 af, Atten= 3%, Lag= 19.1 min
 Primary = 129.99 cfs @ 15.19 hrs, Volume= 56.689 af
 Routed to nonexistent node 8R

Routing by Stor-Ind method, Time Span= 5.00-36.00 hrs, dt= 0.05 hrs
 Peak Elev= 165.27' @ 15.19 hrs Surf.Area= 2.501 ac Storage= 9.719 af

Plug-Flow detention time= 82.1 min calculated for 56.597 af (100% of inflow)
 Center-of-Mass det. time= 80.8 min (1,107.0 - 1,026.2)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	11.606 af	Custom Stage Data (Prismatic) Listed below (Recalc)

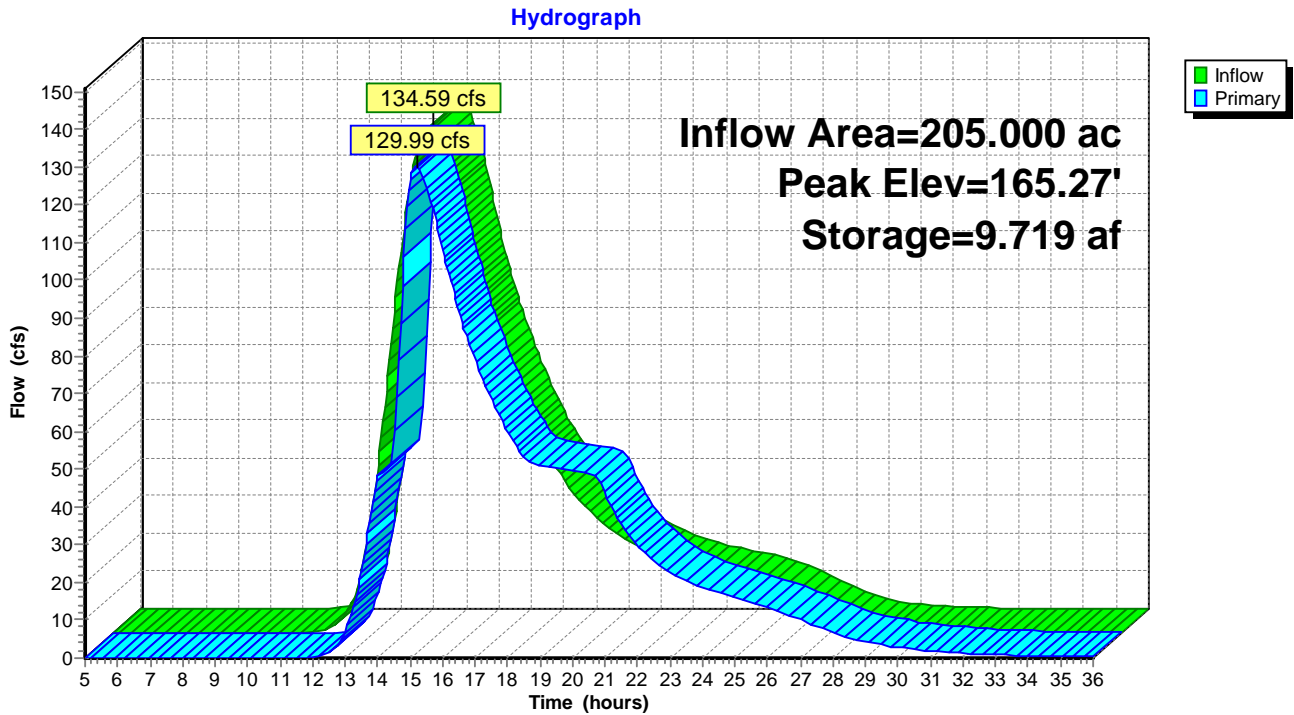
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
152.00	0.001	0.000	0.000
153.00	0.001	0.001	0.001
154.00	0.001	0.001	0.002
155.00	0.001	0.001	0.003
156.00	0.001	0.001	0.004
157.00	0.001	0.001	0.005
158.00	0.001	0.001	0.006
160.19	0.001	0.002	0.008
160.20	1.240	0.006	0.014
161.00	1.490	1.092	1.106
162.00	1.780	1.635	2.741
163.00	1.990	1.885	4.626
164.00	2.210	2.100	6.726
165.00	2.430	2.320	9.046
166.00	2.690	2.560	11.606

Device	Routing	Invert	Outlet Devices
#1	Primary	152.00'	24.0" Round Culvert L= 210.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 152.00' / 143.99' S= 0.0381 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Device 1	160.20'	36.0" W x 36.0" H Vert. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Primary	164.50'	Custom Weir/Orifice, Cv= 2.62 (C= 3.28) Head (feet) 0.00 0.50 1.50 Width (feet) 20.00 40.00 165.00

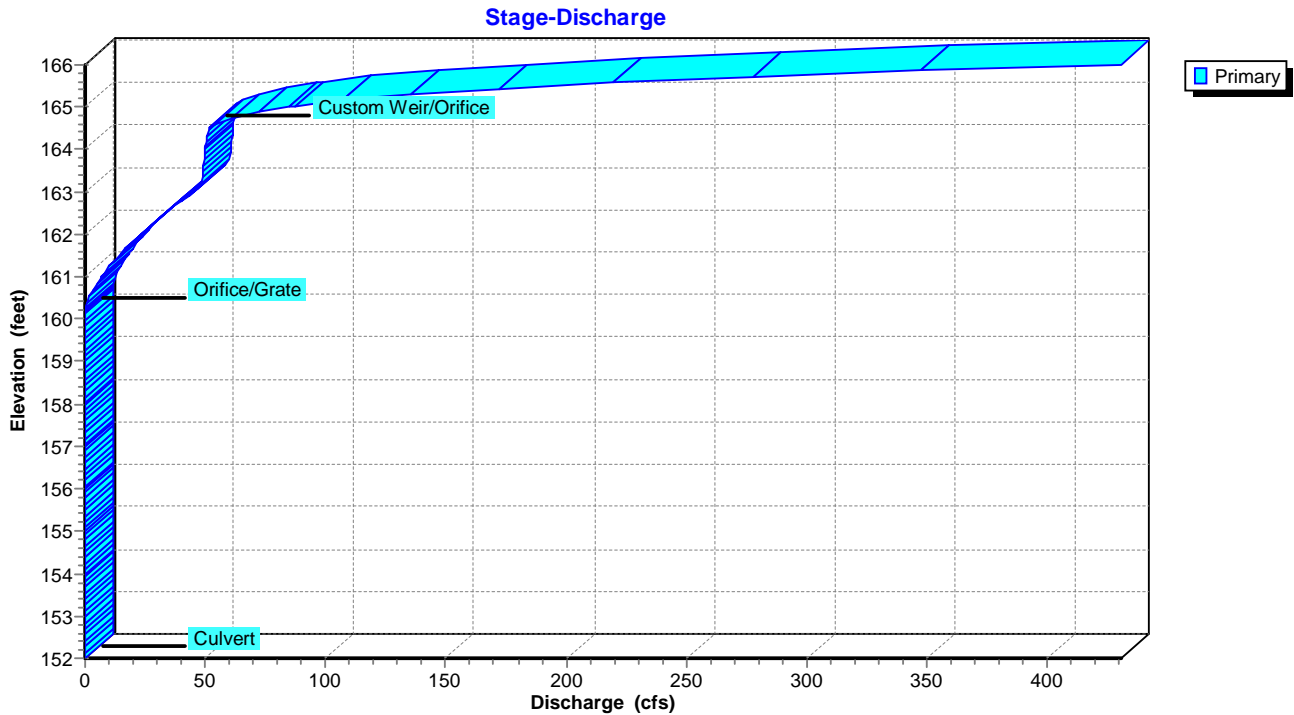
Primary OutFlow Max=129.29 cfs @ 15.19 hrs HW=165.27' (Free Discharge)

- 1=Culvert (Inlet Controls 52.99 cfs @ 16.87 fps)
- 2=Orifice/Grate (Passes 52.99 cfs of 81.29 cfs potential flow)
- 3=Custom Weir/Orifice (Weir Controls 76.30 cfs @ 2.50 fps)

Pond 1P: Titus Pond outlet control structure



Pond 1P: Titus Pond outlet control structure



South Hadley Titus Pond

Prepared by Fuss & O'Neill

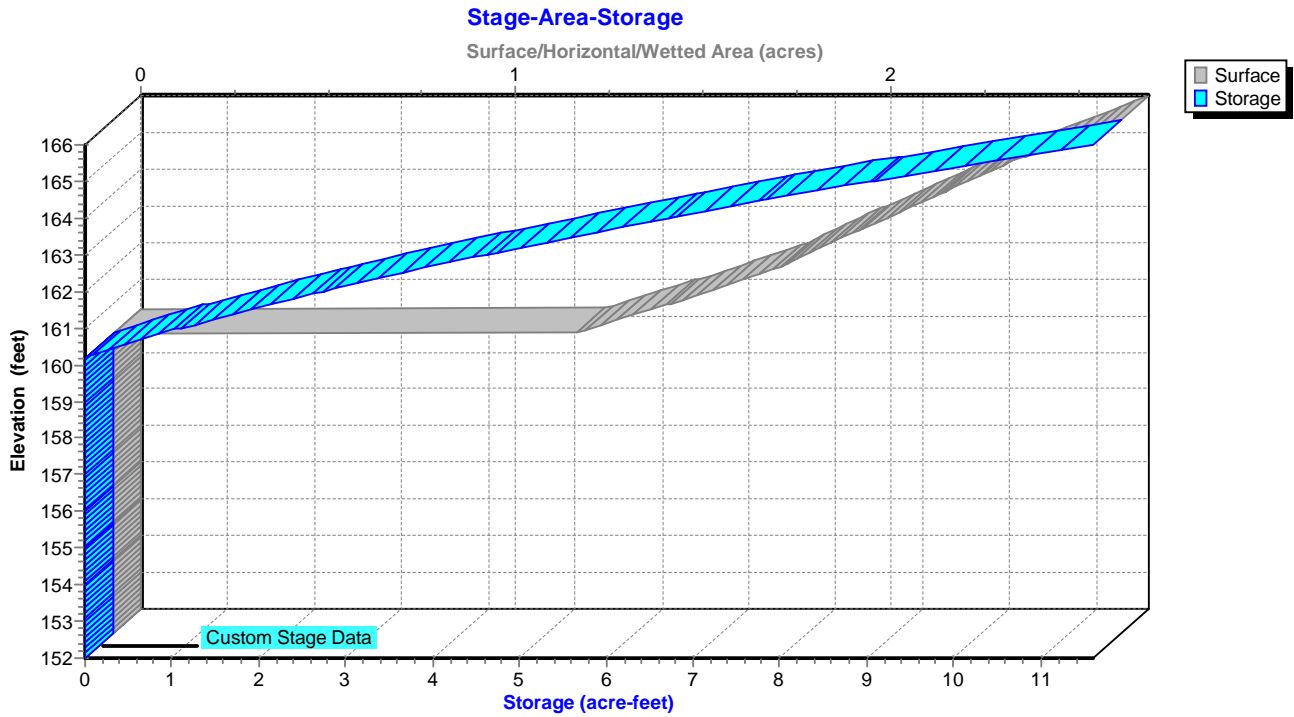
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Type III 24-hr 100yr (2022) Rainfall=7.99"

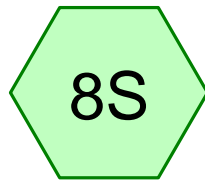
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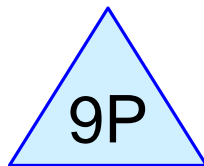
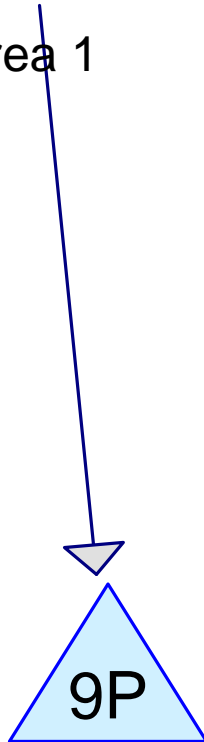
Pond 1P: Titus Pond outlet control structure



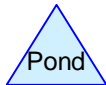
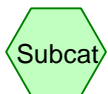
Proposed Conditions -
4/5/22 CMN, PA draft



area 1



24" RCP outlet



South Hadley Titus Pond

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Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	100-yr, 2070	Type III 24-hr		Default	24.00	1	10.15	2
2	100yr (2022)	Type III 24-hr		Default	24.00	1	7.99	2

South Hadley Titus Pond

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Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
205.000	60	(8S)
205.000	60	TOTAL AREA

South Hadley Titus Pond

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Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
205.000	Other	8S
205.000		TOTAL AREA

South Hadley Titus Pond

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Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	9P	152.00	143.99	210.0	0.0381	0.012	0.0	24.0	0.0

South Hadley Titus Pond

Type III 24-hr 100-yr, 2070 Rainfall=10.15"

Prepared by Fuss & O'Neill

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Time span=5.00-36.00 hrs, dt=0.05 hrs, 621 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 8S: area 1

Runoff Area=205.000 ac 0.00% Impervious Runoff Depth=5.02"
Tc=200.0 min CN=60 Runoff=206.63 cfs 85.766 af

Pond 9P: 24" RCP outlet

Peak Elev=165.54' Storage=13.533 af Inflow=206.63 cfs 85.766 af
Outflow=205.26 cfs 85.766 af

Total Runoff Area = 205.000 ac Runoff Volume = 85.766 af Average Runoff Depth = 5.02"
100.00% Pervious = 205.000 ac 0.00% Impervious = 0.000 ac

South Hadley Titus Pond

Prepared by Fuss & O'Neill

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Type III 24-hr 100-yr, 2070 Rainfall=10.15"

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Summary for Subcatchment 8S: area 1

Runoff = 206.63 cfs @ 14.70 hrs, Volume= 85.766 af, Depth= 5.02"

Routed to Pond 9P : 24" RCP outlet

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-36.00 hrs, dt= 0.05 hrs

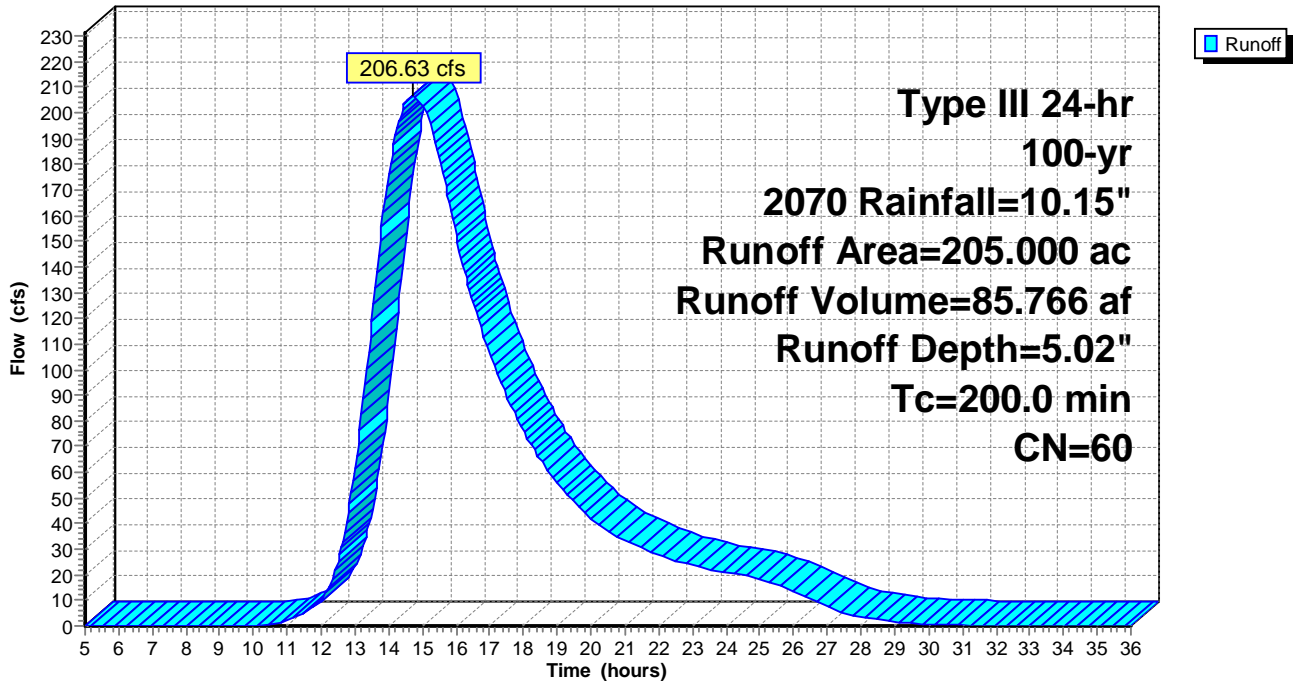
Type III 24-hr 100-yr, 2070 Rainfall=10.15"

Area (ac)	CN	Description
* 205.000	60	
205.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
200.0					Direct Entry,

Subcatchment 8S: area 1

Hydrograph



South Hadley Titus Pond

Type III 24-hr 100-yr, 2070 Rainfall=10.15"

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Summary for Pond 9P: 24" RCP outlet

Inflow Area = 205.000 ac, 0.00% Impervious, Inflow Depth = 5.02" for 100-yr, 2070 event
 Inflow = 206.63 cfs @ 14.70 hrs, Volume= 85.766 af
 Outflow = 205.26 cfs @ 14.94 hrs, Volume= 85.766 af, Atten= 1%, Lag= 14.6 min
 Primary = 205.26 cfs @ 14.94 hrs, Volume= 85.766 af

Routing by Stor-Ind method, Time Span= 5.00-36.00 hrs, dt= 0.05 hrs
 Peak Elev= 165.54' @ 14.94 hrs Storage= 13.533 af

Plug-Flow detention time= 80.8 min calculated for 85.766 af (100% of inflow)
 Center-of-Mass det. time= 80.8 min (1,094.9 - 1,014.1)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	14.717 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
152.00	0.000
153.00	0.017
154.00	0.050
155.00	0.106
156.00	0.216
157.00	0.516
158.00	1.086
159.00	1.888
160.00	2.903
161.00	4.206
162.00	5.843
163.00	7.728
164.00	9.829
165.00	12.153
166.00	14.717

Device	Routing	Invert	Outlet Devices
#1	Primary	152.00'	24.0" Round Culvert L= 210.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 152.00' / 143.99' S= 0.0381 '/ Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Primary	164.50'	Custom Weir/Orifice, Cv= 2.62 (C= 3.28) Head (feet) 0.00 0.50 1.50 Width (feet) 20.00 40.00 165.00

Primary OutFlow Max=204.09 cfs @ 14.94 hrs HW=165.54' (Free Discharge)

- 1=Culvert (Inlet Controls 53.56 cfs @ 17.05 fps)
- 2=Custom Weir/Orifice (Weir Controls 150.53 cfs @ 2.75 fps)

South Hadley Titus Pond

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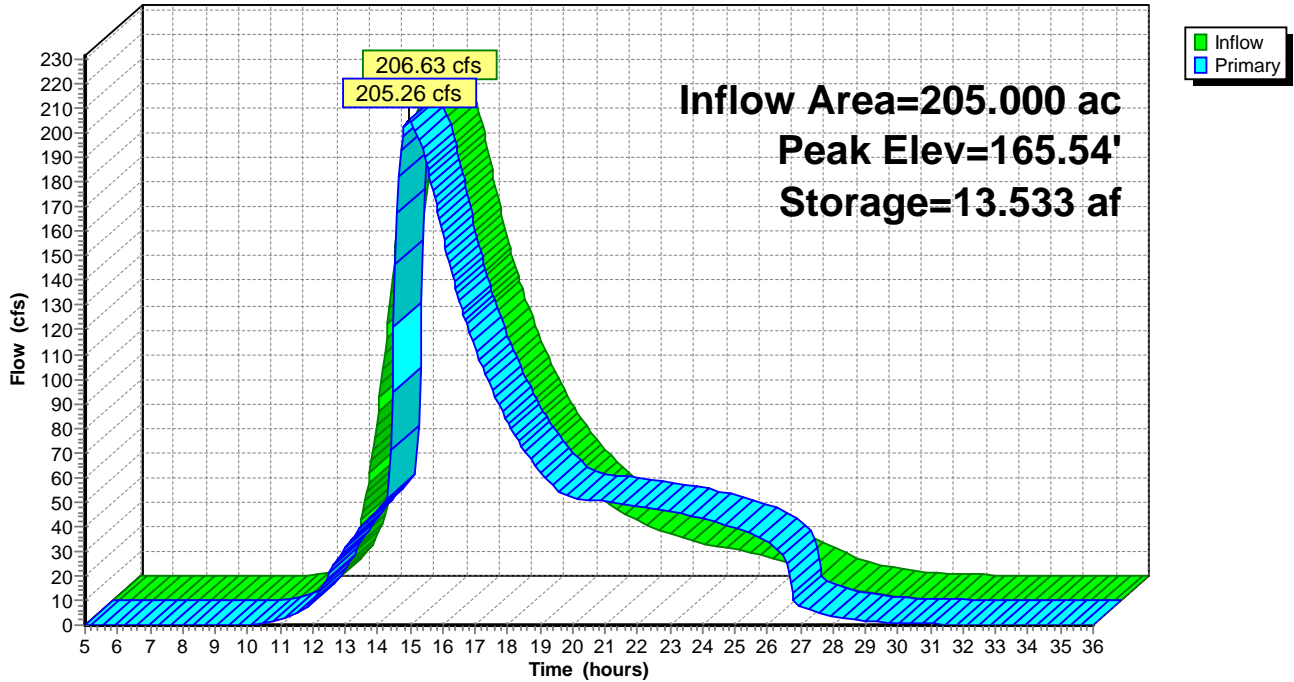
Type III 24-hr 100-yr, 2070 Rainfall=10.15"

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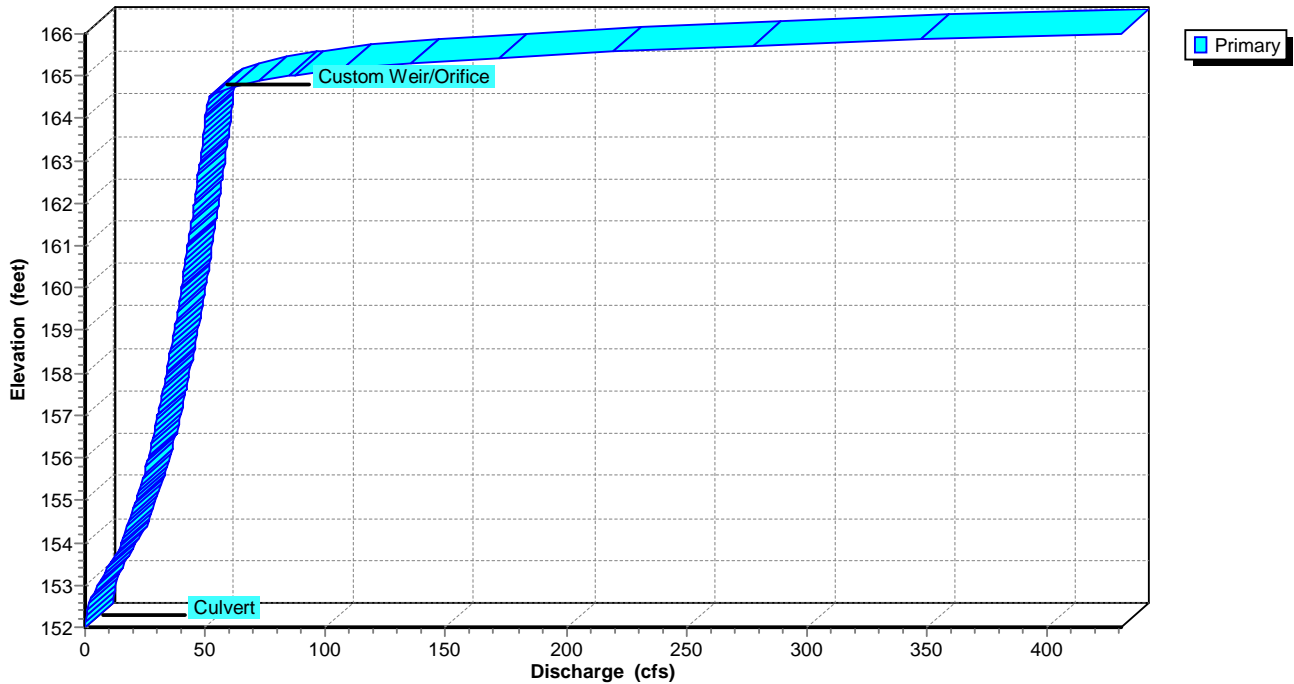
Pond 9P: 24" RCP outlet

Hydrograph



Pond 9P: 24" RCP outlet

Stage-Discharge



South Hadley Titus Pond

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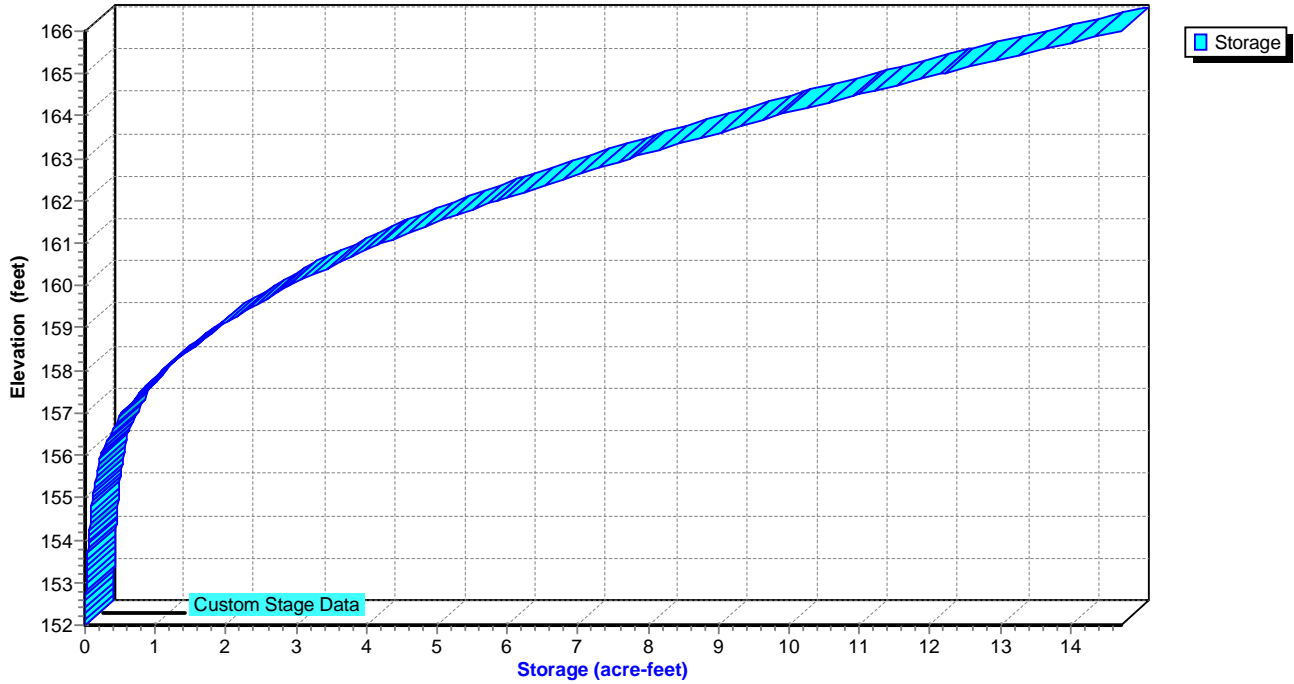
Type III 24-hr 100-yr, 2070 Rainfall=10.15"

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Pond 9P: 24" RCP outlet

Stage-Area-Storage



South Hadley Titus Pond

Type III 24-hr 100yr (2022) Rainfall=7.99"

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Time span=5.00-36.00 hrs, dt=0.05 hrs, 621 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 8S: area 1

Runoff Area=205.000 ac 0.00% Impervious Runoff Depth=3.33"
Tc=200.0 min CN=60 Runoff=134.59 cfs 56.816 af

Pond 9P: 24" RCP outlet

Peak Elev=165.19' Storage=12.636 af Inflow=134.59 cfs 56.816 af
Outflow=113.21 cfs 56.816 af

Total Runoff Area = 205.000 ac Runoff Volume = 56.816 af Average Runoff Depth = 3.33"
100.00% Pervious = 205.000 ac 0.00% Impervious = 0.000 ac

South Hadley Titus Pond

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Type III 24-hr 100yr (2022) Rainfall=7.99"

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Summary for Subcatchment 8S: area 1

Runoff = 134.59 cfs @ 14.87 hrs, Volume= 56.816 af, Depth= 3.33"

Routed to Pond 9P : 24" RCP outlet

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-36.00 hrs, dt= 0.05 hrs

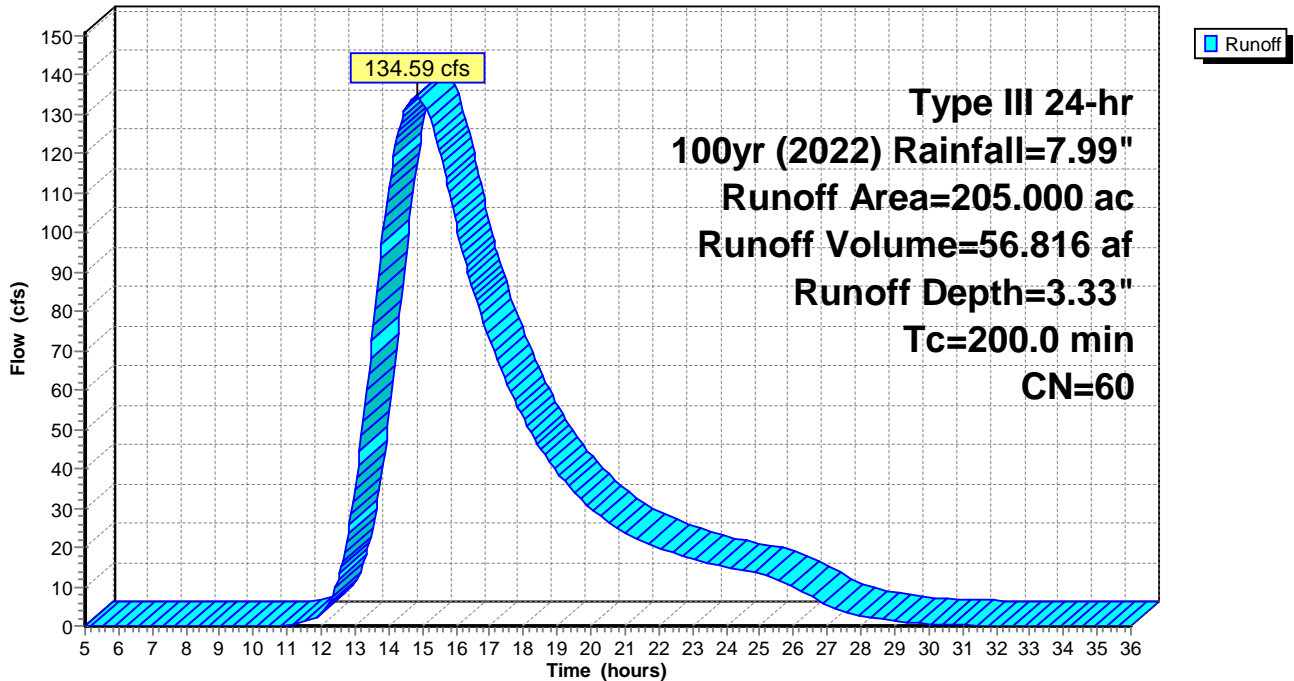
Type III 24-hr 100yr (2022) Rainfall=7.99"

Area (ac)	CN	Description
* 205.000	60	
205.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
200.0					Direct Entry,

Subcatchment 8S: area 1

Hydrograph



South Hadley Titus Pond

Type III 24-hr 100yr (2022) Rainfall=7.99"

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Summary for Pond 9P: 24" RCP outlet

Inflow Area = 205.000 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100yr (2022) event
 Inflow = 134.59 cfs @ 14.87 hrs, Volume= 56.816 af
 Outflow = 113.21 cfs @ 15.72 hrs, Volume= 56.816 af, Atten= 16%, Lag= 51.4 min
 Primary = 113.21 cfs @ 15.72 hrs, Volume= 56.816 af

Routing by Stor-Ind method, Time Span= 5.00-36.00 hrs, dt= 0.05 hrs
 Peak Elev= 165.19' @ 15.72 hrs Storage= 12.636 af

Plug-Flow detention time= 93.7 min calculated for 56.816 af (100% of inflow)
 Center-of-Mass det. time= 93.6 min (1,119.8 - 1,026.2)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	14.717 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
152.00	0.000
153.00	0.017
154.00	0.050
155.00	0.106
156.00	0.216
157.00	0.516
158.00	1.086
159.00	1.888
160.00	2.903
161.00	4.206
162.00	5.843
163.00	7.728
164.00	9.829
165.00	12.153
166.00	14.717

Device	Routing	Invert	Outlet Devices
#1	Primary	152.00'	24.0" Round Culvert L= 210.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 152.00' / 143.99' S= 0.0381 '/ Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Primary	164.50'	Custom Weir/Orifice, Cv= 2.62 (C= 3.28) Head (feet) 0.00 0.50 1.50 Width (feet) 20.00 40.00 165.00

Primary OutFlow Max=112.47 cfs @ 15.72 hrs HW=165.19' (Free Discharge)

- 1=Culvert (Inlet Controls 52.81 cfs @ 16.81 fps)
- 2=Custom Weir/Orifice (Weir Controls 59.66 cfs @ 2.41 fps)

South Hadley Titus Pond

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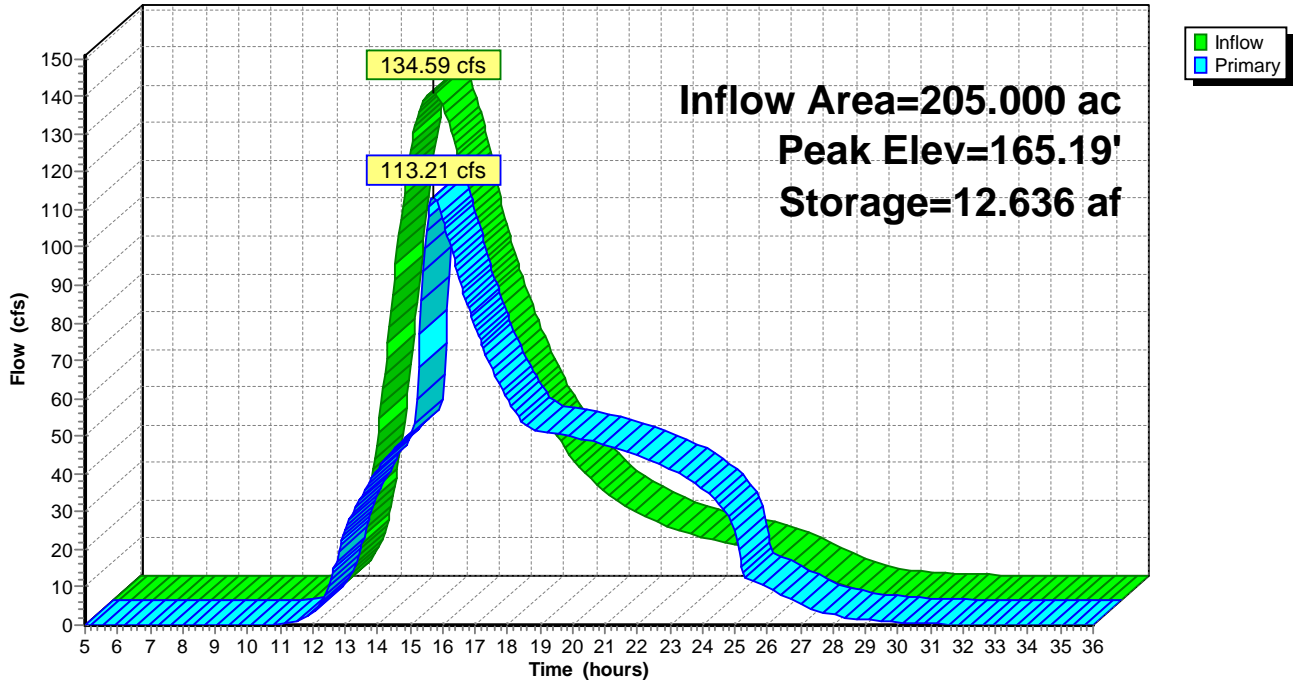
Type III 24-hr 100yr (2022) Rainfall=7.99"

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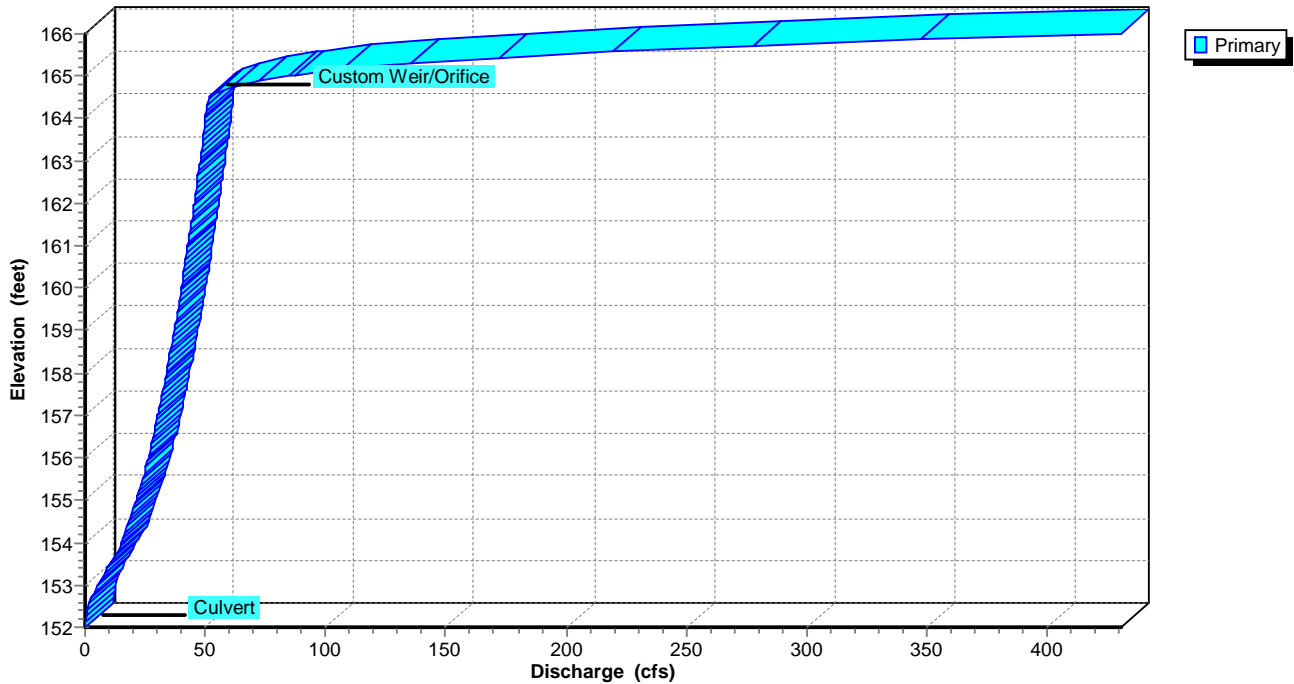
Pond 9P: 24" RCP outlet

Hydrograph



Pond 9P: 24" RCP outlet

Stage-Discharge



South Hadley Titus Pond

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Type III 24-hr 100yr (2022) Rainfall=7.99"

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Pond 9P: 24" RCP outlet

Stage-Area-Storage

